Department Name: Biotechnology

Program Name: M.Sc. in Biotechnology

Program Code: 303

Semester: Semester I √ Semester II Semester III Semester IV

Course Name: Biochemistry

Course Code: BIOT-CT- 101 (For new course keep it blank; else enter the old course code)

Course Credit: 4

Marks Allotted: Theoretical/Practical: 75 Continuing Evaluation: 25

Course Type (tick the correct alternatives):

Core √

Department Specific Elective

Generic Elective

Is the course focused on employability / entrepreneurship? YES √ O

Is the course focused on imparting life skill? YES NO √

Is the course based on Activity ? YES NO √

Percentage of change in syllabus (applicable in case of change in syllabus only)

Minor (up to 15%)

Moderate (>15% and up to 50%) √

Major (> 50%)

Summary of changes

Unit 7 has been completely changed and several new topics have been introduced. Some portions in unit 6 have been shifted to the Paper BIOT-CT 102.

PG BOS Meeting Reference Number: F.71/288/FCS/2022 Date: 18.04.22

Semester One

Course Code: BIOT-CT- 101

Course Name: Biochemistry

Credits: 4

Course Objectives:

The goal of this course is to build on postgraduate-level knowledge of biochemical principles, with a focus on various metabolic pathways. Within the context of each topic, the course will make students aware of numerous disease pathologies.

Student Learning Outcomes:

On completion of this course, students should be able to:

- Gain fundamental knowledge in biochemistry;
- Understand the molecular basis of various pathological conditions from the perspective of biochemical reactions.

Course Syllabus:

Unit I **Chemical basis of life**	Chemical basis of life: Miller-Urey experiment, abiotic formation of amino acid oligomers, composition of living matter; Water – properties of water, essential role of water for life on earth pH, buffer, maintenance of blood pH and pH of gastric juice, pH optima of different enzymes (pepsin, trypsin and alkaline phosphatase), ionization and hydrophobicity, emergent properties of biomolecules in water, biomolecular hierarchy, macromolecules, molecular assemblies.
Unit II **Protein structure**	Structure-function relationships: amino acids – structure and functional group properties, peptides and covalent structure of proteins, elucidation of primary and higher order structures, Ramachandran plot, evolution of protein structure, protein degradation and introduction to molecular pathways controlling protein degradation, structure-function relationships in model proteins like ribonuclease A, myoglobin, hemoglobin, chymotrypsin etc.; basic principles of protein purification; tools to characterize expressed proteins; Protein folding: Anfinsen's Dogma, Levinthal paradox, cooperativity in protein folding, free energy landscape of protein folding and pathways of protein folding, molten globule state, chaperons, diseases associated with protein folding, introduction to molecular dynamic simulation.
Unit III **Enzyme kinetics**	Enzyme catalysis – general principles of catalysis; quantitation of enzyme activity and efficiency; enzyme characterization and Michaelis-Menten kinetics; relevance of enzymes in metabolic regulation, activation, inhibition and covalent modification; single substrate enzymes; concept of catalytic antibodies; catalytic strategies with specific examples of proteases, carbonic anhydrases, allosteric enzymes; regulatory strategies with specific example of hemoglobin; isozymes; role of covalent modification in enzymatic activity; zymogens.

Unit IV **Glycobiology**	Sugars - mono, di, and polysaccharides with specific reference to glycogen, amylose and cellulose, glycosylation of other biomolecules - glycoproteins and glycolipids; lipids - structure and properties of important members of storage and membrane lipids; lipoproteins.
Unit V **Structure and functions of DNA & RNA and lipids**	Self-assembly of lipids, micelle, biomembrane organization - sidedness and function; membrane bound proteins - structure, properties and function; transport phenomena; nucleosides, nucleotides, nucleic acids - structure, a historical perspective leading up to the proposition of DNA double helical structure; difference in RNA and DNA structure and their importance in evolution of DNA as the genetic material.
Unit VI **Bioenergetics**	Bioenergetics-basic principles; equilibria and concept of free energy; coupled interconnecting reactions in metabolism; oxidation of carbon fuels; recurring motifs in metabolism; allosteric enzymes; glycolysis and gluconeogenesis; reciprocal regulations and non-carbohydrate sources of glucose; phosphorylation; F1-F0 ATP Synthase; shuttles across mitochondria; Citric acid cycle, entry to citric acid cycle, citric acid cycle as a source of biosynthetic precursors; Oxidative phosphorylation; importance of electron transfer in oxidative phosphorylation; F1-F0 ATP Synthase; shuttles across mitochondria; regulation of oxidative phosphorylation; Photosynthesis- chloroplast and two photosystems; proton gradient across thylakoid membrane; Calvin cycle and pentose phosphate pathway; glycogen metabolism, reciprocal control of glycogen synthesis and breackdown, roles of epinephrine and glucagon and insulin in glycogen metabolism; Fatty acid metabolism; protein turnover and amino acid catabolism; nucleotide biosynthesis; biosynthesis of membrane lipids and sterols with specific emphasis on cholesterol metabolism and mevalonate pathway; elucidation of metabolic pathways; logic and integration of central metabolism; entry/ exit of various biomolecules from central pathways; principles of metabolic regulation; steps for regulation; target of rapamycin (TOR) & Autophagy regulation in relation to C & N metabolism, starvation responses and insulin signaling.
Unit VII **Chromatographic techniques**	Chromatographic methods for separation of macromolecules, reverse phase, hydrophobic, affinity chromatography, HPLC, criteria of protein purity; Electrophoretic techniques: Theory and application of PAGE and SDS PAGE., 2D electrophoresis, pulse field gel electrophoresis

Suggested Readings:

1. Stryer, L. (2015). Biochemistry. (8th ed.) New York: Freeman.
2. Lehninger, A. L. (2012). Principles of Biochemistry (6th ed.). New York, NY: Worth.
3. Voet, D., & Voet, J. G. (2016). Biochemistry (5th ed.). Hoboken, NJ: J. Wiley & Sons.
4. Dobson, C. M. (2003). Protein Folding and Misfolding. Nature, 426(6968), 884-890. doi:10.1038/nature02261.
5. Richards, F. M. (1991). The Protein Folding Problem. Scientific American, 264(1), 54-63. doi:10.1038/scientificamerican0191-54.

Department Name: Biotechnology

Program Name: M.Sc. in Biotechnology

Program Code: 303

Semester: Semester I [√] Semester II Semester III Semester IV

Course Name: Cell and Molecular Biology

Course Code: BIOT-CT- 102 (For new course keep it blank; else enter the old course code)

Course Credit: 4

Marks Allotted: Theoretical/Practical: 75 Continuing Evaluation: 25

Course Type (tick the correct alternatives):

Core [√]

Department Specific Elective

Generic Elective

Is the course focused on employability / entrepreneurship? YES [√] NO

Is the course focused on imparting life skill? YES NO [√]

Is the course based on Activity ? YES NO [√]

Percentage of change in syllabus (applicable in case of change in syllabus only)

Minor (up to 15%)

Moderate (>15% and up to 50%) [√]

Major (> 50%)

Summary of changes

Unit II- 'Telomerase and its role in termination' incorporated.

Unit III- 'Protein sorting' incorporated

Unit IV- Introduction to GPCR, Inositol/DAG/PKC and Ca2+ signaling' incorporated.

PG BOS Meeting Reference Number: F.71/288/FCS/2022 Date: 18.04.22

Course Code: BIOT-CT- 102

Course Name: Cell and Molecular Biology

Credits: 4

Course Objectives:

The goal of this course is to make students aware that as we progress down the scale of magnitude from cells to organelles to molecules, our comprehension of numerous biological processes gets more comprehensive.

Student Learning Outcomes:

Student should be equipped to understand three fundamental aspects in biological phenomenon: a) what to seek; b) how to seek; c) why to seek?

Course Syllabus:

Unit I **Dynamic organization of cell**	Universal features of cells; cell chemistry and biosynthesis: chemical organization of cells; internal organization of the cell - cell membranes: structure of cell membranes and concepts related to compartmentalization in eukaryotic cells; intracellular organelles: endoplasmic reticulum and Golgi apparatus, lysosomes and peroxisomes, ribosomes, cellular cytoskeleton, mitochondria, chloroplasts and cell energetics; nuclear compartment: nucleus, nucleolus and chromosomes.
Unit II **Chromatin structure and dynamics**	Organization of Prokaryotic and Eukaryotic Genome; DNA-replication: structure and assembly of eukaryotic and prokaryotic DNA polymerase, Initiation, elongation and termination of replication in prokaryotes, Telomerase and its role in termination; Transcription: Structure and assembly of eukaryotic and prokaryotic RNA Polymerases; trancriptional initiation, elongation and termination; RNA processing; transcriptional control: promoters and enhancers, transcription factors as activators and repressors; transcription and post-transcriptional control; breakdown of selective and specific mRNAs through interference by small non-coding RNAs (miRNAs and siRNAs),mRNA flow through nuclear envelope into cytoplasm; protein translation machinery; ribosomes-composition and assembly; universal genetic codes, degeneracy of codons, Wobble hypothesis; Iso-accepting tRNA; mechanism of initiation, elongation and termination; co- and post-translational modifications, mitochondrial genetic code translation product cleavage, modification and activation.
Unit III **Cellular signalling, transport and trafficking**	Molecular mechanisms of membrane transport, nuclear transport, transport across mitochondria and chloroplasts; intracellular vesicular trafficking from endoplasmic reticulum through Golgi apparatus to lysosomes/cell exterior; protein sorting
Unit IV **Cellular processes**	Cell cycle and its regulation; cell division: mitosis, meiosis and cytokinesis; cell differentiation: stem cells, their differentiation into different cell types and organization into specialized tissues; cell-ECM and cell-cell interactions; cell motility and migration; cell death: different modes of cell death and their

	regulation.Introduction to GPCR, Inositol/DAG//PKC and Ca++ signaling pathways;
Unit V **Manipulating and studying cells**	Isolation of cells and basics of cell culture; observing cells under a microscope, different types of microscopy; analyzing and manipulating DNA, RNA and proteins.
Unit VI **Genome instability and cell transformation**	Mutations, proto-oncogenes, oncogenes and tumour suppressor genes, physical, chemical and biological mutagens; types of mutations; intra-genic and intergenic suppression; transpositions- transposable genetic elements in prokaryotes and eukaryotes, role of transposons in genome; viral and cellular oncogenes; tumor suppressor genes; structure, function and mechanism of action; activation and suppression of tumor suppressor genes; oncogenes as transcriptional activators.

Suggested Readings:

1. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2008).
2. Molecular Biology of the Cell (5th Ed.). New York: Garland Science.
3. Lodish, H. F. (2016). Molecular Cell Biology (8th Ed.). New York: W.H. Freeman.
4. Krebs, J. E., Lewin, B., Kilpatrick, S. T., & Goldstein, E. S. (2014). Lewin's Genes XI. Burlington, MA: Jones & Bartlett Learning.
5. Cooper, G. M., & Hausman, R. E. (2013). The Cell: a Molecular Approach (6th Ed.). Washington: ASM ; Sunderland.
6. Hardin, J., Bertoni, G., Kleinsmith, L. J., & Becker, W. M. (2012). Becker's World of the Cell. Boston (8th Ed.). Benjamin Cummings.
7. Watson, J. D. (2008). Molecular Biology of the Gene (5th ed.). Menlo Park, CA: Benjamin/Cummings.

Department Name: Biotechnology

Program Name: M.Sc. in Biotechnology

Program Code: 303

Semester: Semester I √ Semester II Semester III Semester IV

Course Name: Microbiology and Genetics

Course Code: BIOT-CT- 103 (For new course keep it blank; else enter the old course code)

Course Credit: 4

Marks Allotted: Theoretical/Practical: 75 Continuing Evaluation: 25

Course Type (tick the correct alternatives):

Core √

Department Specific Elective

Generic Elective

Is the course focused on employability / entrepreneurship? YES √ NO

Is the course focused on imparting life skill? YES NO √

Is the course based on Activity ? YES NO √

Percentage of change in syllabus (applicable in case of change in syllabus only)

Minor (up to 15%)

Moderate (>15% and up to 50%) √

Major (> 50%)

Summary of changes

A new course paper is created with merging of Microbiology with genetics. The rationality of this merger lay on the solid foundation of bacterial genetics. Curriculum of Genetics progressed from bacterial and viral genetics to yeast genetics to Drosophila genetics to plant genetics. On the whole, credit increased from 3 to 4.

PG BOS Meeting Reference Number: F.71/288/FCS/2022 Date: 18.04.22

Course Code: BIOT-CT- 103

Course Name: Microbiology and Genetics

Credits: 4

Course Objectives:

The goals of this course are to introduce students to the field of microbiology, with a focus on microbial diversity, morphology, physiology, and nutrition; methods for controlling microbes and host-microbe interactions; and basic genetics and classical genetics, including prokaryotic/phage genetics, yeast, and higher eukaryotic domains. Students will be exposed to concepts of population genetics, quantitative genetics embracing complex characteristics, clinical genetics, and genetics of evolution in addition to all classical Mendelian genetics principles.

Student Learning Outcomes:

Students should be able to:

- Identify major categories of microorganisms and analyze their classification, diversity, and ubiquity;
- Identify and demonstrate structural, physiological, genetic similarities and differences of major categories of microorganisms;
- Identify and demonstrate how to control microbial growth;
- Demonstrate and evaluate interactions between microbes, hosts and environment.
- Describe fundamental molecular principles of genetics;
- Understand relationship between phenotype and genotype in human genetic traits;
- Describe the basics of genetic mapping;
- Understand how gene expression is regulated.

Course Syllabus:

Unit I **Microbial characteristics**	Introduction to microbiology and microbes, history & scope of microbiology, morphology, structure, growth and nutrition of bacteria, bacterial growth curve, bacterial culture methods; bacterial genetics: mutation and recombination in bacteria, plasmids, transformation, transduction and conjugation; antimicrobial resistance.
Unit II **Microbial diversity**	Microbial taxonomy and evolution of diversity, classification of microorganisms, criteria for classification; classification of bacteria; Cyanobacteria, acetic acid bacteria, Pseudomonads, lactic and propionic acid bacteria, endospore forming bacteria, Mycobacteria and Mycoplasma. Archaea: Halophiles, Methanogens, Hyperthermophilic archae, Thermoplasm; eukarya: algae, fungi, slime molds and protozoa; extremophiles and unculturable microbes.
Unit III **Control of microorganisms**	Sterilization, disinfection and antisepsis: physical and chemical methods for control of microorganisms, antibiotics, antiviral and antifungal drugs, biological control of microorganisms.
Unit IV	Virus and bacteriophages, general properties of viruses, viral structure,

Virology	taxonomy of virus, viral replication, cultivation and identification of viruses; sub-viral particles – viroids and prions.
Unit V **Host-microbes interaction**	Host-pathogen interaction, ecological impact of microbes; symbiosis (Nitrogen fixation and ruminant symbiosis); microbes and nutrient cycles; microbial communication system; bacterial quorum sensing; microbial fuel cells; prebiotics and probiotics.
Unit VI **Genetics of bacteria and bacteriophages**	Concept of a gene in pre-DNA era; mapping of genes in bacterial and phage chromosomes by classical genetic crosses; fine structure analysis of a gene; genetic complementation and other genetic crosses using phenotypic markers; phenotype to genotype connectivity prior to DNA-based understanding of gene.
Unit VII **Yeast genetics**	Meiotic crosses, tetrad analyses, non-Mendelian and Mendelian ratios, gene conversion, models of genetic recombination, yeast mating type switch; dominant and recessive genes/mutations, suppressor or modifier screens, complementation groups, transposon mutagenesis, synthetic lethality, genetic epistasis.
Unit VIII **Drosophila genetics as a model of higher eukaryotes**	Monohybrid & dihybrid crosses, back-crosses, test-crosses, analyses of autosomal and sex linkages, screening of mutations based on phenotypes and mapping the same, hypomorphy, genetic mosaics, genetic epistasis in context of developmental mechanism.
Unit IX **Plant genetics**	Laws of segregation in plant crosses, inbreeding, selfing, heterosis, maintenance of genetic purity, gene pyramiding.

Suggested Readings:

1. Pelczar, M. J., Reid, R. D., & Chan, E. C. (2001). Microbiology (5th ed.). New York: McGraw-Hill.
2. Willey, J. M., Sherwood, L., Woolverton, C. J., Prescott, L. M., & Willey, J. M. (2011).
3. Prescott's Microbiology. New York: McGraw-Hill.
4. Matthai, W., Berg, C. Y., & Black, J. G. (2005). Microbiology, Principles and Explorations. Boston, MA: John Wiley & Sons.
5. Hartl, D. L., & Jones, E. W. (1998). Genetics: Principles and Analysis. Sudbury, MA: Jones and Bartlett.
6. Pierce, B. A. (2005). Genetics: a Conceptual Approach. New York: W.H. Freeman.
7. Tamarin, R. H., & Leavitt, R. W. (1991). Principles of Genetics. Dubuque, IA: Wm. C. Brown.
8. Smith, J. M. (1998). Evolutionary Genetics. Oxford: Oxford University Press.

Department Name: Biotechnology

Program Name: M.Sc. in Biotechnology

Program Code: 303

Semester: Semester I √ Semester II Semester III Semester IV

Course Name: Laboratory I: Biochemistry & Analytical Techniques

Course Code: BIOT-CP- 104 (For new course keep it blank; else enter the old course code)

Course Credit: 4

Marks Allotted: Theoretical/Practical: 75 Continuing Evaluation: 25

Course Type (tick the correct alternatives):

Core √

Department Specific Elective

Generic Elective

Is the course focused on employability / entrepreneurship? YES √ NO

Is the course focused on imparting life skill? YES NO √

Is the course based on Activity ? YES √ NO

Percentage of change in syllabus (applicable in case of change in syllabus only)

Minor (up to 15%)

Moderate (>15% and up to 50%) √

Major (> 50%)

Summary of changes

Mass spectrometry methods have been modified to improve practicality and student benefit

PG BOS Meeting Reference Number: F.71/288/FCS/2022 Date: 18.04.22

Course Code: BIOT-CP- 104

Course Name: Laboratory I: Biochemistry & Analytical Techniques

Credits: 4

Course Objectives:

The goal of this laboratory course is to introduce students to biochemistry experiments. The principal objective of the course is to teach students how to use a set of experimental procedures in biochemistry to solve problems.

Student Learning Outcomes:

On completion of this course, students should be able to:

- To elaborate concepts of biochemistry with easy to run experiments;
- To familiarize with basic laboratory instruments and understand the principle of measurements using those instruments with experiments in biochemistry.

Course Syllabus:

1. Preparing various stock solutions and working solutions that will be needed for the course.
2. To prepare an Acetic-Na Acetate Buffer and validate the Henderson-Hasselbach equation.
3. To determine an unknown protein concentration by plotting a standard graph of BSA using UV-Vis Spectrophotometer and validating the Beer- Lambert's Law.
4. Titration of Amino Acids and separation of aliphatic, aromatic and polar amino acids by thin layer chromatography.
5. Purification and characterization of an enzyme from a recombinant source (such as Alkaline Phosphatase or Lactate Dehydrogenase or any enzyme of the institution's choice).
    a) Preparation of cell-free lysates
    b) Ammonium Sulfate precipitation
    c) Ion-exchange Chromatography
    d) Gel Filtration
    e) Affinity Chromatography
    f) Dialysis of the purified protein solution against 60% glycerol as a demonstration of storage method
    g) Generating a Purification Table (protein concentration, amount of total protein; Computing specific activity of the enzyme preparation at each stage of purification)
    h) Assessing purity of samples from each step of purification by SDS-PAGE Gel Electrophoresis
    i) Enzyme Kinetic Parameters: Km, Vmax and Kcat.
6. Experimental verification that absorption at OD260 is more for denatured DNA as compared to native double stranded DNA. reversal of the same following DNA renaturation. Kinetics of DNA renaturation as a function of DNA size.
7. Identification of an unknown sample as DNA, RNA or protein using available laboratory tools. (Optional Experiments)

Department Name: Biotechnology

Program Name: M.Sc. in Biotechnology

Program Code: 303

Semester: Semester I √ Semester II Semester III Semester IV

Course Name: Laboratory II: Microbiology

Course Code: BIOT-CP- 105 (For new course keep it blank; else enter the old course code)

Course Credit: 4

Marks Allotted: Theoretical/Practical: 75 Continuing Evaluation: 25

Course Type (tick the correct alternatives):

Core √

Department Specific Elective

Generic Elective

Is the course focused on employability / entrepreneurship? YES √ NO

Is the course focused on imparting life skill? YES NO √

Is the course based on Activity ? YES √ NO

Percentage of change in syllabus (applicable in case of change in syllabus only)

Minor (up to 15%)

Moderate (>15% and up to 50%) √

Major (> 50%)

Summary of changes

There has been major revision (>50%) in the syllabus. We have re-designed the syllabus around a few major concepts-proper use of aseptic techniques, bacterial staining and microscopy, bacterial metabolism, and control of microbial growth.

PG BOS Meeting Reference Number: F.71/288/FCS/2022 Date: 18.04.22

Course Code: BIOT-CP- 105

Course Name: Laboratory II: Microbiology

Credits: 4

Course Objectives:

The objective of this laboratory course is to provide practical skills on basic microbiological techniques.

Student Learning Outcomes:

Students should be able to:

- Isolate, characterize and identify common bacterial organisms;
- Determine bacterial load of different samples;
- Perform antimicrobial sensitivity tests;
- Preserve bacterial cultures.

Course Syllabus:

1. Microbiology Laboratory: Basic rules and requirements.
2. Media preparation and plating techniques.
3. Preparation of different media for cultivation of bacteria: synthetic media, complex media, selective media.
4. Isolation of pure culture of bacteria by streaking method.
5. Estimation of CFU count by spread plate and pour plate method.
6. Study of colony and growth characteristics of some common bacteria: Bacillus, E. coli, Staphylococcus, Streptococcus, etc.
7. Biochemical tests for identification of bacteria.
8. Staining: Gram's staining, Capsule staining, Endospore staining
9. Antimicrobial sensitivity test (Kirby-Bauer Method) or Disc diffusion methods and demonstration of drug resistance.
10. Preservation of bacterial cultures by various techniques.
11. Isolation and identification of bacteria from soil/water samples.

Suggested Readings:

1. Cappuccino, J. G., & Welsh, C. (2016). Microbiology: a Laboratory Manual. Benjamin-Cummings Publishing Company.
2. Collins, C. H., Lyne, P. M., Grange, J. M., & Falkinham III, J. (2004). Collins and Lyne's Microbiological Methods (8th ed.). Arnolds.
3. Tille, P. M., & Forbes, B. A. Bailey & Scott's Diagnostic Microbiology.

Department Name: Biotechnology

Program Name: M.Sc. in Biotechnology

Program Code: 303

Semester: Semester I √ Semester II Semester III Semester IV

Course Name: Basics of Chemistry and Physics

Course Code: BIOT-DSE-106 (For new course keep it blank; else enter the old course code)

Course Credit: 2

Marks Allotted: Theoretical/Practical: 42 Continuing Evaluation: 8

Course Type (tick the correct alternatives):

Core

Department Specific Elective √

Generic Elective

Is the course focused on employability / entrepreneurship? YES √ NO

Is the course focused on imparting life skill? YES NO √

Is the course based on Activity ? YES NO √

Percentage of change in syllabus (applicable in case of change in syllabus only)

Minor (up to 15%)

Moderate (>15% and up to 50%)

Major (> 50%)

Summary of changes

The course code has been changed.

PG BOS Meeting Reference Number: F.71/288/FCS/2022 Date: 18.04.22

Course Code: BIOT-DSE- 106

Course Name: Basics of Chemistry and Physics

Credits: 2

Course Objectives:

The objectives of this course are to cover all essentials required to appreciate physico-chemical principles underlying biological processes.

Student Learning Outcomes:

Students should be able to have a firm foundation in fundamentals and application of current chemical and physical scientific theories.

Course Syllabus:

Unit I **Basic physics for biologists**	Physical quantities and their dynamics: definitions and dimensions; vectors & scalars, displacement, velocity, acceleration, kinematic formulas, angular momentum, torque, force, power, work, energy (kinetic & potential/electric charge separation, electromagnetic spectrum, photons etc.); springs & Hookes laws; elastic and inelastic collisions; Newton's law of motions (centripetal and centrifugal forces etc.); simple harmonic motions, mechanical waves, Doppler effect, wave interference, amplitude, period, frequency & wavelength; diffusion, dissipation, random walks, and directed motions in biological systems; low Reynolds number - world of Biology, buoyant forces, Bernoulli's equation, viscosity, turbulence, surface tension, adhesion; laws of thermodynamics: Maxwell Boltzmann distribution, conduction, convection and radiation, internal energy, entropy, temperature and free energy, Maxwell's demon (entropic forces at work in biology, chemical assemblies, self-assembled systems, role of ATP); Coulomb's law, conductors and insulators, electric potential energy of charges, nerve impulses, voltage gated channels, ionic conductance; Ohms law (basic electrical quantities: current, voltage & power), electrolyte conductivity, capacitors and capacitance, dielectrics; various machines in biology i.e. enzymes, allostery and molecular motors (molecules to cells and organisms).
Unit II **Basic chemistry for biologists**	Basic constituents of matter - elements, atoms, isotopes, atomic weights, atomic numbers, basics of mass spectrometry, molecules, Avogadro number, molarity, gas constant, molecular weights, structural and molecular formulae, ions and polyatomic ions; chemical reactions, reaction stoichiometry, rates of reaction, rate constants, order of reactions, Arrhenious equation, Maxwell Boltzmann distributions, rate- determining steps, catalysis, free-energy, entropy and enthalpy changes during reactions; kinetic versus thermodynamic controls of a reaction, reaction equilibrium (equilibrium constant); light and matter interactions (optical spectroscopy, fluorescence, bioluminescence, paramagnetism and diamagnetism, photoelectron spectroscopy; chemical bonds (ionic, covalent, Van der Walls forces); electronegativity, polarity; VSEPR theory and molecular geometry, dipole moment, orbital hybridizations; states of matter - vapor pressure, phase diagrams, surface tension, boiling and

	melting points, solubility, capillary action, suspensions, colloids and solutions; acids, bases and pH - Arrhenious theory, pH, ionic product of water, weak acids and bases, conjugate acid-base pairs, buffers and buffering action etc; chemical thermodynamics - internal energy, heat and temperature, enthalpy (bond enthalpy and reaction enthalpy), entropy, Gibbs free energy of ATP driven reactions, spontaneity versus driven reactions in biology; redox reactions and electrochemistry - oxidation-reduction reactions, standard cell potentials, Nernst equation, resting membrane potentials, bond rotations and molecular conformations - Newman projections, conformational analysis of alkanes, alkenes and alkynes; functional groups, optically asymmetric carbon centers

Suggested Readings:

1. Baaquie, B. E. (2000). Laws of Physics: a Primer. Singapore: National University of Singapore.
2. Matthews, C. P., & Shearer, J. S. (1897). Problems and Questions in Physics. New York: Macmillan Company.
3. Halliday, D., Resnick, R., & Walker, J. (1993). Fundamentals of Physics.
4. New York: Wiley.
5. Ebbing, D. D., & Wrighton, M. S. (1990). General Chemistry. Boston: Houghton Mifflin.
6. Averill, B., & Eldredge, P. (2007). Chemistry: Principles, Patterns, and Applications. San Francisco: Benjamin Cummings.
7. Mahan, B. H. (1965). University Chemistry. Reading, MA: Addison-Wesley Pub.
8. Cantor, C. R., & Schimmel, P. R. (2004). Biophysical Chemistry. San Francisco:
9. W.H. Freeman.

Department Name: Biotechnology

Program Name: M.Sc. in Biotechnology

Program Code: 303

Semester: Semester I √ Semester II Semester III Semester IV

Course Name: Basics of Mathematics and Statistics

Course Code: BIOT-DSE-107 (For new course keep it blank; else enter the old course code)

Course Credit: 2

Marks Allotted: Theoretical/Practical: 42 Continuing Evaluation: 8

Course Type (tick the correct alternatives):

Core

Department Specific Elective √

Generic Elective

Is the course focused on employability / entrepreneurship? YES √ NO

Is the course focused on imparting life skill? YES NO √

Is the course based on Activity ? YES NO √

Percentage of change in syllabus (applicable in case of change in syllabus only)

Minor (up to 15%)

Moderate (>15% and up to 50%)

Major (> 50%)

Summary of changes

The course code has been changed.

PG BOS Meeting Reference Number: F.71/288/FCS/2022 Date: 18.04.22

Course Code: BIOT-DSE- 107

Course Name: Basics of Mathematics and Statistics

Credits: 2

Course Objectives:

The objective of this course is to give conceptual exposure of essential contents of mathematics and statistics to students.

Student Learning Outcomes:

On completion of this course, students should be able to:

- Gain broad understanding in mathematics and statistics;
- Recognize importance and value of mathematical and statistical thinking, training, and approach to problem solving, on a diverse variety of disciplines.

Course Syllabus:

Unit I **Algebra**	Linear equations, functions: slopes-intercepts, forms of two-variable linear equations; constructing linear models in biological systems; quadratic equations (solving, graphing, features of, interpreting quadratic models etc.), introduction to polynomials, graphs of binomials and polynomials; Symmetry of polynomial functions, basics of trigonometric functions, Pythagorean theory, graphing and constructing sinusoidal functions, imaginary numbers, complex numbers, adding-subtracting-multiplying complex numbers, basics of vectors, introduction to matrices.
Unit II **Calculus**	Differential calculus (limits, derivatives), integral calculus (integrals, sequences and series etc.).
Unit III **Mathematical models in biology**	Population dynamics; oscillations, circadian rhythms, developmental patterns, symmetry in biological systems, fractal geometries, size-limits & scaling in biology, modeling chemical reaction networks and metabolic networks.
Unit IV **Statistics**	Probability: counting, conditional probability, discrete and continuous random variables; Error propagation; Populations and samples, expectation, parametric tests of statistical significance, nonparametric hypothesis tests, linear regression, correlation & causality, analysis of variance, factorial experiment design.

Suggested Readings:

1. Stroud, K. A., & Booth, D. J. (2009). Foundation Mathematics. New York, NY: Palgrave Macmillan.
2. Aitken, M., Broadhursts, B., & Haldky, S. (2009) Mathematics for Biological Scientists. Garland Science.
3. Billingsley, P. (1986). Probability and Measure. New York: Wiley.
4. Rosner, B. (2000). Fundamentals of Biostatistics. Boston, MA: Duxbury Press.
5. Daniel, W. W. (1987). Biostatistics, a Foundation for Analysis in the Health Sciences. New York: Wiley.

Department Name: Biotechnology

Program Name: M.Sc. in Biotechnology

Program Code: 303

Semester: Semester I Semester II √ Semester III Semester IV

Course Name: Genetic Engineering

Course Code: BIOT-CT- 201 (For new course keep it blank; else enter the old course code)

Course Credit: 4

Marks Allotted: Theoretical/Practical: 75 Continuing Evaluation: 25

Course Type (tick the correct alternatives):

Core √

Department Specific Elective

Generic Elective

Is the course focused on employability / entrepreneurship? YES √ O

Is the course focused on imparting life skill? YES NO √

Is the course based on Activity ? YES NO √

Percentage of change in syllabus (applicable in case of change in syllabus only)

Minor (up to 15%) √

Moderate (>15% and up to 50%)

Major (> 50%)

Summary of changes

The very minor changes

PG BOS Meeting Reference Number: F.71/288/FCS/2022 Date: 18.04.22

Semester Two

Course Code: BIOT-CT- 201

Course Name: Genetic Engineering

Credits: 4

Course Objectives:

The goals of this course are to provide students with an understanding of diverse approaches to genetic engineering and their applications in biological research and the biotechnology industry. The contents of this course reflect the fact that genetic engineering is a technique that was developed based on our fundamental understanding of molecular biology principles.

Student Learning Outcomes:

Given the importance of genetic engineering in modern culture, students should be well-versed in the theory of the technology. In addition to molecular biology and genetic engineering practicals, students should be able to conduct biological research and obtain employment in the appropriate biotech business.

Course Syllabus:

Unit I **Introduction and tools for genetic engineering**	Impact of genetic engineering in modern society; general requirements for performing a genetic engineering experiment; restriction endonucleases and methylases; DNA ligase, Klenow enzyme, T4 DNA polymerase, polynucleotide kinase, alkaline phosphatase; cohesive and blunt end ligation; linkers; adaptors; homopolymeric tailing; labelling of DNA: nick translation, random priming, radioactive and non-radioactive probes, hybridization techniques: northern, southern, south-western and far-western and colony hybridization, fluorescence in situ hybridization.
Unit II **Different types of vectors**	Plasmids; Bacteriophages; M13 mp vectors; PUC19 and Bluescript vectors, hagemids; Lambda vectors; Insertion and Replacement vectors; Cosmids; Artificial chromosome vectors (YACs; BACs); Principles for maximizing gene expression expression vectors; pMal; GST; pET-based vectors; Protein purification; His-tag; GST-tag; MBP-tag etc.; Intein-based vectors; Inclusion bodies; methodologies to reduce formation of inclusion bodies; mammalian expression and replicating vectors; Baculovirus and Pichia vectors system, plant based vectors, Ti and Ri as vectors, yeast vectors, shuttle vectors.
Unit III **Different types of PCR techniques**	Principles of PCR: primer design; fidelity of thermostable enzymes; DNA polymerases; types of PCR – multiplex, nested; reverse-transcription PCR, real time PCR, touchdown PCR, hot start PCR, colony PCR, asymmetric PCR, cloning of PCR products; T-vectors; proof reading enzymes; PCR based site specific mutagenesis; PCR in molecular diagnostics; viral and bacterial detection; sequencing methods; enzymatic DNA sequencing; chemical sequencing of DNA; automated DNA sequencing; RNA sequencing; chemical synthesis of oligonucleotides; mutation detection: SSCP, DGGE, RFLP.

Unit IV **Gene manipulation and protein-DNA interaction**	Insertion of foreign DNA into host cells; transformation, electroporation, transfection; construction of libraries; isolation of mRNA and total RNA; reverse transcriptase and cDNA synthesis; cDNA and genomic libraries; construction of microarrays – genomic arrays, cDNA arrays and oligo arrays; study of protein-DNA interactions: electrophoretic mobility shift assay; DNase footprinting; methyl interference assay, chromatin immunoprecipitation; protein-protein interactions using yeast two-hybrid system; phage display.
Unit V **Gene silencing and genome editing technologies**	Gene silencing techniques; introduction to siRNA; siRNA technology; Micro RNA; construction of siRNA vectors; principle and application of gene silencing; gene knockouts and gene therapy; creation of transgenic plants; debate over GM crops; introduction to methods of genetic manipulation in different model systems e.g. fruit flies (Drosophila), worms (C. elegans), frogs (Xenopus), fish (zebra fish) and chick; Transgenics - gene replacement; gene targeting; creation of transgenic and knock-out mice; disease model; introduction to genome editing by CRISPR-CAS with specific emphasis on Chinese and American clinical trials.

Suggested Readings:

1. Old, R. W., Primrose, S. B., & Twyman, R. M. (2001). Principles of Gene Manipulation: an Introduction to Genetic Engineering. Oxford: Blackwell Scientific Publications.
2. Green, M. R., & Sambrook, J. (2012). Molecular Cloning: a Laboratory Manual. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.
3. Brown, T. A. (2006). Genomes (3rd ed.). New York: Garland Science Pub.
4. Selected papers from scientific journals, particularly Nature & Science.
5. Technical Literature from Stratagene, Promega, Novagen, New England Biolab etc.

Department Name: Biotechnology

Program Name: M.Sc. in Biotechnology

Program Code: 303

Semester: Semester I Semester II √ Semester III Semester IV

Course Name: Immunology

Course Code: BIOT-CT- 202 (For new course keep it blank; else enter the old course code)

Course Credit: 4

Marks Allotted: Theoretical/Practical: 75 Continuing Evaluation: 25

Course Type (tick the correct alternatives):

Core √

Department Specific Elective

Generic Elective

Is the course focused on employability / entrepreneurship? YES √ NO

Is the course focused on imparting life skill? YES NO √

Is the course based on Activity ? YES NO √

Percentage of change in syllabus (applicable in case of change in syllabus only)

Minor (up to 15%) √

Moderate (>15% and up to 50%)

Major (> 50%)

Summary of changes

No changes

PG BOS Meeting Reference Number: F.71/288/FCS/2022 Date: 18.04.22

Course Code: BIOT-CT- 202

Course Name: Immunology

Credits: 4

Course Objectives:

The purpose of this course is to teach students about the structural and functional characteristics of immune system components. The focus of this course will be on the immune system's development and the methods through which our bodies elicit immunological responses. This will be crucial for students because it will allow them to predict the type of the immune response that develops in the face of bacterial, viral, or parasite infection and then confirm it through the design of new tests.

Student Learning Outcomes:

On completion of this course, students should be able to:

- Evaluate usefulness of immunology in different pharmaceutical companies;
- Identify proper research lab working in area of their own interests;
- Apply their knowledge and design immunological experiments to demonstrate innate, humoral or cytotoxic T lymphocyte responses and figure out kind of immune responses in the setting of infection (viral or bacterial).

Course Syllabus:

Unit I **Immunology: fundamental concepts and overview of the immune system**	Components of innate and acquired immunity; phagocytosis; complement and inflammatory responses; pathogen recognition receptors (PRR) and pathogen associated molecular pattern (PAMP); innate immune response; mucosal immunity; antigens: immunogens, haptens; Major Histocompatibility Complex: MHC genes, MHC and immune responsiveness and disease susceptibility, Organs of immune system, primary and secondary lymphoid organs.
Unit II **Immune responses generated by B and T lymphocytes**	Immunoglobulins - basic structure, classes & subclasses of immunoglobulins, antigenic determinants; multigene organization of immunoglobulin genes; B-cell receptor; Immunoglobulin superfamily; principles of cell signaling; basis of self & non-self discrimination; kinetics of immune response, memory; B cell maturation, activation and differentiation; generation of antibody diversity; T-cell maturation, activation and differentiation and T-cell receptors; functional T Cell subsets; cell-mediated immune responses, ADCC; cytokines: properties, receptors and therapeutic uses; antigen processing and presentation- endogenous antigens, exogenous antigens, non-peptide bacterial antigens and super-antigens; cell-cell co-operation, Hapten-carrier system.
Unit III **Antigen-antibody interactions**	Precipitation, agglutination and complement mediated immune reactions; advanced immunological techniques: RIA, ELISA, Western blotting, ELISPOT assay, immunofluorescence microscopy, flow cytometry and immunoelectron microscopy; surface plasmon resonance, biosensor assays for assessing ligand –receptor interaction; CMI techniques: lymphoproliferation assay, mixed lymphocyte reaction, cell cytotoxicity assays, apoptosis, microarrays, transgenic mice, gene knock outs.
Unit IV **Vaccinology**	Active and passive immunization; live, killed, attenuated, subunit vaccines; vaccine technology: role and properties of adjuvants, recombinant DNA and

	protein based vaccines, plant-based vaccines, reverse vaccinology; peptide vaccines, conjugate vaccines; antibody genes and antibody engineering:chimeric, generation of monoclonal antibodies, hybrid monoclonal antibodies; catalytic antibodies and generation of immunoglobulin gene libraries, idiotypic vaccines and marker vaccines, viral-like particles (VLPs), dendritic cell based vaccines, vaccine against cancer, T cell based vaccine, edible vaccine and therapeutic vaccine.
Unit V **Clinical immunology**	Immunity to infection : bacteria, viral, fungal and parasitic infections (with examples from each group); hypersensitivity: Type I-IV; autoimmunity; types of autoimmune diseases; mechanism and role of CD4+ T cells; MHC and TCR in autoimmunity; treatment of autoimmune diseases; transplantation: immunological basis of graft rejection; clinical transplantation and immunosuppressive therapy; tumor immunology: tumor antigens; immune response to tumors and tumor evasion of the immune system, cancer immunotherapy; immunodeficiency: primary immunodeficiencies, acquired or secondary immunodeficiencies, autoimmune disorder, anaphylactic shock, immunosenescence, immune exhaustion in chronic viral infection, immune tolerance, NK cells in chronic viral infection and malignancy.
Unit VI **Immunogenetics**	Major histocompatibility complex genes and their role in autoimmune and infectious diseases, HLA typing, human major histocompatibility complex (MHC), Complement genes of the human major histocompatibility complex: implication for linkage disequilibrium and disease associations, genetic studies of rheumatoid arthritis, systemic lupus erythematosus and multiple sclerosis, genetics of human immunoglobulin, immunogenetics of spontaneous control of HIV, KIR complex.

Suggested Readings:

1. Kindt, T. J., Goldsby, R. A., Osborne, B. A., & Kuby, J. (2006). Kuby Immunology. New York: W.H. Freeman.
2. Brostoff, J., Seaddin, J. K., Male, D., & Roitt, I. M. (2002). Clinical Immunology. London: Gower Medical Pub.
3. Murphy, K., Travers, P., Walport, M., & Janeway, C. (2012). Janeway's Immunobiology. New York: Garland Science.
4. Paul, W. E. (2012). Fundamental Immunology. New York: Raven Press.
5. Goding, J. W. (1996). Monoclonal Antibodies: Principles and Practice: Production and Application of Monoclonal Antibodies in Cell Biology, Biochemistry, and Immunology. London: Academic Press.
6. Parham, P. (2005). The Immune System. New York: Garland Science.

Department Name: Biotechnology

Program Name: M.Sc. in Biotechnology

Program Code: 303

Semester: Semester I Semester II √ Semester III Semester IV

Course Name: Genomics, Proteomics and Bioinformatics

Course Code: BIOT-CT- 203 (For new course keep it blank; else enter the old course code)

Course Credit: 4

Marks Allotted: Theoretical/Practical: 75 Continuing Evaluation: 25

Course Type (tick the correct alternatives):

Core √

Department Specific Elective

Generic Elective

Is the course focused on employability / entrepreneurship? YES √ NO

Is the course focused on imparting life skill? YES NO √

Is the course based on Activity ? YES NO √

Percentage of change in syllabus (applicable in case of change in syllabus only)

Minor (up to 15%) √

Moderate (>15% and up to 50%)

Major (> 50%)

Summary of changes

A major merger of erstwhile two papers (2 credits each) into a single 4 credit paper. Necessary modifications to accommodate and substantiate each unit has been made.

PG BOS Meeting Reference Number: F.71/288/FCS/2022 Date: 18.04.22

Course Code: BIOT-CT- 203

Course Name: Genomics, Proteomics and Bioinformatics

Credits: 4

Course Objectives:

The goals of this course are to provide an overview of genomics, proteomics, and their applications, as well as theory and hands-on experience with standard computational tools and databases that aid in the research of molecular biology and evolution-related ideas.

Student Learning Outcomes:

Students should be able to learn the principles of genomics, proteomics, transcriptomics, and metabolomics, as well as their applications in a variety of biological fields. Develop a working grasp of these computational tools and procedures; recognize their significance for exploring specific contemporary biological topics; critically analyze and interpret the outcomes of their research.

Course Syllabus:

Unit I **Basics of genomics and proteomics**	Brief overview of prokaryotic and eukaryotic genome organization; extra-chromosomal DNA: bacterial plasmids, mitochondria and chloroplast.
Unit II **Genome mapping**	Genetic and physical maps; markers for genetic mapping; methods and techniques used for gene mapping, physical mapping, linkage analysis, cytogenetic techniques, FISH technique in gene mapping, somatic cell hybridization, radiation hybrid maps, in situ hybridization, comparative gene mapping.
Unit III **Genome sequencing projects**	Human Genome Project, genome sequencing projects for microbes, plants and animals, accessing and retrieving genome project information from the web.
Unit IV **Comparative genomics**	Identification and classification of organisms using molecular markers- 16S rRNA typing/sequencing, SNPs; use of genomes to understand evolution of eukaryotes, track emerging diseases and design new drugs; determining gene location in genome sequence.
Unit V **Proteomics**	Aims, strategies and challenges in proteomics; proteomics technologies: 2D-PAGE, isoelectric focusing, mass spectrometry, MALDI-TOF, yeast 2-hybrid system, proteome databases.
Unit VI **Functional genomics and proteomics**	Transcriptome analysis for identification and functional annotation of gene, Contig assembly, chromosome walking and characterization of chromosomes, mining functional genes in genome, gene function- forward and reverse genetics, gene ethics; protein-protein and protein-DNA interactions; protein chips and functional proteomics; clinical and biomedical applications of proteomics; introduction to metabolomics, lipidomics, metagenomics and systems biology.
Unit VII **Bioinformatics basics**	Bioinformatics basics: Computers in biology and medicine; Introduction to Unix and Linux systems and basic commands; Database concepts; Protein and nucleic acid databases; Structural databases; Biological XML DTD's; pattern matching algorithm basics; databases and search tools: biological background for sequence analysis; Identification of protein sequence from DNA sequence; searching of databases similar sequence; NCBI; publicly available tools; resources at EBI; resources on web; database mining tools.

Unit VIII **DNA sequence analysis**	DNA sequence analysis: gene bank sequence database; submitting DNA sequences to databases and database searching; sequence alignment; pairwise alignment techniques; motif discovery and gene prediction; local structural variants of DNA, their relevance in molecular level processes, and their identification; assembly of data from genome sequencing.
Unit IX **Multiple sequence analysis**	Multiple sequence analysis; multiple sequence alignment; flexible sequence similarity searching with the FASTA3 program package; use of CLUSTALW and CLUSTALX for multiple sequence alignment; submitting DNA protein sequence to databases: where and how to submit, SEQUIN, genome centres; submitting aligned sets of sequences, updating submitted sequences, methods of phylogenetic analysis.
Unit X **Protein modelling**	Protein modelling: introduction; force field methods; energy, buried and exposed residues; side chains and neighbours; fixed regions; hydrogen bonds; mapping properties onto surfaces; fitting monomers; RMS fit of conformers; assigning secondary structures; sequence alignment- methods, evaluation, scoring; protein completion: backbone construction and side chain addition; small peptide methodology; software accessibility; building peptides; protein displays; substructure manipulations, annealing.
Unit XI **Protein structure prediction and virtual library**	Protein structure prediction: protein folding and model generation; secondary structure prediction; analyzing secondary structures; protein loop searching; loop generating methods; homology modelling: potential applications, description, methodology, homologous sequence identification; align structures, align model sequence; construction of variable and conserved regions; threading techniques; topology fingerprint approach for prediction; evaluation of alternate models; structure prediction on a mystery sequence; structure aided sequence techniques of structure prediction; structural profiles, alignment algorithms, mutation tables, prediction, validation, sequence based methods of structure prediction, prediction using inverse folding, fold prediction; significance analysis, scoring techniques, sequence-sequence scoring; protein function prediction; elements of in silico drug design;Virtual library: Searching PubMed, current content, science citation index and current awareness services, electronic journals, grants and funding information.

Suggested Readings:

1. Primrose, S. B., Twyman, R. M., Primrose, S. B., & Primrose, S. B. (2006). Principles of Gene Manipulation and Genomics. Malden, MA: Blackwell Pub.
2. Liebler, D. C. (2002). Introduction to Proteomics: Tools for the New Biology. Totowa, NJ: Humana Press.
3. Campbell, A. M., & Heyer, L. J. (2003). Discovering Genomics, Proteomics, and Bioinformatics. San Francisco: Benjamin Cummings.
4. Lesk, A. M. (2002). Introduction to Bioinformatics. Oxford: Oxford University Press.
5. Mount, D. W. (2001). Bioinformatics: Sequence and Genome Analysis. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.
6. Baxevanis, A. D., & Ouellette, B. F. (2001). Bioinformatics: a Practical Guide to the Analysis of Genes and Proteins. New York: Wiley-Interscience.
7. Pevsner, J. (2015). Bioinformatics and Functional Genomics. Hoboken, NJ.: Wiley-Blackwell.
8. Bourne, P. E., & Gu, J. (2009). Structural Bioinformatics. Hoboken, NJ: Wiley-Liss.
9. Lesk, A. M. (2004). Introduction to Protein Science: Architecture, Function, and Genomics. Oxford: Oxford University Press.

Department Name: Biotechnology

Program Name: M.Sc. in Biotechnology

Program Code: 303

Semester: Semester I Semester II √ Semester III Semester IV

Course Name: Laboratory III: Molecular Biology, Molecular Immunology and Genetic Engineering

Course Code: BIOT-CP- 204 (For new course keep it blank; else enter the old course code)

Course Credit: 4

Marks Allotted: Theoretical/Practical: 75 Continuing Evaluation: 25

Course Type (tick the correct alternatives):

Core √

Department Specific Elective

Generic Elective

Is the course focused on employability / entrepreneurship? YES √ NO

Is the course focused on imparting life skill? YES NO √

Is the course based on Activity ? YES √ NO

Percentage of change in syllabus (applicable in case of change in syllabus only)

Minor (up to 15%)

Moderate (>15% and up to 50%) √

Major (> 50%)

Summary of changes

Adding new experiments for advancement.

PG BOS Meeting Reference Number: F.71/288/FCS/2022 Date: 18.04.22

Course Code: BIOT-CP- 204

Course Name: Laboratory III: Molecular Biology, Molecular Immunology and Genetic Engineering

Credits: 4

Course Objectives:

The goal of this course is to give students hands-on experience in molecular biology and genetic engineering. Students will gain knowledge of the practical elements of immune system components as well as their function. Basic and advanced methods for detecting antigen and antibody interactions, isolating distinct lymphocyte cells, and other topics will be covered, as well as how they might be applied to specific research projects.

Student Learning Outcomes:

Students should be able to practice gene cloning, protein expression, and purification on their own. This knowledge would prepare them for a future in the genetic engineering sector or in research facilities undertaking fundamental research.

Students should be able to:

- Evaluate usefulness of immunology in different pharmaceutical companies;
- Identify proper research lab working in area of their own interests;
- Apply their knowledge and design immunological experiments to demonstrate innate, humoral or cytotoxic T lymphocyte responses and figure out kind of immune responses in setting of infection (viral or bacterial) by looking at cytokine profile.

Course Syllabus:

1. Concept of lac-operon:
    a. Lactose induction of B-galactosidase.
    b. Glucose Repression.
    c. Diauxic growth curve of E. coli
2. UV mutagenesis to isolate amino acid auxotroph
3. Phage titre with epsilon phage/M13
4. Genetic Transfer-Conjugation, gene mapping
5. Plasmid DNA isolation and DNA quantitate on
6. Restriction Enzyme digestion of plasmid DNA
7. Agarose gel electrophoresis
8. Polymerase Chain Reaction and analysis by agarose gel electrophoresis
9. Vector and Insert Ligation
10. Preparation of competent cells
11. Transformation of E. coli with standard plasmids, Calculation of transformation efficiency
12. Confirmation of the insert by Colony PCR and Restriction mapping
13. Expression of recombinant protein, concept of soluble proteins and inclusion body formation in E. coli, SDS-PAGE analysis, Purification of His-tagged protein on Ni-NTA column.
14. Selection of animals, preparation of antigens, immunization and methods of blood collection, serum separation and storage.
15. Antibody titre by ELISA method.
16. Double diffusion, Immuno-electrophoresis and Radial Immuno diffusion.
17. Complement fixation test.

18. Isolation and purification of IgG from serum or IgY from chicken egg.
19. SDS-PAGE, Immunoblotting, Dot blot assays.
20. Blood smear identification of leucocytes by Giemsa stain.
21. Separation of leucocytes by dextran method.
22. Demonstration of Phagocytosis of latex beads and their cryopreservation.
23. Separation of mononuclear cells by Ficoll-Hypaque and their cryopreservation.
24. Demonstration of ELISPOT.
25. Demonstration of FACS.

Suggested Readings:

Green, M. R., & Sambrook, J. (2012). Molecular Cloning: a Laboratory Manual. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.

Department Name: Biotechnology

Program Name: M.Sc. in Biotechnology

Program Code: 303

Semester: Semester I Semester II √ Semester III Semester IV

Course Name: Laboratory IV: Bioinformatics

Course Code: BIOT-CP- 205 (For new course keep it blank; else enter the old course code)

Course Credit: 4

Marks Allotted: Theoretical/Practical: 75 Continuing Evaluation: 25

Course Type (tick the correct alternatives):

Core √

Department Specific Elective

Generic Elective

Is the course focused on employability / entrepreneurship? YES √ NO

Is the course focused on imparting life skill? YES NO √

Is the course based on Activity ? YES √ NO

Percentage of change in syllabus (applicable in case of change in syllabus only)

Minor (up to 15%) √

Moderate (>15% and up to 50%)

Major (> 50%)

Summary of changes

PG BOS Meeting Reference Number: F.71/288/FCS/2022 Date: 18.0422

Course Code: BIOT-CP- 205

Course Name: Laboratory IV: Bioinformatics

Credits: 4

Course Objectives:

The goal of this course is to provide hands-on instruction in bioinformatics approaches, such as accessing important public sequence databases, using various computational tools to identify sequences, and analyzing protein and nucleic acid sequences using various software programs.

Student Learning Outcomes:

On completion of this course, students should be able to:

- Describe contents and properties of most important bioinformatics databases;
- Perform text- and sequence-based searches and analyze and discuss results in light of molecular biological knowledge;
- Explain major steps in pairwise and multiple sequence alignment, explain principle and execute pairwise sequence alignment by dynamic programming;
- Predict secondary and tertiary structures of protein sequences.

Course Syllabus:

1. Using NCBI and Uniprot web resources.
2. Introduction and use of various genome databases.
3. Sequence information resource: Using NCBI, EMBL, Genbank, Entrez, Swissprot/ TrEMBL, UniProt.
4. Similarity searches using tools like BLAST and interpretation of results.
5. Multiple sequence alignment using ClustalW.
6. Phylogenetic analysis of protein and nucleotide sequences.
7. Use of gene prediction methods (GRAIL, Genscan, Glimmer).
8. Using RNA structure prediction tools.
9. Use of various primer designing and restriction site prediction tools.
10. Use of different protein structure prediction databases (PDB, SCOP, CATH).
11. Construction and study of protein structures using Deepview/PyMol.
12. Homology modelling of proteins.
13. Use of tools for mutation and analysis of the energy minimization of protein structures.
14. Use of miRNA prediction, designing and target prediction tools.

Department Name: Biotechnology

Program Name: M.Sc. in Biotechnology

Program Code: 303

Semester: Semester I Semester II √ Semester III Semester IV

Course Name: Organic Farming

Course Code: BIOT-DSE- 206 (for new course keep it blank; else enter the old course code)

Course Credit: 2

Marks Allotted: Theoretical/Practical: 42 Continuing Evaluation: 8

Course Type (tick the correct alternatives):

Core

Department Specific Elective √

Generic Elective

Is the course focused on employability / entrepreneurship? YES √ NO

Is the course focused on imparting life skill? YES NO √

Is the course based on Activity ? YES √ NO

Percentage of change in syllabus (applicable in case of change in syllabus only)

Minor (up to 15%)

Moderate (>15% and up to 50%)

Major (> 50%) √

Summary of changes

New Course

PG BOS Meeting Reference Number: F.71/288/FCS/2022 Date: 18.04.22

Course Code: BIOT-DSE- 206

Course Name: Organic Farming

Credits: 2

Course Objectives:

The course is designed to train students on organic farming practices, quality analysis of the products, environmental impact assessment, health benefit of the organic food, entrepreneurship development etc.

Student Learning Outcomes:

On completion of this course, the students should be able to design resource efficient farming system for small and marginal farmers for improving their economy while meeting the quality food demand in a sustainable environment.They would be able to identify scope for entrepreneurship in organic farming and utilize the schemes promoted through knowledge centres and various agencies.

Course Syllabus:

Unit I: Introduction and fundamental concepts	Key principles of organic agriculture,the ecological goal,hazards of chemical use, biodiversity threats and health risks, pesticide contamination in soil, water and food, social and economic impacts,Indian organic logo, NPOP certification mark, Organic food regulation in India, Government initiatives: role of ICAR, National Horticulture Mission, Rashtriya Krishi Vikas Yojana. Activity: Assignment/Seminar on relevant topics.
Unit II: Soil and nutrient management in organic farming	Essential plant nutrients and their sources, soil composition and properties, impact of physical and chemical properties of soil in plant growth, irrigation, influence of organic matter in soil fertility, types of problem soils and their reclamation, manures, bulky and concentrated organic manures, composting: methods and benefits, vermicomposting, biofertilizers,role of microbes in improving soil fertility. Activity: Basic techniques for preparation and application of composts, manures and microbial fertilizers: Vermicompost,Jeevamrit, ShivanshKhad,Panchagavya, Amrit Pani,general compost, Neem-khol& Mustard-khol, Leaf Manure, Waste Decomposer, Azotobacter, Rhizobium, Nitrobacter, Azospirillum, Phosphate solubilizing bacteria, Potash mobilizing bacteria.
Unit IV: Organic farming techniques	Requirements in an organic farm, choice of crops and varieties, modern concepts of tillage, mono and multiple cropping systems, crop rotation, seed treatments and sowing, integrated farming systems, livestock in organic farming, weed management, water management, pure and integrated organic farming: concepts and benefits, developed farming systems: permaculture, zero-budget natural farming, bio-dynamic agriculture. Activity: Organic farming practices,Mushroom cultivation technique, Techniques in cultivation of strawberry, dragon fruit etc.
Unit V:	Types of pests and diseases of major crops, cultural controls, physical methods,

Ecofriendly plant protection	biological methods of plant protection: botanical pesticides, biopesticides, bioherbicides, role of neem, important microbesin biocontrol: *Trichoderma*, *Pseudomonas*, *Bacillus* spp., *Bacillus thuringensis*, Baculoviruses, integrated pest management: concepts and protocols, post-harvest management of organic crops. Activity:Identification of common crop diseases, Preparation and application of Neemastra, Dashparni ark, Verm wash, Neem oil/Caster Oil,*Trichoderma viride*, *Trichoderma harzianum*, *Pseudomonas florescence.*
Unit VI: Organic certification and entrepreneurship	Purpose and process of certification for organic products, National Standards for Organic Production (NSOP), requirements for conversion to organic, storage and transport, field inspection, Scope in Bio-entrepreneurship, Entrepreneurship development programs of public and private agencies (MSME, DBT, BIRAC, Make In India), challenges in marketing in bio business, demand-supply, viability of a farm, financial management issues of procurement of capital and management of costs. Introduction to IP, farmers rights act. Activity: Preparation and presentation of project proposalrelevant to bio-entrepreneurship development.

Suggested Readings:

Somasundaram, E.,Udhaya Nandhini, D., Meyyappan, M. (2021). Principles of Organic Farming, CRC Press, London

Shiva, V., Pande, P. and J. Singh (2004). Principles of Organic Farming: Renewing the Earth's Harvest. Navdanya, New Delhi.

Gomez I., Thivant, L. (2017). Training Manual for Organic Agriculture. Scientific Publishers, United Book Prints.

Department Name: Biotechnology

Program Name: M.Sc. in Biotechnology

Program Code: 303

Semester: Semester I Semester II √ Semester III Semester IV

Course Name: Plant Tissue Culture

Course Code: BIOT-DSE-207 (For new course keep it blank; else enter the old course code)

Course Credit: 2

Marks Allotted: Theoretical/Practical: 42 Continuing Evaluation: 8

Course Type (tick the correct alternatives):

Core

Department Specific Elective √

Generic Elective

Is the course focused on employability / entrepreneurship? YES √ O

Is the course focused on imparting life skill? YES NO √

Is the course based on Activity ? YES √ O

Percentage of change in syllabus (applicable in case of change in syllabus only)

Minor (up to 15%) √

Moderate (>15% and up to 50%)

Major (> 50%)

Summary of changes

New Course

PG BOS Meeting Reference Number: F.71/288/FCS/2022 Date: 18.04.22

Course Code: BIOT-DSE-207

Course Name: Plant Tissue Culture

Credits: 2

Course Objectives:

This course aims to introduce students to the fundamental principles of plant tissue culture as well as its applications. To give students hands-on experience in labs with the most frequent of these approaches, as well as demonstrations of more sophisticated or unique techniques.

Student Learning Outcomes:

At the end of the course, students should be able to: disinfest and place into culture suitable explants capable of being cultured and multiplied, make culture medium from reagent grade chemicals and stock solutions, routinely transfer cultures without contamination, and analyze the usefulness of information available from the scientific literature that deals with plant tissue culture.

Course Syllabus:

Unit- I	Introduction and history of plants tissue culture. Tissue Culture media (composition and preparation). Types of culture: Callus culture, cell suspension culture, single cell culture, organogenesis, somatic embryogenesis; somaclonal variation; clonal propagation transfer and establishment of whole plants in soil.
Unit- II	Methods of Micropropagation and their application in forestry, floriculture, agriculture and conservation of biodiversity and threatened plants. Applications of plants biotechnology in breeding and crop improvement anther, embryo and endosperm culture, production of haploids, Male sterile plant. Application of plants tissue culture in plant pathology. Development of virus free plants. Growth of obligate parasites in culture. Development of disease resistance. Screening of germplasm.
Unit- III	In vitro pollination, embryo culture and embryo rescue. Protoplast isolation, culture and fusion; selection of hybrid cell and regeneration of hybrid plants; symmetric and asymmetric hybrids, cybrids. Anther and pollen culture: production of haploid plants and homozygous lines. Crop preservation and germplasm conservation.
Unit- IV	Transgenic plants and Gene transfer methods, Selection of clones marker and reporter genes in screening methods. Molecular markers: RFLP, AFLP, RAPD and SSR markers. Natural Products with special reference to alkaloids: production in plant tissue culture. Optimization, extraction of alkaloids and steroids, selection for cells for higher yields. Biotransformation, immobilization, elicitors and hairy root culture for production of useful metabolites. Antisense RNA technology and its application.

Suggested Readings:

1. S.S. Bhojwani and M.K. Razdan : Plant Tissue Culture - Theory & Practice, Elsevier, London, 1983.

2. J. Reinert and Y.P.S. Bajaj : Plant Cell, tissue and Organ Culture, Narosa Publishing House, New Delhi, 1989.
3. J. Reinert and M.M. Yeoman : Plant Cell & Tissue Culture - a laboratory manual, Narosa Publishing House, New Delhi, 1982.
4. Plant Tissue Culture Concepts and Laboratory Exercises, Second Edition, Robert N Trigiano, Dennis J Gray, CRC Press November 1999
5. Plant Biotechnology by Adrian Slater, Nigel W. Scott and Mark R. Fowler, Second Edition, Oxford Publisher

Department Name: Biotechnology

Program Name: M.Sc. in Biotechnology

Program Code: 303

Semester: Semester I Semester II Semester III √ Semester IV

Course Name: Bioprocess Engineering & Technology

Course Code: BIOT-CT- 301 (For new course keep it blank; else enter the old course code)

Course Credit: 4

Marks Allotted: Theoretical/Practical: 75 Continuing Evaluation: 25

Course Type (tick the correct alternatives):

Core √

Department Specific Elective

Generic Elective

Is the course focused on employability / entrepreneurship? YES √ NO

Is the course focused on imparting life skill? YES NO √

Is the course based on Activity ? YES NO √

Percentage of change in syllabus (applicable in case of change in syllabus only)

Minor (up to 15%) √

Moderate (>15% and up to 50%)

Major (> 50%)

Summary of changes

Certain important subject content have been introduced in the course content.

PG BOS Meeting Reference Number: F.71/288/FCS/2022 Date: 18.04.22

Semester Three

Course Code: BIOT-CT- 301

Course Name: Bioprocess Engineering & Technology

Credits: 4

Course Objectives:

The goals of this course are to teach students the fundamental ideas of bioprocess technology and its applications, preparing them to meet the challenges of the biotechnology industry's new and expanding fields.

Student Learning Outcomes:

Students should be able to:

- Appreciate relevance of microorganisms from industrial context;
- Carry out stoichiometric calculations and specify models of their growth;
- Give an account of design and operations of various fermenters;
- Present unit operations together with the fundamental principles for basic methods in production technique for bio-based products;
- Calculate yield and production rates in a biological production process, and also interpret data;
- Calculate the need for oxygen and oxygen transfer;
- Critically analyze any bioprocess from market point of view;
- Give an account of important microbial/enzymatic industrial processes in food and fuel industry.

Course Syllabus:

Unit I **Basic principles of biochemical engineering**	Isolation, screening and maintenance of industrially important microbes; microbial growth and death kinetics (an example from each group, particularly with reference to industrially useful microorganisms); strain improvement for increased yield and other desirable characteristics.
Unit II **Stoichiometry and models of microbial growth**	Elemental balance equations; metabolic coupling – ATP and NAD+; yield coefficients; unstructured models of microbial growth; structured models of microbial growth; Mass transfer of oxygen, fluid rheology.
Unit III **Bioreactor design and analysis**	General design information, Material and energy balance, Process flow sheet, Scale up and scale down issues, Scale up and downstream processes. Selection and specifications of bioprocess equipments, Facility design aspects. Utilities, Process economics Batch and continuous fermenters; modifying batch and continuous reactors: chemostat with recycle, multistage chemostat systems, fed-batch operations; conventional fermentation v/s biotransformation; immobilized cell systems; large scale animal and plant cell cultivation; fermentation economics; upstream processing: media formulation and optimization; sterilization; aeration, agitation and heat transfer in bioprocess.

Unit IV **Downstream processing and product recovery**	Separation of insoluble products - filtration, centrifugation, sedimentation, flFloocculation; Biomass removal and disruption, Precipitation by salts, solvents, Membrane based purification, Adsorption and chromatography, Extraction (solvent, aqueous two-phase, super critical), reverse osmosis, ultra and micro filtration, electrophoresis; final purification: drying; crystallization; storage and packaging.
Unit V **Fermentation economics**	Isolation of micro-organisms of potential industrial interest; strain improvement; market analysis; equipment and plant costs; media; sterilization, heating and cooling; aeration and agitation; bath-process cycle times and continuous cultures; recovery costs; water usage and recycling; effluent treatment and disposal.
Unit VI **Applications of enzyme technology in food processing**	Mechanism of enzyme function and reactions in process techniques; enzymatic bioconversions e.g. starch and sugar conversion processes; high-fructose corn syrup; interesterified fat; hydrolyzed protein etc. and their downstream processing; baking by amylases, deoxygenation and desugaring by glucoses oxidase, beer mashing and chill proofing; cheese making by proteases and various other enzyme catalytic actions in food processing.
Unit VII **Applications of micro-bial technology in food process operations and production, biofuels and biorefinery**	Fermented foods and beverages; food ingredients and additives prepared by fermentation and their purification; fermentation as a method of preparing and preserving foods; microbes and their use in pickling, producing colours and flavours, alcoholic beverages and other products; process wastes-whey, molasses, starch substrates and other food wastes for bioconversion to useful products; bacteriocins from lactic acid bacteria – production and applications in food preservation; biofuels and biorefinery

Suggested Readings:

1. Shuler, M. L., & Kargi, F. (2002). Bioprocess Engineering: Basic Concepts. Upper Saddle River, NJ: Prentice Hall.
2. Stanbury, P. F., & Whitaker, A. (2010). Principles of Fermentation Technology. Oxford: Pergamon Press.
3. Blanch, H. W., & Clark, D. S. (1997). Biochemical Engineering. New York: M. Dekker.
4. Bailey, J. E., & Ollis, D. F. (1986). Biochemical Engineering Fundamentals. New York: McGraw-Hill.

Department Name: Biotechnology

Program Name: M.Sc. in Biotechnology

Program Code: 303

Semester: Semester I Semester II Semester III √ Semester IV

Course Name: Plant and Animal Biotechnology

Course Code: BIOT-CT- 302 (For new course keep it blank; else enter the old course code)

Course Credit: 4

Marks Allotted: Theoretical/Practical: 75 Continuing Evaluation: 25

Course Type (tick the correct alternatives):

Core √

Department Specific Elective

Generic Elective

Is the course focused on employability / entrepreneurship? YES √ O

Is the course focused on imparting life skill? YES NO √

Is the course based on Activity ? YES NO √

Percentage of change in syllabus (applicable in case of change in syllabus only)

Minor (up to 15%) √

Moderate (>15% and up to 50%)

Major (> 50%)

Summary of changes

Segregation of plant and animal topics.

PG BOS Meeting Reference Number: F.71/288/FCS/2022 Date: 18.04.22

Course Code: BIOT-CT- 302

Course Name: Plant and Animal Biotechnology

Credits: 4

Course Objectives:

The objectives of this course are to introduce students to the principles, practices and application of animal biotechnology, plant tissue culture, plant and animal genomics, genetic transformation and molecular breeding of plants and animals.

Student Learning Outcomes:

Students should be able to gain fundamental knowledge in animal and plant biotechnology and their applications.

Course Syllabus:

Unit I **Plant tissue culture**	Plant tissue culture: historical perspective; totipotency; Tissue culture media composition-nutrients and plant hormones; sterilization techniques; Types of plant tissue culture: Callus culture, Cell suspension culture, Organogenesis; Somatic embryogenesis; Applications of tissue culture - micropropagation; somaclonal variation; androgenesis and its applications in genetics and plant breeding; synthetic seed production; protoplast isolation, protoplast culture and somatic hybridization; germplasm conservation and cryopreservation; somatic hybridization - methods and applications; cybrids and somatic cell genetics; plant cell cultures for secondary metabolite production.
Unit II **Animal cell culture**	Animal cell culture: brief history of animal cell culture; cell culture media and reagents; culture of mammalian cells, tissues and organs; primary culture, secondary culture, continuous cell lines, suspension cultures; application of animal cell culture for virus isolation and in vitro testing of drugs, testing of toxicity of environmental pollutants in cell culture, application of cell culture technology in production of human and animal viral vaccines and pharmaceutical proteins.
Unit III **Plant genetic manipulation**	Genetic engineering: Agrobacterium-plant interaction; virulence; Ti and Ri plasmids; opines and their significance; T-DNA transfer; disarmed Ti plasmid; Genetic transformation - Agrobacterium-mediated gene delivery; cointegrate and binary vectors and their utility; direct gene transfer - PEG-mediated, electroporation, particle bombardment and alternative methods; screenable and selectable markers; characterization of transgenics; chloroplast transformation; marker-free methodologies; advanced methodologies - cisgenesis, intragenesis and genome editing; molecular pharming - concept of plants as biofactories, production of industrial enzymes and pharmaceutically important compounds.
Unit IV **Animal reproductive biotechnology and vaccinology**	Animal reproductive biotechnology: structure of sperms and ovum; cryopreservation of sperms and ova of livestock; artificial insemination; super ovulation, embryo recovery and in vitro fertilization; culture of embryos; cryopreservation of embryos; embryo transfer technology; transgenic manipulation of animal embryos; applications of transgenic animal technology; animal cloning - basic concept, cloning for conservation

	for conservation endangered species; Vaccinology: history of development of vaccines, introduction to the concept of vaccines, conventional methods of animal vaccine production, recombinant approaches to vaccine production, modern vaccines.
Unit V **Molecular mapping and marker assisted selection**	Molecular markers - Hybridization and PCR based markers RFLP, RAPD, STS, SSR, AFLP, SNP markers; DNA fingerprinting-principles and applications; introduction to mapping of genes/QTLs; marker-assisted selection; strategies for Introducing genes of biotic and abiotic stress resistance in plants; genetic basis for disease resistance in animals; molecular diagnostics of pathogens in plants and animals; detection of meat adulteration using DNA based methods.

Suggested Readings:

1. Chawla, H. S. (2000). Introduction to Plant Biotechnology. Enfield, NH: Science.
2. Razdan, M. K. (2003). Introduction to Plant Tissue Culture. Enfield, NH: Science.
3. Slater, A., Scott, N. W., & Fowler, M. R. (2008). Plant Biotechnology: an Introduction to Genetic Engineering. Oxford: Oxford University Press.
4. Buchanan, B. B., Gruissem, W., & Jones, R. L. (2015). Biochemistry & Molecular Biology of Plants. Chichester, West Sussex: John Wiley & Sons.
5. Umesha, S. (2013). Plant Biotechnology. The Energy And Resources.
6. Glick, B. R., & Pasternak, J. J. (2010). Molecular Biotechnology: Principles and Applications of Recombinant DNA. Washington, D.C.: ASM Press.
7. Brown, T. A. (2006). Gene Cloning and DNA Analysis: an Introduction. Oxford: Blackwell Pub.
8. Primrose, S. B., & Twyman, R. M. (2006). Principles of Gene Manipulation and Genomics. Malden, MA: Blackwell Pub.
9. Slater, A., Scott, N. W., & Fowler, M. R. (2003). Plant Biotechnology: The Genetic Manipulation of Plants. Oxford: Oxford University Press.
10. Gordon, I. (2005). Reproductive Techniques in Farm Animals. Oxford: CAB International.
11. Levine, M. M. (2004). New Generation Vaccines. New York: M. Dekker.
12. Pörtner, R. (2007). Animal Cell Biotechnology: Methods and Protocols. Totowa, NJ: Humana Press.

Department Name: Biotechnology

Program Name: M.Sc. in Biotechnology

Program Code: 303

Semester: Semester I Semester II Semester III √ Semester IV

Course Name: Laboratory V: Bioprocess Engineering & Technology

Course Code: BIOT-CP- 303 (For new course keep it blank; else enter the old course code)

Course Credit: 4

Marks Allotted: Theoretical/Practical: 75 Continuing Evaluation: 25

Course Type (tick the correct alternatives):

Core √

Department Specific Elective

Generic Elective

Is the course focused on employability / entrepreneurship? YES √ NO

Is the course focused on imparting life skill? YES NO √

Is the course based on Activity ? YES √ NO

Percentage of change in syllabus (applicable in case of change in syllabus only)

Minor (up to 15%) √

Moderate (>15% and up to 50%)

Major (> 50%)

Summary of changes

Minor changes.

PG BOS Meeting Reference Number: F.71/288/FCS/2022 Date: 18.04.22

Course Code: BIOT-CP- 303

Course Name: Laboratory V: Bioprocess Engineering & Technology

Credits: 4

Course Objectives:

The objectives of this laboratory course are to provide hands-on training to students in upstream and downstream unit operations.

Student Learning Outcomes:

Students should be able to:

- Investigate, design and conduct experiments, analyze and interpret data, and apply the laboratory skills to solve complex bioprocess engineering problems;
- Apply skills and knowledge gained will be useful in solving problems typical of bio industries and research.

Course Syllabus:

1.Basic Microbiology techniques

a) Scale up from frozen vial to agar plate to shake flask culture.

b) Instrumentation: Microplate reader, spectrophotometer, microscopy.

c) Isolation of microorganisms from soil samples.

2. Experimental set-up

a) Assembly of bioreactor and sterilization.

b) Growth kinetics.

c) Substrate and product inhibitions.

d) Measurement of residual substrates.

3. Data Analysis

a) Introduction to Metabolic Flux Analysis (MFA).

4. Fermentation

a) Batch.

b) Fed-batch.

c) Continuous.

5. Unit operations

a) Microfiltrations: Separation of cells from broth.

b) Bioseparations: Various chromatographic techniques and extractions.

6. Bioanalytics

a) Analytical techniques like HPLC, FPLC, GC, GC-MS etc. for measurement of amounts of products/substrates

Suggested Readings:

1. Shuler, M. L., & Kargi, F. (2002). Bioprocess Engineering: Basic Concepts. Upper Saddle River, NJ: Prentice Hall.
2. Stanbury, P. F., & Whitaker, A. (2010). Principles of Fermentation Technology. Oxford: Pergamon Press.
3. Blanch, H. W., & Clark, D. S. (1997). Biochemical Engineering. New York:
4. M. Dekker.
5. Bailey, J. E., & Ollis, D. F. (1986). Biochemical Engineering Fundamentals. New York: McGraw-Hill.
6. El-Mansi, M., & Bryce, C. F. (2007). Fermentation Microbiology and Biotechnology. Boca Raton: CRC/Taylor & Francis.

Department Name: Biotechnology

Program Name: M.Sc. in Biotechnology

Program Code: 303

Semester: Semester I Semester II Semester III √ Semester IV

Course Name: Bioentrepreneurship

Course Code: BIOT-DSE- 304 (For new course keep it blank; else enter the old course code)

Course Credit: 2

Marks Allotted: Theoretical/Practical: 42 Continuing Evaluation: 8

Course Type (tick the correct alternatives):

Core

Department Specific Elective √

Generic Elective

Is the course focused on employability / entrepreneurship? YES √ O

Is the course focused on imparting life skill? YES NO √

Is the course based on Activity ? YES NO √

Percentage of change in syllabus (applicable in case of change in syllabus only)

Minor (up to 15%) √

Moderate (>15% and up to 50%)

Major (> 50%)

Summary of changes

Minor changes.

PG BOS Meeting Reference Number: F.71/288/FCS/2022 Date: 18.04.22

Course Code: BIOT-DSE- 304

Course Name: Bioentrepreneurship

Credits: 2

Course Objectives:

Research and business belong together and both are needed. In a rapidly developing life science industry, there is an urgent need for people who combine business knowledge with the understanding of science & technology. Bio-entrepreneurship, an interdisciplinary course, revolves around the central theme of how to manage and develop life science companies and projects. The objectives of this course are to teach students about concepts of entrepreneurship including identifying a winning business opportunity, gathering funding and launching a business, growing and nurturing the organization and harvesting the rewards.

Student Learning Outcomes:

Students should be able to gain entrepreneurial skills, understand the various operations involved in venture creation, identify scope for entrepreneurship in biosciences and utilize the schemes promoted through knowledge centres and various agencies. The knowledge pertaining to management should also help students to be able to build up a strong network within the industry.

Course Syllabus:

Unit I **Innovation and entrepreneurship in bio-business**	Introduction and scope in Bio-entrepreneurship, Types of bio-industries and competitive dynamics between the sub-industries of the bio-sector (e.g. pharmaceuticals vs. Industrial biotech), Strategy and operations of bio-sector firms: Factors shaping opportunities for innovation and entrepreneurship in bio-sectors, and the business implications of those opportunities, Alternatives faced by emerging bio-firms and the relevant tools for strategic decision, Entrepreneurship development programs of public and private agencies (MSME, DBT, BIRAC, Make In India), strategic dimensions of patenting & commercialization strategies.
Unit II **Bio markets - business strategy and marketing**	Negotiating the road from lab to the market (strategies and processes of negotiation with financiers, government and regulatory authorities), Pricing strategy, Challenges in marketing in bio business (market conditions & segments; developing distribution channels, the nature, analysis and management of customer needs), Basic contract principles, different types of agreement and contract terms typically found in joint venture and development agreements, Dispute resolution skills.
Unit III **Finance and accounting**	Business plan preparation including statutory and legal requirements, Business feasibility study, financial management issues of procurement of capital and management of costs, Collaborations & partnership, Information technology.
Unit IV **Technology management**	Technology – assessment, development & upgradation, Managing technology transfer, Quality control & transfer of foreign technologies, Knowledge centers and Technology transfer agencies, Understanding of regulatory compliances and procedures (CDSCO, NBA, GCP, GLA, GMP).

Suggested Readings:

1. Adams, D. J., & Sparrow, J. C. (2008). Enterprise for Life Scientists: Developing Innovation and Entrepreneurship in the Biosciences. Bloxham: Scion.
2. Shimasaki, C. D. (2014). Biotechnology Entrepreneurship: Starting, Managing, and Leading Biotech Companies. Amsterdam: Elsevier. Academic Press is an imprint of Elsevier.
3. Onetti, A., & Zucchella, A. Business Modeling for Life Science and Biotech Companies: Creating Value and Competitive Advantage with the Milestone Bridge. Routledge.
4. Jordan, J. F. (2014). Innovation, Commercialization, and Start-Ups in Life Sciences. London: CRC Press.
5. Desai, V. (2009). The Dynamics of Entrepreneurial Development and Management. New Delhi: Himalaya Pub. House

Department Name: Biotechnology

Program Name: M.Sc. in Biotechnology

Program Code: 303

Semester: Semester I Semester II Semester III √ Semester IV

Course Name: Intellectual Property Rights, Biosafety and Bioethics

Course Code: BIOT-DSE- 305 (For new course keep it blank; else enter the old course code)

Course Credit: 2

Marks Allotted: Theoretical/Practical: 42 Continuing Evaluation: 8

Course Type (tick the correct alternatives):

Core

Department Specific Elective √

Generic Elective

Is the course focused on employability / entrepreneurship? YES √ O

Is the course focused on imparting life skill? YES NO √

Is the course based on Activity ? YES NO √

Percentage of change in syllabus (applicable in case of change in syllabus only)

Minor (up to 15%) √

Moderate (>15% and up to 50%)

Major (> 50%)

Summary of changes

Minor changes

PG BOS Meeting Reference Number: F.71/288/FCS/2022 Date: 18.04.22

Course Code: BIOT-DSE- 305

Course Name: Intellectual Property Rights, Biosafety and Bioethics

Credits: 2

Course Objectives:

The objectives of this course are:

- To provide basic knowledge on intellectual property rights and their implications in biological research and product development;
- To become familiar with India's IPR Policy;
- To learn biosafety and risk assessment of products derived from biotechnolo- gy and regulation of such products;
- To become familiar with ethical issues in biological research. This course will focus on consequences of biomedical research technologies such as cloning of whole organisms, genetic modifications, DNA testing.

Student Learning Outcomes:

On completion of this course, students should be able to:

- Understand the rationale for and against IPR and especially patents;
- Understand why India has adopted an IPR Policy and be familiar with broad outline of patent regulations;
- Understand different types of intellectual property rights in general and protection of products derived from biotechnology research and issues related to application and obtaining patents;
- Gain knowledge of biosafety and risk assessment of products derived from recombinant DNA research and environmental release of genetically modified organisms, national and international regulations;
- Understand ethical aspects related to biological, biomedical, health care and biotechnology research.

Course Syllabus:

Unit I **Introduction to IPR**	Introduction to intellectual property; types of IP: patents, trademarks, copyright & related rights, industrial design, traditional knowledge, geographical indications, protection of new GMOs; International framework for the protection of IP; IP as a factor in R&D; IPs of relevance to biotechnology and few case studies; introduction to history of GATT, WTO, WIPO and TRIPS; plant variety protection and farmers rights act; concept of 'prior art': invention in context of "prior art"; patent databases - country-wise patent searches (USPTO, EPO, India); analysis and report formation.
Unit II **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; 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/credit sharing among parties/community, commercial (financial) and non-commercial incentives.
Unit III **Biosafety**	Biosafety and Biosecurity - 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.
Unit IV **National and international 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; Draft bill of Biotechnology Regulatory authority of India - containments – biosafety levels and category of rDNA experiments; field trails – biosafety research trials – standard operating procedures - guidelines of state governments; GM labeling – Food Safety and Standards Authority of India (FSSAI).
Unit V **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.

Suggested Readings:

1. Ganguli, P. (2001). Intellectual Property Rights: Unleashing the Knowledge Economy. New Delhi: Tata McGraw-Hill Pub.
2. National IPR Policy, Department of Industrial Policy & Promotion, Ministry of Commerce, GoI
3. Complete Reference to Intellectual Property Rights Laws. (2007). Snow White Publication Oct.

4. Kuhse, H. (2010). Bioethics: an Anthology. Malden, MA: Blackwell.
5. Office of the Controller General of Patents, Design & Trademarks; Department of Industrial Policy & Promotion; Ministry of Commerce & Industry; Government of India. http://www.ipindia.nic.in/
6. Karen F. Greif and Jon F. Merz, Current Controversies in the Biological Sciences -Case Studies of Policy Challenges from New Technologies, MIT Press
7. World Trade Organisation. http://www.wto.org
8. World Intellectual Property Organisation. http://www.wipo.int
9. International Union for the Protection of New Varieties of Plants. http://www.upov.int
10. National Portal of India. http://www.archive.india.gov.in
11. National Biodiversity Authority. http://www.nbaindia.org
12. 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
13. 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
14. 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

15. Guidelines for Safety Assessment of Foods Derived from Genetically Engineered Plants. 2008.
16. Guidelines and Standard Operating Procedures for Confined Field Trials of Regulated Genetically Engineered Plants. 2008. Retrieved from http://www.igmoris.nic.in/guidelines1.asp
17. 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/inhousepublicationscollectionbiosafetyreviews.

Department Name: Biotechnology

Program Name: M.Sc. in Biotechnology

Program Code: 303

Semester: Semester I Semester II Semester III √ Semester IV

Course Name: Molecular Diagnostics

Course Code: BIOT-DSE- 306 (For new course keep it blank; else enter the old course code)

Course Credit: 2

Marks Allotted: Theoretical/Practical: 42 Continuing Evaluation: 8

Course Type (tick the correct alternatives):

Core

Department Specific Elective √

Generic Elective

Is the course focused on employability / entrepreneurship? YES √ NO

Is the course focused on imparting life skill? YES NO √

Is the course based on Activity ? YES NO √

Percentage of change in syllabus (applicable in case of change in syllabus only)

Minor (up to 15%) √

Moderate (>15% and up to 50%)

Major (> 50%)

Summary of changes

Minor modification

PG BOS Meeting Reference Number: F.71/288/FCS/2022 Date: 18.04.22

Course Code: BIOT-DSE- 306

Course Name: Molecular Diagnostics

Credits: 2

Course Objectives:

The objectives of this course are to sen-sitize students about recent advances in molecular biology and various facets of molecular medicine which has potential to profoundly alter many aspects of modern medicine including pre- or post-natal analysis of genetic diseases and identification of individuals predisposed to disease ranging from common cold to cancer.

Student Learning Outcomes:

Students should be able to understand various facets of molecular procedures and basics of genomics, proteomics and metabolomics that could be employed in early diagnosis and prognosis of human diseases.

Course Syllabus:

Unit I **Genome biology in health and disease**	DNA, RNA, Protein: An overview; chromosomal structure & mutations; DNA polymorphism: human identity; clinical variability and genetically determined adverse reactions to drugs.
Unit II **Genome: resolution, detection & analysis**	PCR: Real-time; ARMS; Multiplex; ISH; FISH; ISA; RFLP; DHPLC; DGGE; CSCE; SSCP; Nucleic acid sequencing: new generations of automated sequencers; Microarray chips; EST; SAGE; microarray data normalization & analysis; molecular markers: 16S rRNA typing; Diagnostic proteomics: SELDI-TOF-MS; Bioinformatics data acquisition & analysis.
Unit III **Diagnostic metabolomics**	Metabolite profile for biomarker detection the body fluids/tissues in various metabolic disorders by making using LCMS & NMR technological platforms.
Unit IV **Detection and identity of microbial diseases**	Direct detection and identification of pathogenic-organisms that are slow growing or currently lacking a system of in vitro cultivation as well as genotypic markers of microbial resistance to specific antibiotics.
Unit V **Detection of inherited diseases**	Exemplified by two inherited diseases for which molecular diagnosis has provided a dramatic improvement of quality of medical care: Fragile X Syndrome: Paradigm of new mutational mechanism of unstable triplet repeats, von-Hippel Lindau disease: recent acquisition in growing number of familial cancer syndromes.
Unit VI **Molecular oncology**	Detection of recognized genetic aberrations in clinical samples from cancer patients; types of cancer-causing alterations revealed by next-generation sequencing of clinical isolates; predictive biomarkers for personalized onco-therapy of human diseases such as chronic myeloid leukemia, colon, breast, lung cancer and melanoma as well as matching targeted therapies with patients and preventing toxicity of standard systemic therapies.
Unit VII **Quality assurance and control**	Quality oversight; regulations and approved testing.

Suggested Readings:

1. Campbell, A. M., & Heyer, L. J. (2006). Discovering Genomics, Proteomics, and Bioinformatics. San Francisco: Benjamin Cummings.
2. Brooker, R. J. (2009). Genetics: Analysis & Principles. New York, NY: McGraw-Hill.
3. Glick, B. R., Pasternak, J. J., & Patten, C. L. (2010). Molecular Biotechnology: Principles and Applications of Recombinant DNA. Washington, DC: ASM Press.
4. Coleman, W. B., & Tsongalis, G. J. (2010). Molecular Diagnostics: for the Clinical Laboratorian. Totowa, NJ: Humana Press.

Department Name: Biotechnology

Program Name: M.Sc. in Biotechnology

Program Code: 303

Semester: Semester I Semester II Semester III √ Semester IV

Course Name: Drug Discovery and Development

Course Code: BIOT-DSE- 307 (For new course keep it blank; else enter the old course code)

Course Credit: 2

Marks Allotted: Theoretical/Practical: 42 Continuing Evaluation: 8

Course Type (tick the correct alternatives):

Core

Department Specific Elective √

Generic Elective

Is the course focused on employability / entrepreneurship? YES √ O

Is the course focused on imparting life skill? YES NO √

Is the course based on Activity ? YES NO √

Percentage of change in syllabus (applicable in case of change in syllabus only)

Minor (up to 15%) √

Moderate (>15% and up to 50%)

Major (> 50%)

Summary of changes

No major changes have been made. One subsection entitled “Drug delivery systems’ has been included in new CBCS syllabus.

PG BOS Meeting Reference Number: F.71/288/FCS/2022 Date: 18.04.2

Course Code: BIOT-DSE- 307

Course Name: Drug Discovery and Development

Credits: 2

Course Objectives:

This course will give a broad overview of research and development carried out in industrial setup towards drug discovery.

Student Learning Outcomes:

On completion of this course, students should be able to understand basics of R&D in drug discovery and should be able to apply knowledge gained in respective fields of pharmaceutical industry.

Course Syllabus:

Unit I **Target identification and molecular modelling**	Identification of target or drug leads associated with a particular disease by a number of different techniques including combinations of molecular modeling, combinatorial libraries and high-throughput screening (HTS); Conceptualizing the automation of the HTS process and the importance of bioinformatics and data processing in identification of lead compounds; Rational drug design, based on understanding the three-dimensional structures and physicochemical properties of drugs and receptors; Modelling drug/ receptor interactions with the emphasis on molecular mechanisms, molecular dynamics simulations and homology modelling; Conformational sampling, macromolecular folding, structural bioinformatics, receptor-based and ligand-based design and docking methods, in silico screening of libraries, semi-empirical and ab-initio methods, QSAR methods, molecular diversity, design of combinatorial libraries of drug-like molecules, macromolecular and chemical databases.
Unit II **Lead optimization**	Identification of relevant groups on a molecule that interact with a receptor and are responsible for biological activity; Understanding structure activity relationship; Structure modification to increase potency and therapeutic index; Concept of quantitative drug design using Quantitative structure–activity relationship models (QSAR models) based on the fact that the biological properties of a compound are a function of its physicochemical parameters such as solubility, lipophilicity, electronic effects, ionization, stereochemistry, etc.; Bioanalytical assay development in support of in vitro and in vivo studies (LC/MS/MS, GC/MS and ELISA).
Unit III **Preclinical development**	Principles of drug absorption, drug metabolism and distribution - intestinal absorption, metabolic stability, drug-drug interactions, plasma protein binding assays, metabolite profile studies, Principles of toxicology, Experimental design for preclinical and clinical PK/PD/TK studies, Selection of animal model; Regulatory guidelines for preclinical PK/ PD/TK studies; Scope of GLP, SOP for conduct of clinical & non clinical testing, control on animal house, report preparation and documentation Integration of non-clinical and preclinical data to aid design of clinical studies.
Unit IV **Drug manufacturing**	Requirements of GMP implementation, Documentation of GMP practices, CoA, Regulatory certification of GMP, Quality control and Quality assurance, concept and philosophy of TQM, ICH and ISO 9000; ICH guidelines for Manufacturing, Understanding Impurity Qualification Data, Stability Studies.

Unit V **Clinical trial designand Drug delivery systems**	Objectives of Phase I, II, III and IV clinical studies, Clinical study design, enrollment, sites and documentation, Clinical safety studies: Adverse events and adverse drug reactions, Clinical PK, pharmacology, drug-drug interaction studies, Statistical analysis and documentation. Introduction to Controlled and Novel Drug Delivery Systems, Sustained release dosage forms, nanoparticles, liposomes as drug carrier, Targeted Drug Delivery
Unit VI **Fundamentals of regulatory affairs and bioethics**	Global Regulatory Affairs and different steps involved, Regulatory Objectives, Regulatory Agencies; FDA guidelines on IND and NDA submissions, Studies required for IND and NDA submissions for oncology, HIV, cardiovascular indications, On-label vs. off-label drug use GCP and Requirements of GCP Compliance, Ethical issues and Compliance to current ethical guidelines, Ethical Committees and their set up, Animal Ethical issues and compliance.

Suggested Readings:

1. Krogsgaard-Larsen et al. Textbook of Drug Design and Discovery. 4th Edition. CRC Press.
2. Kuhse, H. (2010). Bioethics: an Anthology. Malden, MA: Blackwell.
3. Nally, J. D. (2006) GMP for Pharmaceuticals. 6th edition. CRC Press
4. Brody, T. (2016) Clinical Trials: Study Design, Endpoints and Biomarkers, Drug Safety, and FDA and ICH Guidelines. Academic Press.

Department Name: Biotechnology

Program Name: M.Sc. in Biotechnology

Program Code: 303

Semester: Semester I Semester II Semester III √ Semester IV

Course Name: Microbial Technology

Course Code: BIOT-DSE- 308 (For new course keep it blank; else enter the old course code)

Course Credit: 2

Marks Allotted: Theoretical/Practical: 42 Continuing Evaluation: 8

Course Type (tick the correct alternatives):

Core

Department Specific Elective √

Generic Elective

Is the course focused on employability / entrepreneurship? YES √ NO

Is the course focused on imparting life skill? YES NO √

Is the course based on Activity ? YES NO √

Percentage of change in syllabus (applicable in case of change in syllabus only)

Minor (up to 15%) √

Moderate (>15% and up to 50%)

Major (> 50%)

Summary of changes

PG BOS Meeting Reference Number: F.71/288/FCS/2022 Date: 18.04.22

Course Code: BIOT-DSE- 308

Course Name: Microbial Technology

Credits: 2

Course Objectives:

The objectives of this course are to introduce students to developments/ advances made in field of microbial technology for use in human welfare and solving problems of the society.

Student Learning Outcomes:

On completion of this course, students would develop deeper understanding of the microbial technology and its applications.

Course Syllabus:

Unit I **Introduction to microbial technology**	Microbial technology in human welfare; Isolation and screening of microbes important for industry – advances in methodology and its application; Advanced genome and epigenome editing tools (e.g., engineered zinc finger proteins, TALEs/TALENs, and the CRISPR/Cas9 system as nucleases for genome editing, transcription factors for epigenome editing, and other emerging tools) for manipulation of useful microbes/ strains and their applications; Strain improvement to increase yield of selected molecules, e.g., antibiotics, enzymes, biofuels.
Unit II **Environmental applications of microbial technology**	Environmental application of microbes; Ore leaching; Biodegradation - biomass recycle and removal; Bioremediation - toxic waste removal and soil remediation; Global Biogeochemical cycles; Environment sensing (sensor organisms/ biological sensors); International and National guidelines regarding use of genetically modified organisms in environment, food and pharmaceuticals.
Unit III **Pharmaceutical applications of microbial technology**	Recombinant protein and pharmaceuticals production in microbes – common bottlenecks and issues (technical/operational, commercial and ethical); Attributes required in industrial microbes (Streptomyces sp., Yeast) to be used as efficient cloning and expression hosts (biologicals production); Generating diversity and introduction of desirable properties in industrially important microbes (Streptomyces/Yeast); Microbial cell factories; Downstream processing approaches used in industrial production process (Streptomyces sp., Yeast).
Unit IV **Food applications of microbial technology**	Application of microbes and microbial processes in food and healthcare industries - food processing and food preservation, antibiotics and enzymes production, microbes in targeted delivery application – drugs and vaccines (bacterial and viral vectors); Non- recombinant ways of introducing desirable properties in Generally recognized as safe (GRAS) microbes to be used in food (e.g., Yeast) - exploiting the existing natural diversity or the artificially introduced diversity through conventional acceptable techniques (mutagenesis, protoplast fusion, breeding, genome shuffling, directed evolution etc.).
Unit V **Advances in microbial technology**	Microbial genomics for discovery of novel enzymes, drugs/ antibiotics; Limits of microbial genomics with respect to use in human welfare; Metagenomics and metatranscriptomics – their potential, methods to study and applications/use (animal and plant health, environmental clean-up, global

	nutrient cycles & global sustainability, understanding evolution), Global metagenomics initiative - surveys/projects and outcome, metagenomic library construction and functional screening in suitable hosts – tools and techniques for discovery/identification of novel enzymes, drugs (e.g., protease, antibiotic) etc.

Suggested Readings:

1. Lee, Y. K. (2013). Microbial Biotechnology: Principles and Applications. Hackensack, NJ: World Scientific.
2. Moo-Young, M. (2011). Comprehensive Biotechnology. Amsterdam: Elsevier.
3. Nelson, K. E. (2015). Encyclopedia of Metagenomics. Genes, Genomes and Metagenomes: Basics, Methods, Databases and Tools. Boston, MA: Springer US.
4. The New Science of Metagenomics Revealing the Secrets of Our Microbial Planet. (2007). Washington, D.C.: National Academies Press.
5. Journals: (a) Nature, (b) Nature Biotechnology, (c) Applied microbiology and biotechnology, (d) Trends in Biotechnology, (e) Trends in Microbiology, (f) Current opinion in Microbiology, (g) Biotechnology Advances, (h) Genome Research)
6. Websites: http://jgi.doe.gov/our-science/

Department Name: Biotechnology

Program Name: M.Sc. in Biotechnology

Program Code: 303

Semester: Semester I Semester II Semester III √ Semester IV

Course Name: Molecular Virology

Course Code: BIOT-DSE- 309 (For new course keep it blank; else enter the old course code)

Course Credit: 2

Marks Allotted: Theoretical/Practical: 42 Continuing Evaluation: 8

Course Type (tick the correct alternatives):

Core

Department Specific Elective √

Generic Elective

Is the course focused on employability / entrepreneurship? YES √ O

Is the course focused on imparting life skill? YES NO √

Is the course based on Activity ? YES NO √

Percentage of change in syllabus (applicable in case of change in syllabus only)

Minor (up to 15%)

Moderate (>15% and up to 50%)

Major (> 50%)

Summary of changes

New Course.

PG BOS Meeting Reference Number: F.71/288/FCS/2022 Date: 18.04.22

Course Code: BIOT-DSE- 309

Course Name: Molecular Virology

Credits: 2

Course Objectives:

In this course the students will obtain advanced knowledge of different aspects of virology - from the molecular basis of the virus life cycle to the importance of viruses in human medicine and the use of viruses in biotechnology and cell biology.

Student Learning Outcomes:

On completion of this course, students should be able to:

- Explain the molecular details of the virus life cycle and identify the implications for human disease and treatment including gene therapy
- Explain the biotechnological importance and usage of virurses
- Relate and summarize different virological disciplines in a broader context
- account for the structure and chemical and physical properties of viruses
- account for general mechanisms in conjunction with virus infection of cells (virus adsorption, replication of the genome, synthesis and processing of RNA, gene regulation, protein synthesis, virion assembly and egress) and predict the properties of newly discovered viruses
- account for basic pathogenetic concepts such as tropism, latency, persistence and acute infection, local and systemic infection, incubation period
- account for the variability of viruses and its consequences
- account for pathogenesis and epidemiology in relation to the properties of viruses and the functions

Course Syllabus:

Unit I	Economic losses due to important viruses; Types of plant viruses, DNA Viruses, RNA viruses, satellite viruses, satellite RNA, satellite DNA, viroids, virusoids; Disease symptoms, local and systemic symptoms, necrosis hypoplasia, hyperplasia; Vectors for virus transmission; Cell to cell and systemic movement of viruses plasmodesmata and virus movement.
Unit II	Genome Organization of DNA viruses; Caulimovirus - eg. Cauliflower mosaic virus, Replication of CaMV, Badnavirus - Rice tungro virus (RTBV); Geminiviridae - Bean golden mosaic virus, B- DNAS of geminiviruses, rolling circle replication, Nanovirus - Banana bunchy top virus
Unit III	Genome Organization of positive-stranded RNA viruses - Potyoiridae, Potato virusY (PVY), processing of polyprotein, Comoviridae, Citrus triesteza virus; Bromoviridae, Alfalfa mosaic virus; Tubiviridae, Tobacco mosaic vrIis, Replication of TM, Tobacco rattle virus.
Unit IV	Genome Organization of negative-stranded RNA viruses; Rhabdoviridae, Sonchus yellow net virus; Bunyaviride, Tomato spotted wilt virus; Tenuivirus, Rice stripe virus; Double-stranded RNA viruses, Reoviridae, Rice dvarfvir
Unit V	Virus detection and diagnosis; Infectivity assays- Sap transmission, insect vector transmission, agroinfection (using Agrobacterium);

	Ultracentrifugation, electron microscopy, serological methods, immunelectrophoresis in gels, direct double-antibody sandwich method, Dot ELISA, Immunosorbent electron microscopy (15EV Decoration technique, Polymerase chain reaction; DNA and oligonucleotide microarray; Gene silencing PTGS& TGS, viral suppressors of gene silencing.

Suggested Readings:

1. Ed. CL. Mandahar, Molecular Biology of Plant viruses, Kluwer Academic Publishers, Dordrect, 1999.
2. Roger Hull(Ed), Mathews Plant Virology,4h Edition,Academic Press,SanDiego, 2002
3. D.G.A. Walkey (Ed), Applied Plant Virololgy, 2d Edition,Chapman& Hall,London,1991.

Department Name: Biotechnology

Program Name: M.Sc. in Biotechnology

Program Code: 303

Semester: Semester I Semester II Semester III √ Semester IV

Course Name: Environmental Biotechnology

Course Code: BIOT-GE- 310 (For new course keep it blank; else enter the old course code)

Course Credit: 4

Marks Allotted: Theoretical/Practical: 75 Continuing Evaluation: 25

Course Type (tick the correct alternatives):

Core

Department Specific Elective

Generic Elective √

Is the course focused on employability / entrepreneurship? YES √ O

Is the course focused on imparting life skill? YES NO √

Is the course based on Activity ? YES NO √

Percentage of change in syllabus (applicable in case of change in syllabus only)

Minor (up to 15%) √

Moderate (>15% and up to 50%)

Major (> 50%)

Summary of changes

PG BOS Meeting Reference Number: F.71/288/FCS/2022 Date: 18.04.22

Course Code: BIOT-GE- 310

Course Name: Environmental Biotechnology

Credits: 4

Course Objectives:

This course aims to introduce fundamentals of Environmental Biotechnology. The course will introduce major groups of microorganisms tools in biotechnology and their most important environmental applications. The environmental applications of biotechnology will be presented in detail and will be supported by examples from the national and international literature.

Student Learning Outcomes:

On completion of course, students will be able to understand use of basic microbiological, molecular and analytical methods, which are extensively used in environmental biotechnology.

Course Syllabus:

Unit I **Introduction to environment**	Introduction to environment; pollution and its control; pollution indicators; waste management: domestic, industrial, solid and hazardous wastes; strain improvement; Biodiversity and its conservation; Role of microorganisms in geochemical cycles; microbial energy metabolism, microbial growth kinetics and elementary chemostat theory, relevant microbiological processes, microbial ecology.
Unit II **Bioremediation**	Bioremediation: Fundamentals, methods and strategies of application (biostimulation, bioaugmentation) – examples, bioremediation of metals (Cr, As, Se, Hg), radionuclides (U, Te), organic pollutants (PAHs, PCBs, Pesticides, TNT etc.), technological aspects of bioremediation (in situ, ex situ).
Unit III **Role of microorganisms in bioremediation**	Application of bacteria and fungi in bioremediation: White rot fungi vs specialized degrading bacteria: examples, uses and advantages vs disadvantages; Phytoremediation: Fundamentals and description of major methods of application (phytoaccumulation, phytovolatilization, rhizofiltration phytostabilization).
Unit IV **Biotechnology and agriculture**	Bioinsecticides: Bacillus thuringiensis, Baculoviruses, uses, genetic modifications and aspects of safety in their use; Biofungicides: Description of mode of actions and mechanisms (e.g. Trichoderma, Pseudomonas fluorescens); Biofertilizers: Symbiotic systems between plants – microorganisms (nitrogen fixing symbiosis, mycorrhiza fungi symbiosis), Plant growth promoting rhizobacteria (PGPR) – uses, practical aspects and problems in application.
Unit V **Biofuels**	Environmental Biotechnology and biofuels: biogas; bioethanol; biodiesel; biohydrogen; Description of the industrial processes involved, microorganisms and biotechnological interventions for optimization of production; Microbiologically enhanced oil recovery (MEOR); Bioleaching of metals; Production of bioplastics; Production of biosurfactants: bioemulsifiers; Paper production: use of xylanases and white rot fungi.

Suggested Readings:

1. G. M. Evans and J. C. Furlong (2003), Environmental Biotechnology: Theory and Applications, Wiley Publishers.

2. B. Ritmann and P. L. McCarty, (2000), Environmental Biotechnology: Principle & Applications, 2nd Ed., McGraw Hill Science.
3. Scragg A., (2005) Environmental Biotechnology. Pearson Education Limited.
4. J. S. Devinny, M. A. Deshusses and T. S. Webster, (1998), Biofiltration for Air Pollution Control, CRC Press.
5. H. J. Rehm and G. Reed, (2001), Biotechnology – A Multi-volume Comprehensive Treatise, Vol. 11, 2nd Ed., VCH Publishers Inc.
6. H. S. Peavy, D. R. Rowe and G. Tchobanoglous, (2013), Environmental Engineering, McGraw-Hill Inc.

Department Name: Biotechnology

Program Name: M.Sc. in Biotechnology

Program Code: 303

Semester: Semester I Semester II Semester III √ Semester IV

Course Name: Protein Engineering

Course Code: BIOT-GE- 311 (For new course keep it blank; else enter the old course code)

Course Credit: 4

Marks Allotted: Theoretical/Practical: 75 Continuing Evaluation: 25

Course Type (tick the correct alternatives):

Core

Department Specific Elective

Generic Elective √

Is the course focused on employability / entrepreneurship? YES √ O

Is the course focused on imparting life skill? YES NO √

Is the course based on Activity ? YES NO √

Percentage of change in syllabus (applicable in case of change in syllabus only)

Minor (up to 15%) √

Moderate (>15% and up to 50%)

Major (> 50%)

Summary of changes

PG BOS Meeting Reference Number: F.71/288/FCS/2022 Date: 18.04.22

Course Code: BIOT-GE- 311

Course Name: Protein Engineering

Credits: 4

Course Objectives:

The aim of this course is to introduce methods and strategies commonly used in protein engineering.

Student Learning Outcomes:

On completion of this course, students should be able to:

- Analyse structure and construction of proteins by computer-based methods;
- Describe structure and classification of proteins;
- Analyse purity and stability of proteins and explain how to store them in
- best way;
- Explain how proteins can be used for different industrial and academic purposes such as structure determination, organic synthesis and drug design.

Course Syllabus:

Unit I **Introduction toprotein engineering**	Protein engineering – definition, applications; Features or characteristics of proteins that can be engineered (definition and methods of study) – affinity and specificity; Spectroscopic properties; Stability to changes in parameters as pH, temperature and amino acid sequence, aggregation propensities, etc. Protein engineering with unnatural amino acids and its applications.
Unit II **Stability of protein structure**	Methods of measuring stability of a protein; Spectroscopic methods to study physicochemical properties of proteins: far-UV and near-UV CD; Fluorescence; UV absorbance; ORD; Hydrodynamic properties–viscosity, hydrogen-deuterium exchange; Brief introduction to NMR spectroscopy – emphasis on parameters that can be measured/obtained from NMR and their interpretation.
Unit III **Applications**	Forces stabilizing proteins – Van der waals, electrostatic, hydrogen bonding and weakly polar interactions, hydrophobic effects; Entropy – enthalpy compensation; Experimental methods of protein engineering: directed evolution like gene site saturation mutagenesis; Module shuffling; Guided protein recombination, etc., Optimization and high throughput screening methodologies like GigaMetrix, High throughput microplate screens etc., Application to devices with bacteriorhodopsin as an example; Engineering antibody affinity by yeast surface display; Applications to vaccines, Peptidomimetics and its use in drug discovery.
Unit IV **Computational approaches**	Computational approaches to protein engineering: sequence and 3D structure analysis, Data mining, Ramachandran map, Mechanism of stabilization of proteins from psychrophiles and thermophiles vis-à-vis those from mesophiles; Protein design, Directed evolution for protein engineering and its potential.
Unit V **Case studies**	Case Studies.

Suggested Readings:

1. Edited by T E Creighton, (1997), Protein Structure: a Practical Approach, 2nd Edition, Oxford university press.
2. Cleland and Craik, (2006), Protein Engineering, Principles and Practice, Vol 7, Springer Netherlands.
3. Mueller and Arndt, Protein Engineering Protocols, 1st Edition, Humana Press.
4. Ed. Robertson DE, Noel JP, (2004), Protein Engineering Methods in Enzymology, 388, Elsevier Academic Press.
5. J Kyte; (2006), Structure in Protein Chemistry, 2nd Edition, Garland publishers.

Department Name: Biotechnology

Program Name: M.Sc. in Biotechnology

Program Code: 303

Semester: Semester I Semester II Semester III √ Semester IV

Course Name: Molecular Therapeutics

Course Code: BIOT-GE- 312 (For new course keep it blank; else enter the old course code)

Course Credit: 4

Marks Allotted: Theoretical/Practical: 75 Continuing Evaluation: 25

Course Type (tick the correct alternatives):

Core

Department Specific Elective

Generic Elective √

Is the course focused on employability / entrepreneurship? YES √ O

Is the course focused on imparting life skill? YES NO √

Is the course based on Activity ? YES NO √

Percentage of change in syllabus (applicable in case of change in syllabus only)

Minor (up to 15%)

Moderate (>15% and up to 50%)

Major (> 50%)

Summary of changes

New Course

PG BOS Meeting Reference Number: F.71/288/FCS/2022 Date: 18.04.2

Course Code: BIOT-GE- 312

Course Name: Molecular Therapeutics

Credits: 4

Course Objectives:

This course involves a wide range of new disease therapies such as gene therapy, cellular therapy, Recombinant therapy, immunotherapy, antisense therapy and stem cells therapy.

Student Learning Outcomes:

On completion of this course, students should be able to:

- Demonstrate an in-depth knowledge of recent developments in molecular therapeutics research specifically in the areas of gene therapy, cellular therapy, Recombinant and its role in therapy and immunotherapy.
- Demonstrate an in-depth knowledge of recent developments in Gene their silencing technology.

Course Syllabus:

Unit I	Gene therapy; Intracellular barriers to gene delivery; Overview of inherited and therapy; Unit II Retro and adeno virus mediated gene transfer; Liposome and nanoparticles acquired mediated diseases gene delivery
Unit II	Cellular stem embryonic cells; therapy; Concept stem cells; Stem of Clinical tissue cells: engineering; definition, properties Role of scaffolds; and potency Role of stem growth cells; factors; Role embryonic of adult. and adult applications; Ethical issues
Unit III	Recombinant therapy; Clinical applications of recombinant technology; Erythropoietin; Insulin analogs and its role in diabetes, Recombinant human growth hormone, Streptokinase and urokinase in thrombosis, Recombinant coagulation factors
Unit IV	Immunotherapy; Monoclonal antibodies and their role in cancer, Role of recombinant interferons, Immunostimulants, Immunosupressor in organ transplant ,Role of cytokine therapy in cancer, Vaccines: types, recombinant vaccines and clinical applications
Unit V	Gene silencing technology; Antisense therapy; siRNA; Tissue and organ transplantation; Transgenics and their uses; Ethical issues

Suggested Readings:

1. Bernhard Palsson and Sangeeta N Bhatia, Tissue Engineering, 2n Edition, Prentice Hall, 2004.
2. Pamela Greenwell, Michelle McCulley, Molecular Therapeutics: 21t century medicine. I Edition, Sringer, 2008.

Department Name: Biotechnology

Program Name: M.Sc. in Biotechnology

Program Code: 303

Semester: Semester I Semester II Semester III Semester IV √

Course Name: Project Proposal Preparation & Presentation

Course Code: BIOT-CP- 401 (For new course keep it blank; else enter the old course code)

Course Credit: 4

Marks Allotted: Theoretical/Practical: 75 Continuing Evaluation: 25

Course Type (tick the correct alternatives):

Core √

Department Specific Elective

Generic Elective

Is the course focused on employability / entrepreneurship? YES √ O

Is the course focused on imparting life skill? YES NO √

Is the course based on Activity ? YES NO √

Percentage of change in syllabus (applicable in case of change in syllabus only)

Minor (up to 15%) √

Moderate (>15% and up to 50%)

Major (> 50%)

Summary of changes

PG BOS Meeting Reference Number: F.71/288/FCS/2022 Date: 18.04.22

Semester Four

Course Code: BIOT-CP- 401

Course Name: Project Proposal Preparation & Presentation

Credits: 4

Course Objectives:

The purpose of this course is to help students organize ideas, material and objectives for their dissertation and to begin development of communication skills and to prepare the students to present their topic of research and explain its importance to their fellow classmates and teachers.

Student Learning Outcomes:

Students should be able to demonstrate the following abilities:

- Formulate a scientific question;
- Present scientific approach to solve the problem;
- Interpret, discuss and communicate scientific results in written form;
- Gain experience in writing a scientific proposal;
- Learn how to present and explain their research findings to the audience effectively.

Course Syllabus:

Project Proposal Preparation	Selection of research lab and research topic: Students should first select a lab wherein they would like to pursue their dissertation. The supervisor or senior researchers should be able to help the students to read papers in the areas of interest of the lab and help them select a topic for their project. The topic of the research should be hypothesis driven. Review of literature: Students should engage in systematic and critical review of appropriate and relevant information sources and appropriately apply qualitative and/or quantitative evaluation processes to original data; keeping in mind ethical standards of conduct in the collection and evaluation of data and other resources. Writing Research Proposal: With the help of the senior researchers, students should be able to discuss the research questions, goals, approach, methodology, data collection, etc. Students should be able to construct a logical outline for the project including analysis steps and expected outcomes and prepare a complete proposal in scientific proposal format for dissertation.
Poster Presentation	Students will have to present the topic of their project proposal after few months of their selection of the topic. They should be able to explain the novelty and importance of their research topic.
Oral Presentation	At the end of their project, presentation will have to be given by the students to explain work done by them in detail. Along with summarizing their findings they should also be able to discuss the future expected outcome of their work.

Department Name: Biotechnology

Program Name: M.Sc. in Biotechnology

Program Code: 303

Semester: Semester I Semester II Semester III Semester IV √

Course Name: Dissertation

Course Code: BIOT-CP- 402 (For new course keep it blank; else enter the old course code)

Course Credit: 4

Marks Allotted: Theoretical/Practical: 75 Continuing Evaluation: 25

Course Type (tick the correct alternatives):

Core √

Department Specific Elective

Generic Elective

Is the course focused on employability / entrepreneurship? YES √ O

Is the course focused on imparting life skill? YES NO √

Is the course based on Activity ? YES NO √

Percentage of change in syllabus (applicable in case of change in syllabus only)

Minor (up to 15%) √

Moderate (>15% and up to 50%)

Major (> 50%)

Summary of changes

PG BOS Meeting Reference Number: F.71/288/FCS/2022 Date: 18.04.22

Course Code: BIOT-CP- 402

Course Name: Dissertation

Credits: 4

Course Objectives:

The objectives of this course are to prepare the students to adapt to the research environment and understand how projects are executed in a research laboratory. It will also enable students to learn practical aspects of research and train students in the art of analysis and thesis writing.

Student Learning Outcomes:

Students should be able to learn how to select and defend a topic of their research, how to effectively plan, execute, evaluate and discuss their experiments. Students should be able to demonstrate considerable improvement in the following areas:

- In-depth knowledge of the chosen area of research.
- Capability to critically and systematically integrate knowledge to identify issues that must be addressed within framework of specific thesis.
- Competence in research design and planning.
- Capability to create, analyse and critically evaluate different technical solutions.
- Ability to conduct research independently.
- Ability to perform analytical techniques/experimental methods.
- Project management skills.
- Report writing skills.
- Problem solving skills.
- Communication and interpersonal skills.

Course Syllabus:

Planning & performing experiments	Based on the project proposal submitted in earlier semester, students should be able to plan, and engage in, an independent and sustained critical investigation and evaluate a chosen research topic relevant to biological sciences and society. They should be able to systematically identify relevant theory and concepts, relate these to appropriate method- ologies and evidence, apply appropriate techniques and draw appropriate conclusions. Senior researchers should be able to train the students such that they can work inde- pendently and are able to understand the aim of each experiment performed by them. They should also be able to understand the possible outcomes of each experiment.
Thesis writing	At the end of their project, thesis has to be written giving all the details such as aim, methodology, results, discussion and future work related to their project. Students may aim to get their research findings published in a peer-reviewed journal. If the research findings have application-oriented outcomes, the students may file patent application.

Department Name: Biotechnology

Program Name: M.Sc. in Biotechnology

Program Code: 303

Semester: Semester I Semester II Semester III Semester IV √

Course Name: Research Methodology and Scientific Communication

Course Code: BIOT-CT- 403 (For new course keep it blank; else enter the old course code)

Course Credit: 4

Marks Allotted: Theoretical/Practical: 75 Continuing Evaluation: 25

Course Type (tick the correct alternatives):

Core √

Department Specific Elective

Generic Elective

Is the course focused on employability / entrepreneurship? YES √ NO

Is the course focused on imparting life skill? YES NO √

Is the course based on Activity ? YES NO √

Percentage of change in syllabus (applicable in case of change in syllabus only)

Minor (up to 15%) √

Moderate (>15% and up to 50%)

Major (> 50%)

Summary of changes

PG BOS Meeting Reference Number: F.71/288/FCS/2022 Date: 18.04.22

Course Code: BIOT-CT- 403

Course Name: Research Methodology and Scientific Communication Skills

Credits: 4

Course Objectives:

The objectives of this course are to give background on history of science, emphasizing methodologies used to do research, use framework of these methodologies for understanding effective lab practices and scientific communication and appreciate scientific ethics.

Student Learning Outcomes:

Students should be able to:

- Understand history and methodologies of scientific research, applying these to recent published papers;
- Understand and practice scientific reading, writing and presentations;
- Appreciate scientific ethics through case studies.

Course Syllabus:

Unit I **History of science and science methodologies**	Empirical science; scientific method; manipulative experiments and controls; deductive and inductive reasoning; descriptive science; reductionist vs holistic biology.
Unit II **Preparation for research**	Choosing a mentor, lab and research question; maintaining a lab notebook.
Unit III **Process of communication**	Concept of effective communication- setting clear goals for communication; determining outcomes and results; initiating communication; avoiding breakdowns while communicating; creating value in conversation; barriers to effective communication; non-verbal communication-interpreting non-verbal cues; importance of body language, power of effective listening; recognizing cultural differences; Presentation skills - formal presentation skills; preparing and presenting using over-head projector, PowerPoint; defending interrogation; scientific poster preparation & presentation; participating in group discussions; Computing skills for scientific research - web browsing for information search; search engines and their mechanism of searching; hidden Web and its importance in scientific research; internet as a medium of interaction between scientists; effective email strategy using the right tone and conciseness.
Unit IV **Scientific communication**	Technical writing skills - types of reports; layout of a formal report; scientific writing skills - importance of communicating science; problems while writing a scientific document; plagiarism, software for plagiarism; scientific publication writing: elements of a scientific paper including abstract, introduction, materials & methods, results, discussion, references; drafting titles and framing abstracts; publishing scientific papers - peer review process and problems, recent developments such as

	open access and non- blind review; plagiarism; characteristics of effective technical communication; scientific presentations; ethical issues; scientific misconduct.

Suggested Readings:

1. Valiela, I. (2001). Doing Science: Design, Analysis, and Communication of Scientific Research. Oxford: Oxford University Press.
2. On Being a Scientist: a Guide to Responsible Conduct in Research. (2009). Washington, D.C.: National Academies Press.
3. Gopen, G. D., & Smith, J. A. The Science of Scientific Writing. American Scientist, 78 (Nov-Dec 1990), 550-558.
4. Mohan, K., & Singh, N. P. (2010). Speaking English Effectively. Delhi: Macmillan India.
5. Movie: Naturally Obsessed, The Making of a Scientist.

Department Name: Biotechnology

Program Name: M.Sc. in Biotechnology

Program Code: 303

Semester: Semester I Semester II Semester III Semester IV √

Course Name: Critical Analysis of Classical Papers

Course Code: BIOT-CP- 404 (For new course keep it blank; else enter the old course code)

Course Credit: 4

Marks Allotted: Theoretical/Practical: 75 Continuing Evaluation: 25

Course Type (tick the correct alternatives):

Core √

Department Specific Elective

Generic Elective

Is the course focused on employability / entrepreneurship? YES √ O

Is the course focused on imparting life skill? YES NO √

Is the course based on Activity ? YES NO √

Percentage of change in syllabus (applicable in case of change in syllabus only)

Minor (up to 15%) √

Moderate (>15% and up to 50%)

Major (> 50%)

Summary of changes

PG BOS Meeting Reference Number: F.71/288/FCS/2022 Date: 18.04.22

Course Code: BIOT-CP- 404

Course Name: Critical Analysis of Classical Papers

Credits: 4

Course Objectives:

The objectives of this course are to familiarize students with classic literature to make them appreciate how ground- breaking discoveries were made without, necessarily, use of high-end technologies.

Student Learning Outcomes:

Students should be able to train in the exercise of hypothesis building and methods of addressing the hypothesis with readily available technology.

Course Syllabus:

How does the Course Module work? Students may be divided in groups and each group may be responsible for one classical paper. Each week there may be a 1.5-hour presentation cum discussion for each of the papers. At the end of the semester each student will be asked to write a mini-review (2-3 pages long) on any one classical paper, other than the one he/she presented/discussed.

A list of sixteen classic papers and some suggested reference materials:

Molecular Biology	1. Studies on the chemical nature of the substance inducing transformation of Pneumococcal types: Induction of transformation by a desoxyribonucleic acid fraction isolated from Pneumococcus type III. Avery OT, Macleod CM, McCarty M.; J Exp Med. 1944 Feb 1;79(2):137-58. Note: This paper demonstrates that DNA is the transforming Principle originally described by Fredrick Griffith. 2. Independent functions of viral protein and nucleic acid in growth of bacteriophage Hershey AD and Chase M.; J Gen Physiol. 1952 May;36(1):39-56. Note: Note: This paper demonstrates that DNA, and not protein, component of phages enter bacterial cells. 3. Molecular structure of nucleic acids; a structure for deoxyribose nucleic acid Watson JD and Crick FH; Nature. 1953 Apr 25;171(4356):737-8 Note: In this one page paper Watson and Crick first described the structure of DNA double helix Study help - Watson_Crick_Nature_1953_annotated 4. Transposable mating type genes in Saccharomyces cerevisiae James Hicks, Jeffrey N. Strathern & Amar J.S. Klar; Nature 282, 478-483,1979 Note: This paper provided evidence for 'cassette hypothesis' of yeast mating type switches i.e. interconversion of mating types in yeast (S. cerevisiae) occurs by DNA rearrangement. 5. Messelson & Stahl experiment demonstrating semi-conservative replication of DNA. Meselson M and Stahl FW.; Proc Natl Acad Sci U S A. 1958 Jul 15;44(7):671-82 Note: The experiment demonstrating semi-conservative mode of DNA replication is referred to as "the most beautiful experiment in biology" 6. In vivo alteration of telomere sequences and senescence caused by

	mutated Tetrahymena telomerase RNAs Guo-Liang Yu, John D. Bradley, Laura D. Attardi & Elizabeth H. Blackburn; Nature 344, 126-132, 1990 Note: This paper demonstrates that the telomerase contains the template for telomere synthesis
Cell Biology	1. A protein-conducting channel in the endoplasmic reticulum Simon SM AND Blobel G.; Cell. 1991 May 3;65(3):371-80 Note: This paper demonstrates the existence of a protein conducting channel Study help - A brief history of Signal Hypothesis 2. Identification of 23 complementation groups required for post-translational events in the yeast secretory pathway Novick P, Field C, Schekman R.; Cell. 1980 Aug;21(1):205-15 Note: In this groundbreaking paper Randy Schekman's group used a mutagenesis screen for fast sedimenting yeast mutants to identify genes involved in cell secretion 3. A yeast mutant defective at an early stage in import of secretory protein precursors into the endoplasmic reticulum Deshaies RJ and Schekman R.; J Cell Biol. 1987 Aug;105(2):633-45 Note: Using another yeast mutation screen Schekman lab identifies Sec61, a component of ER protein Conducting Channel (PCC) Suggested reference paper - A biochemical assay for identification of PCC. 4. Reconstitution of the Transport of Protein between Successive Compartments of the Golgi Balch WE, Dunphy WG, Braell WA, Rothman JE.; Cell. 1984 Dec;39(2 Pt 1):405-16 Note: This paper describes setting up of an in vitro reconstituted system for transport between golgi stacks which eventually paved the way for identification of most of the molecular players involved in these steps including NSF, SNAP etc. 5. A complete immunoglobulin gene is created by somatic recombination Brack C, Hirama M, Lenhard-Schuller R, Tonegawa S.; Cell. 1978 Sep;15(1):1-14 Note: This study demonstrates DNA level molecular details of somatic rearrangement of immunoglobulin gene sequences leading to the generation of functionally competent antibody generating gene following recombination. 6. A novel multigene family may encode odorant receptors: a molecular basis for odor recognition Buck L and Axel R; Cell. 1991 Apr 5;65(1):175-87 Note: This paper suggests that different chemical odorants associate with different cell-specific expression of a transmembrane receptor in Drosophila olfactory epithelium where a large family of odorat receptors is expressed. 7. Kinesin walks hand-over-hand Yildiz A, Tomishige M, Vale RD, Selvin PR.; Science. 2004 Jan 30;303(5658):676-8 Note: This paper shows that kinesin motor works as a two-headed dimeric motor walking hand-over-hand rather than like an inchworm on microtubule tract using the energy of ATP hydrolysis.
Developmental Biology/ Genetics	1. Mutations affecting segment number and polarity in Drosophila Christiane Nusslein-Volhard and Eric Weischaus; Nature 287, 795-

	801, 1980 Note: This single mutagenesis screen identified majority of the developmentally important genes not only in flies but in other metazoans as well. 2. Information for the dorsal--ventral pattern of the Drosophila embryo is stored as maternal mRNA Anderson KV and Nüsslein-Volhard C; Nature. 1984 Sep 20-26;311(5983):223-7 Note: This landmark paper demonstrated that early dorsal-ventral pattern information is stored as maternal mRNA in flies and devised the method of identifying genes encoding such genes 3. Hedgehog signalling in the mouse requires intraflagellar transport proteins Huangfu D, Liu A, Rakeman AS, Murcia NS, Niswander L, Anderson KV.; Nature. 2003 Nov 6;426(6962):83-7 Note: One of the architects of original fly mutagenesis screens conducted a mouse mutagenes screen which identified a gene Kif3a as a major component of hedgehog signaling pathway. Eventually this discovery revolutionizes our understanding of mechanisms of action of signaling pathways by demonstrating central role of cillia in it. Suggested Reference paper - Design and execution of a embryonic lethal mutation screen in mouse.

Department Name: Biotechnology

Program Name: M.Sc. in Biotechnology

Program Code: 303

Semester: Semester I Semester II Semester III Semester IV √

Course Name: Emerging Technologies

Course Code: BIOT-DSE- 405 (For new course keep it blank; else enter the old course code)

Course Credit: 4

Marks Allotted: Theoretical/Practical: 75 Continuing Evaluation: 25

Course Type (tick the correct alternatives):

Core

Department Specific Elective √

Generic Elective

Is the course focused on employability / entrepreneurship? YES √ NO

Is the course focused on imparting life skill? YES NO √

Is the course based on Activity ? YES NO √

Percentage of change in syllabus (applicable in case of change in syllabus only)

Minor (up to 15%) √

Moderate (>15% and up to 50%)

Major (> 50%)

Summary of changes

Minor changes.

PG BOS Meeting Reference Number: F.71/288/FCS/2022 Date: 18.04

Course Code: BIOT-DSE- 405

Course Name: Emerging Technologies

Credits: 4

Course Objectives:

This course is broad-based in nature encompassing several new technologies that current experimental researchers are employing to probe complex system biology questions in life-sciences. The objectives of this course are to teach basics of the new principles to students so as to appreciate current-day research tool-kit better.

Student Learning Outcomes:

Students should be to learn history, theoretical basis and basic understanding of latest technologies in area of biotechnology. They should also be able to learn about various applications of these technologies. The students may also learn one application in depth through an assignment and/or seminar.

Course Syllabus:

Unit I **Optical microscopy methods**	Basic Microscopy: Light Microscopy: lenses and microscopes, resolution: Rayleigh's Approach, Darkfield; Phase Contrast; Differential Interference Contrast; fluorescence and fluorescence microscopy: what is fluorescence, what makes a molecule fluorescent, fluorescence microscope; optical arrangement, light source; filter sets: excitation filter, dichroic mirror, and barrier, optical layout for image capture; CCD cameras; back illumination, binning; recording color; three CCD elements with dichroic beamsplitters, boosting the signal. Advanced Microscopy: Confocal microscope: scanning optical microscope, confocal principle, resolution and point spread function, light source: gas lasers & solid-state, primary beamsplitter; beam scanning, pinhole and signal channel configurations, detectors; pixels and voxels; contrast, spatial sampling: temporal sampling: signal-to- noise ratio, multichannel images. nonlinear microscopy: multiphoton microscopy; principles of two-photon fluorescence, advantages of two-photon excitation, tandem scanning (spinning disk) microscopes, deconvolving confocal images; image processing, three-dimensional reconstruction; advanced fluorescence techniques: FLIM, FRET, and FCS, Fluorescence Lifetime, Fluorescence Resonant Energy Transfer (FRET), Fluorescence Correlation Spectroscopy (FCS), Evanescent Wave Microscopy; Near-Field and Evanescent Waves, Total Internal Reflection Microscopy; Near-Field Microscopy; Beyond the Diffraction Limit: Stimulated Emission Depletion (STED), Super-Resolution Summary, Super-Resolution Imaging with Stochastic Optical Reconstruction Microscopy (STORM) and Photoactivated Localization Microscopy (PALM).
Unit II **Mass spectroscopy**	Ionization techniques; mass analyzers/overview MS; FT-ICR and Orbitrap, fragmentation of peptides; proteomics, nano LC-MS; Phospho proteomics; interaction proteomics, mass spectroscopy in structural biology; imaging mass spectrometry.
Unit III **Systems biology**	High throughput screens in cellular systems, target identification, validation of experimental methods to generate the omics data, bioinformatics analyses, mathematical modeling and designing testable predictions.

Unit IV **Structural biology**	X-ray diffraction methods, solution & solid-state NMR, cryo-electron microscopy, small- angle X-ray scattering, Atomic force microscopy.
Unit V **CRISPR-CAS**	History of its discovery, elucidation of the mechanism including introduction to all the molecular players, development of applications for in vivo genome engineering for genetic studies, promise of the technology as a next generation therapeutic method.
Unit VI **Nanobodies**	History of its discovery, elucidation of the mechanism including introduction to all the molecular players, development of applications for in vivo genome engineering for genetic studies, promise of the technology as a next generation therapeutic method.

Suggested Readings:

1. Campbell, I. D. (2012). Biophysical Techniques. Oxford: Oxford University Press.
2. Serdyuk, I. N., Zaccai, N. R., & Zaccai, G. (2007). Methods in Molecular Biophysics: Structure, Dynamics, Function. Cambridge: Cambridge University Press.
3. Phillips, R., Kondev, J., & Theriot, J. (2009). Physical Biology of the Cell. New York: Garland Science.
4. Nelson, P. C., Radosavljević, M., & Bromberg, S. (2004). Biological Physics: Energy, Information, Life. New York: W.H. Freeman.
5. Huang, B., Bates, M., & Zhuang, X. (2009). Super-Resolution Fluorescence Microscopy. Annual Review of Biochemistry, 78(1), 993-1016. doi:10.1146/annurev. biochem.77.061906.092014.
6. Mohanraju, P., Makarova, K. S., Zetsche, B., Zhang, F., Koonin, E. V., & Oost, J. V. (2016). Diverse Evolutionary Roots and Mechanistic Variations of the CRISPR-Cas Systems. Science, 353(6299). doi:10.1126/science.aad5147.
7. Lander, E. (2016). The Heroes of CRISPR. Cell, 164(1-2), 18-28. doi:10.1016/j. cell.2015.12.041.
8. Ledford, H. (2016). The Unsung Heroes of CRISPR. Nature, 535(7612), 342-344. doi:10.1038/535342a.
9. Jinek, M., Chylinski, K., Fonfara, I., Hauer, M., Doudna, J. A., & Charpentier, E. (2012). A Programmable Dual-RNA-Guided DNA Endonuclease in Adaptive Bacterial Immunity. Science, 337(6096), 816-821. doi:10.1126/science.1225829.
10. Hamers-Casterman, C., Atarhouch, T., Muyldermans, S., Robinson, G., Hammers, C., Songa, E. B., Hammers, R. (1993). Naturally Occurring Antibodies Devoid of Light Chains. Nature, 363(6428), 446-448. doi:10.1038/363446a0.
11. Sidhu, S. S., & Koide, S. (2007). Phage Display for Engineering and Analyzing Protein Interaction Interfaces. Current Opinion in Structural Biology, 17(4), 481-487. doi:10.1016/j.sbi.2007.08.007.
12. Steyaert, J., & Kobilka, B. K. (2011). Nanobody Stabilization of G Protein-Coupled Receptor Conformational States. Current Opinion in Structural Biology, 21(4), 567-572. doi:10.1016/j.sbi.2011.06.011.
13. Vincke, C., & Muyldermans, S. (2012). Introduction to Heavy Chain Antibodies and Derived Nanobodies. Single Domain Antibodies, 15-26. doi:10.1007/978-1-61779- 968-6_2.
14. Verheesen, P., & Laeremans, T. (2012). Selection by Phage Display of Single Domain Antibodies Specific to Antigens in their Native Conformation. Single Domain Antibodies, 81-104. doi:10.1007/978-1-61779-968-6_6.

15. Li, J., Xia, L., Su, Y., Liu, H., Xia, X., Lu, Q. Reheman, K. (2012). Molecular Imprint of Enzyme Active Site by Camel Nanobodies. Journal of Biological Chemistry J. Biol. Chem., 287(17), 13713-13721. doi:10.1074/jbc.m111.336370.
16. Sohier, J., Laurent, C., Chevigné, A., Pardon, E., Srinivasan, V., Wernery, U. Galleni, M. (2013). Allosteric Inhibition of VIM Metallo-β-Lactamases by a Camelid Nanobody. Biochemical Journal, 450(3), 477-486. doi:10.1042/bj20121305.
17. Chakravarty, R., Goel, S., & Cai, W. (2014). Nanobody: The "Magic Bullet" for Molecular Imaging? Theranostics, 4(4), 386-398. doi:10.7150/thno.8006.

Department Name: Biotechnology

Program Name: M.Sc. in Biotechnology

Program Code: 303

Semester: Semester I Semester II Semester III Semester IV √

Course Name: Cancer Genetics

Course Code: BIOT-DSE-406 (For new course keep it blank; else enter the old course code)

Course Credit: 4

Marks Allotted: Theoretical/Practical: 75 Continuing Evaluation: 25

Course Type (tick the correct alternatives):

Core

Department Specific Elective √

Generic Elective

Is the course focused on employability / entrepreneurship? YES √ O

Is the course focused on imparting life skill? YES NO √

Is the course based on Activity ? YES NO √

Percentage of change in syllabus (applicable in case of change in syllabus only)

Minor (up to 15%)

Moderate (>15% and up to 50%)

Major (> 50%)

Summary of changes

PG BOS Meeting Reference Number: F.71/288/FCS/2022 Date: 18.04.22

Course Code: BIOT-DSE-406

Course Name: Cancer Genetics

Credits: 4

Course Objectives:

The objectives of this course are to build fundamental knowledge of cancer genetics and genomics. The course shall make the students aware of the genes and pathways that are mutated in various cancer types, mechanisms leading to cancer mutations and cancer development, current genetic and genomic methods used to study and to diagnose cancer, and how genetics and genomics are informing cancer treatment.

Student Learning Outcomes:

On completion of this course, students should be able to:

- Explain the basic pathways and genes that lead to the development of cancer.
- Describe the various factors and complexity of genetic mutations in cancer.
- Be able to interpret genomic data and graphs relating to cancer mutations and cancer biology.

Course Syllabus:

Unit I	Introduction: Types and general characteristics of tumours; Chromosomal aberrations in neoplasia; Cell cycle check point and cancer
Unit II	Cell transformation and tumorigenesis: Oncogenes; Tumour suppressor genes; DNA repair genes and genetic instability; Epigenetic modification, telomerase activity, centrosome malfunction; genetic heterogenecity and clonal evolution
Unit III	Familial cancers: Retinoblastoma, Wilms' tumour, Li-Fraumeni syndrome, colorectal cancer, breast cancer; Genetic predisposition to sporadic cancer
Unit IV	Tumour progression: angiogenesis and metastasis; Tumour specific markers
Unit V	Lancer and environment: physical, chemical and biological carcinogens; Cancer risk assessment, gene therapy and counseling

Suggested Readings:

1. Aberts et al, The Science ofGenetics, Saunders, 1999.
2. Alberts et al., Molecular Biology of the Cell, Garland 2008.
3. Benjamin, Genetics: A Conceptual Approach, 3d Edition, Freeman, 2007
4. Berg and Singer, Genes and Genome, 1998,
5. Black, Microbiology: Principlesand Explorations, 6h Edition Wiley, 2004.
6. Cowell, Molecular Genetics ofCancer,2nd Revised Edition, Bios, 2001

Department Name: Biotechnology

Program Name: M.Sc. in Biotechnology

Program Code: 303

Semester: Semester I Semester II Semester III Semester IV √

Course Name: Clinical Trials & Bioethics

Course Code: BIOT-GE- 407 (For new course keep it blank; else enter the old course code)

Course Credit: 4

Marks Allotted: Theoretical/Practical: 75 Continuing Evaluation: 25

Course Type (tick the correct alternatives):

Core

Department Specific Elective

Generic Elective √

Is the course focused on employability / entrepreneurship? YES √ O

Is the course focused on imparting life skill? YES NO √

Is the course based on Activity ? YES NO √

Percentage of change in syllabus (applicable in case of change in syllabus only)

Minor (up to 15%)

Moderate (>15% and up to 50%)

Major (> 50%)

Summary of changes

PG BOS Meeting Reference Number: F.71/288/FCS/2022 Date: 18.04.22

Course Code: BIOT-GE- 407

Course Name: Clinical Trials & Bioethics

Credits: 4

Course Objectives:

The course introduces students to some of the key ethical, legal, and policy issues that investigators encounter as they conduct clinical research.

Student Learning Outcomes:

On completion of this course, students should be able to:

- relationship between science and ethics in clinical research.
- Recognize the ethical aspects of the design and conduct of clinical research that require explicit assessment and justification.
- Understand key regulations that govern clinical research.

Course Syllabus:

Unit I	Fundamentals of clinical trials; Basic statistics for clinical trials; Clinical trials in practice; Reporting and reviewing clinical trials; Legislation and good clinical practice overview of the European directives and legislation governing clinical on 21st century; International perspectives; Principles of the International Committee Harmonisation trials in the (ICH)-GCP.
Unit II	Drug development and trail planning- pre study requirements for clinical trials; Regulatory approval for clinical trials; Consort statement; Trials responsibilities and protocol- roles and responsibilities of investigations, sponsor and others; Requirements of clinical trials protocols; Legislative requirements for investigational medicinal products.
Unit III	Project management in clinical Research trials – principles of project management; Application in clinical trial management; Risk management; Research ethics and Bioethics-Principles of research ethics; Ethical issues in clinical trials; Use of human in scientific experiments; Ethical committee system including a historical overview; the informed consent; Introduction to ethical codes and conduct; Introduction to animal ethics; Animal right and use of animals in the advancement of medical technology; Introduction to laws and regulation regarding use of animals in research.
Unit IV	Consent and data protection- the principles of informed consent; Consent processes; Data protection; Legislation and its application; Data management - Introduction to trial master files processes; and essential Data documents; Data management.
Unit V	Quality assurance and governance- quality control in clinical trials; Monitoring and audit; Inspection ; Pharmacovigilance; Research governance; Trials closure and pitfalls-trials closure; Reporting and legal requirements; Common pitfalls in clinical trials management.

Suggested Readings:

1. Basic and Clinical Pharmacology, Prentice hall, International, Katzung, B.G
2. Clinical pharmacokinetics, Pub. Springer Verlab, Dr. D.R Krishna, V. Klotz
3. Clinical Pharmacy and therapeutics Herfindal E T and Hirschman JL, Williams and Wilkins,
4. Methodology of Clinical Drug Trials, 2nd Edition. Spriet A., Dupin-Spriet T., Simon P. Publisher: Karger.

Department Name: Biotechnology

Program Name: M.Sc. in Biotechnology

Program Code: 303

Semester: Semester I Semester II Semester III Semester IV √

Course Name: Vaccines

Course Code: BIOT-GE- 408 (For new course keep it blank; else enter the old course code)

Course Credit: 4

Marks Allotted: Theoretical/Practical: 75 Continuing Evaluation: 25

Course Type (tick the correct alternatives):

Core

Department Specific Elective

Generic Elective √

Is the course focused on employability / entrepreneurship? YES √ O

Is the course focused on imparting life skill? YES NO √

Is the course based on Activity ? YES NO √

Percentage of change in syllabus (applicable in case of change in syllabus only)

Minor (up to 15%)

Moderate (>15% and up to 50%)

Major (> 50%)

Summary of changes

PG BOS Meeting Reference Number: F.71/288/FCS/2022 Date: 18.04.22

Course Code: BIOT-GE- 408

Course Name: Vaccines

Course Objectives:

This course will provide students with an overview of vaccines for viral and bacterial diseases. An introduction to vaccine development will be given including the history of vaccines.

Student Learning Outcomes:

On completion of this course, students should be able to:

- Understand the process of the function and development of vaccines.
- Know the use of adjuvants in vaccines.
- Understand differences in vaccines in terms of their production and their modes of prevention

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Course Syllabus:

Unit I	Innate Immunity; Activation of the Innate Immunity through TLR mediated signaling; Adaptive Immunity; T and B cell in adaptive immunity; Immunity response in infection; Protective immune response in bacterial , Viral and parasitic infections, Correlates of protection
Unit II	Vaccination and imnmune response; Appropriate and inappropriate immune response during infection: CD4+ and CD8+ memory T cells; Memory B cells; Generation and Maintenance memory T and B cells; Dendritic cells in immune response.
Unit III	Adjuvants in Vaccination; Induction of Th1 and Th2 responses and by cytokines; using appropriate adjuvants; Microbial, Liposomal and Microparticles as adjuvant; Chemokines and cytokines; Role of soluble mediators in vaccination; Oral immunization and mucosal Immunity
Unit IV	Conventional vaccines; Bacterial vaccines; Live attenuated and inactivated vaccine; Subunit Vaccines and Toxoids; Peptide Vaccine
Unit V	New Vaccine Technologies; Rationally designed Vaccines; DNA Vaccination; Mucosal vaccination; New approaches for vaccine delivery; Engineering virus vectors for vaccination; Vaccines for specific targets Tuberculosis Vaccine; Malaria Vaccine; HIV vaccine

Suggested Readings:

1. Edited by Stefan H.E. Kaufmann, Novel Vaccination Strategies, Wiley-VCH Verlag GmbH& Co. KgaA,2004 or later edition.
2. Topley && Wilson's, Microbiology and Microbial Infections Immunology Edited by Stefan H.E. Kaufmann and Michael W Steward Holder Arnold, ASM Press, 2005 or later edition.
3. Edition Charles A Janeway. Jr, Paul Travers, Mark Walport and Mark] Shlomchik, lmmuno Biology. The Immune system in health and Disease, 6th Edition, Garland Science, New York, 2005 or later edition.

4. Annual Review ofImmunology: Relevant issues
5. Annual Review ofMicrobiology: Relevant issues

Department Name:	Biotechnology
Program Name:	M.Sc. in Biotechnology
Program Code:	303

Semester: Semester I Semester II Semester III Semester IV √

Course Name: Nanobiotechnology

Course Code: BIOT-GE- 409 (For new course keep it blank; else enter the old course code)

Course Credit: 4

Marks Allotted: Theoretical/Practical: 75 Continuing Evaluation: 25

Course Type (tick the correct alternatives):

Core

Department Specific Elective

Generic Elective √

Is the course focused on employability / entrepreneurship? YES √ O

Is the course focused on imparting life skill? YES NO √

Is the course based on Activity ? YES NO √

Percentage of change in syllabus (applicable in case of change in syllabus only)

Minor (up to 15%)

Moderate (>15% and up to 50%)

Major (> 50%)

Summary of changes

New Course

PG BOS Meeting Reference Number: F.71/288/FCS/2022 Date: 18.04.22

Course Code: BIOT-GE- 409

Course Name: Nanobiotechnology

Credits: 4

Course Objectives:

The course aims at providing a general and broad introduction to multi-disciplinary field of nanotechnology. It will familiarize students with the combination of the top-down approach of microelectronics and micromechanics with the bottom-up approach of chemistry/biochemistry; a development that is creating new and exciting cross-disciplinary research fields and technologies. The course will also give an insight into complete systems where nanotechnology can be used to improve our everyday life.

Student Learning Outcomes:

On successful completion of this course, students should be able to describe basic science behind the properties of materials at nanometer scale, and the principles behind advanced experimental and computational techniques for studying nanomaterials.

Course Syllabus:

Unit I **Introduction to nanobiotechnology**	Introduction to Nanobiotechnology; Concepts, historical perspective; Different formats of nanomaterials and applications with example for specific cases; Cellular Nanostructures; Nanopores; Biomolecular motors; Bio-inspired Nanostructures, Synthesis and characterization of different nanomaterials.
Unit II **Nano-films**	Thin films; Colloidal nanostructures; Self Assembly, Nanovesicles; Nanospheres; Nanocapsules and their characterisation.
Unit III **Nanoparticles**	Nanoparticles for drug delivery, concepts, optimization of nanoparticle properties for suitability of administration through various routes of delivery, advantages, strategies for cellular internalization and long circulation, strategies for enhanced permeation through various anatomical barriers.
Unit IV **Applications of nanoparticles**	Nanoparticles for diagnostics and imaging (theranostics); concepts of smart stimuli responsive nanoparticles, implications in cancer therapy, nanodevices for biosensor development.
Unit V **Nanomaterials**	Nanomaterials for catalysis, development and characterization of nanobiocatalysts, application of Nano scaffolds in synthesis, applications of nanobiocatalysis in the production of drugs and drug intermediates.
Unit VI **Nano toxicity**	Introduction to Safety of nanomaterials, Basics of nanotoxicity, Models and assays for Nanotoxicity assessment; Fate of nanomaterials in different stratas of environment; Ecotoxicity models and assays; Life Cycle Assessment, containment.

Suggested Readings:

1. GeroDecher, Joseph B. Schlenoff, (2003); Multilayer Thin Films: Sequential Assembly of Nanocomposite Materials, Wiley-VCH Verlag GmbH & Co. KGaA
2. David S. Goodsell, (2004); Bionanotechnology: Lessons from Nature; Wiley-Liss
3. Neelina H. Malsch (2005), Biomedical Nanotechnology, CRC Press
4. Greg T. Hermanson, (2013); Bioconjugate Techniques, (3rd Edition); Elsevier
5. Recent review papers in the area of Nanomedicine.

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