

		The Maharaja Sayajirao University of Baroda Faculty of Science Department of Microbiology Phone : 0265-2794396		ACADEMIC YEAR 2020-2021	
<u>M.Sc. Biotechnology : Regular</u>					
YEAR	I	CORE BTY2101C01 General Microbiology		CREDI T	3
Semester	I			HOURS	45
OBJECTIVES:		To introduce students to basic microbiology, microbial methods, structure of bacteria, growth, host-parasite interaction, and microbial diseases			
COURSE CONTENT / SYLLABUS					
UNIT-I	Introductory Microbiology				15 hrs.
	History and scope of Microbiology Bacterial Nutrition-Major and minor bioelements, nutritional diversity, oxygenic & anoxygenic, photosynthesis, respiration, fermentations, chemolithotrophy, syntrophy Ultrastructure of bacteria-Endospore, Cell wall, Flagella, Cell membrane, Pili,Capsule Bacterial growth-Kinetics & measurements, methods of estimation, growth curve, factors affecting growth, batch, continuous and fed batch growth, synchronous growth.				
UNIT-II	Microbial systematics, evolution and biodiversity				15 hrs.
	Classification of bacteria - GC content analysis and nucleic acid hybridization, 16S rRNA sequence based phylogeny, Archaeobacteria. Origin of life: universal ancestor, Origin of eukaryotic cells.				
UNIT-III	Microbial Pathogenesis and Host-microbes interaction				15 hrs.
	Diagnostic principles, control and prevention; Bacterial, Fungal, Rickettsia, Mycoplasma and Protozoal diseases, virulence in bacterial pathogenesis Principles of antimicrobial chemotherapy; Antibacterial, antifungal and antiviral drugs. Antibiotics: Mode of action; Antibiotic resistance Viruses: Introduction, Classification of viruses; Viral structure; DNA and RNA viruses, Viral diseases Host-pathogen interaction, ecological impact of microbes; symbiosis (Nitrogen fixation and ruminant symbiosis); microbes and nutrient cycles; microbial communication system; bacterial quorum sensing				
REFERENCES					
1.	Brock Biology of Microorganisms - M.T. Madigan, J.M. Martinko, K. S. Bender & D. H. Buckley, 14 th edition; 2014.				
2.	General microbiology- R. Y. Stanier, M. Doudoroff & E. A. Adelberg, 4 th edition;1997				
3.	Microbiology - L.M Prescott, J.P.Harley and D.A. Klein, 4 th edition; 1999.				
4.	Microbiology - M. J. Pelczar, E.C.S. Chan & N. R. Krieg, 5 th edition; 1993.				
5.	Principles of Microbiology - R. M. Atlas, 2 nd edition ; 1996.				
6.	Schaechter's Mechanisms of Microbial Disease / Edition 5 by N. Cary Engleberg, Terence Dermody, Victor DiRita				

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M.Sc. Biotechnology: Regular							
YEAR		I	CORE			CREDIT	3
Semester		I	BTY2102 C02 Immunology			HOURS	45
OBJECTIVES:		To familiarize the students about structural features of components of immune system as well as their function. The major emphasis of this course will be on development of immune system and mechanisms by which our body elicits immune response.					
COURSE CONTENT / SYLLABUS							
UNIT-I		Immunology: fundamental concepts and overview of the immune system				15 hrs.	
		Overview, Cells and organs of immune system, primary and secondary lymphoid organs, mucosal immunity. Components of innate and acquired immunity; phagocytosis; complement and inflammatory responses. Innate immune response -pathogen recognition receptors (PRR) and pathogen associated molecular pattern (PAMP). Antigens: immunogens, non-peptide bacterial antigens and super-antigens, hapten carrier system. Major Histocompatibility Complex: MHC genes, antigen processing and presentation, immune responsiveness and disease susceptibility. Basis of self & non-self discrimination, Immune Tolerance.					
UNIT-II		Humoral responses				15 hrs.	
		Immunoglobulins - basic structure, classes & subclasses of immunoglobulins, Immunoglobulin effector functions, antigenic determinants; multigene organization of immunoglobulin genes; generation of antibody diversity B-cell receptor, B cell maturation, activation and differentiation; memory					
Unit III		T cell responses				15 hrs.	
		T-cell receptor, T-cell development and maturation, activation and differentiation; functional T Cell subsets; cell-mediated immune responses, Cytokines and chemokines; Hypersensitivity Types, properties, and therapeutic uses.					
REFERENCES							
1.	Kuby Immunology- J.A. Owen, J. Punt & S.A. Stranford,& P. Jones 7 th ed. 2013 , W. H. Freeman and Company.						
2.	Roitt's Essential Immunology- I. M. Roitt & P. J. Delves 10 th ed.2001 , Blackwell Science.						
3.	Clinical Immunology- J. Brostoff, J.K. Seaddin. D. Male & I.M. Roitt 6 th ed., 2002 ,Gower Medical .						
4.	Paul, W. E. (2012). <i>Fundamental Immunology</i> . New York: Raven Press.						
5.	Parham, P. (2005). <i>The Immune System</i> . New York: Garland Science.						
6.	Cellular and Molecular Immunology- A.K. Abbas, A. H. Lichtman & S. Pillai,2017, Elsevier						
7.	Janeway's Immunobiology - K. Murphy, P. Travers, M. Walport, & C. Janeway, 2012, Garland Science.						

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M.Sc. Biotechnology : Regular					
YEAR	I	CORE BTY2103 C03 Biochemistry - I		CREDIT	3
Semester	I			HOURS	45
OBJECTIVES:		To familiarize students with basic biochemical pathways, protein structure; carbohydrate, lipid and vitamins chemistry and introduction to enzymology			
COURSE CONTENT / SYLLABUS					
UNIT-I	Protein structure				15 hrs.
	Amino acids-Building blocks of proteins, structure and functional group properties, peptide bond, Dihedral angles, Ramchandran plot, primary, secondary, tertiary and quaternary structure, determination of sequence, N-terminal & C-terminal analysis. Properties of water, Concepts of pH and buffer, chemical bonds.				
UNIT-II	Principles of Bioenergetics and Carbohydrate				15 hrs.
	Anabolism, catabolism, concept of free energy, Laws of thermodynamics, Biological oxidation-reduction, high energy compounds Structure, properties and classification, stereo chemistry, function of carbohydrates, storage polysaccharides etc.				
UNIT-III	Vitamins, lipid chemistry and Introduction to enzymes				15 hrs.
	Vitamins-Fat soluble, water soluble and coenzyme form: biosynthesis, biological role, chemistry, reaction etc. Urea cycle Lipid Chemistry-structure and properties of important members of lipids, biosynthesis and catabolism of lipids Introduction to enzymes: classification, quantitation of enzyme activity and efficiency, purification				
REFERENCES					
1.	Lehninger ,Principles of Biochemistry- D.L. Nelson & M.M. Cox 7 th ed. 2017, W. H. Freeman and Co.				
2.	Biochemistry - J. M. Berg, J.Tymoczko & L. Stryer, 7 th ed. 2010 ,W.H.Freeman and Co.				
3.	Biochemistry- G.L. Zubay 4 th ed. 1998 ,McGraw-Hill.				
4.	Fundamentals of Enzymology- N. C. Price & L. Stevens, 3 rd ed. 1999 ,Oxford University Press.				
5.	Biochemistry- D. Voet & J. G. Voet, 4 th ed. 2011, John Wiley & Sons.				
6.	ENZYMES : Biochemistry, Biotechnology, Clinical Chemistry- T. Palmer & P. L Bonner,2nd ed.2007 ,Woodhead Publishing Ltd.				

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M.Sc. Biotechnology : Regular						
YEAR	I	CORE			CREDIT	3
Semester	I	BTY2104 C04 Genetic Engineering			HOURS	45
OBJECTIVES:		The objectives of this course are to teach students with various approaches to conducting genetic engineering and their applications in biological research as well as in biotechnology industries				
COURSE CONTENT / SYLLABUS						
UNIT-I	Introduction and tools for genetic engineering				15 hrs.	
	Enzymes used in recombinant DNA technology: Restriction enzymes, ligases, polymerases etc. DNA labelling & hybridization techniques. Nick translation; Northern and Southern blotting, probe preparation etc.; Sanger DNA sequencing; types of PCR; Construction and screening of libraries					
UNIT-II	Type of Vectors				15 hrs.	
	Plasmids- classification, incompatility groups, copy number & control, vectors; Bacteriophages; M13 mp vectors; PUC19 and Bluescript vectors, phagemids; Lambda vectors; Insertion and Replacement vectors; Cosmids; Artificial chromosome vectors (YACs; BACs); Principles for maximizing gene expression expression vectors;; Protein purification; His-tag; GST-tag etc.; Intein-based vectors; Inclusion bodies; methodologies to reduce formation of inclusion bodies; mammalian expression and replicating vectors; Adenovirus, Baculovirus and Pichia vector system, plant based vectors, Ti and Ri as vectors, yeast vectors, shuttle vectors					
UNIT-III	Gene manipulation and protein-DNA interaction				15 hrs.	
	Insertion of foreign DNA into host cells; transformation, electroporation, transfection; 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.					
REFERENCES						
1.	Principles of Gene Manipulation: an Introduction to Genetic Engineering - S. B. Primrose, R. M. Twyman & R. W. Old, 6 th ed. 2004, Blackwell Science.					
2.	Molecular Cloning: A Laboratory Manual- M. R. Green & J. Sambrook 4 th ed. 2012 , Cold Spring Harbor Laboratory Press					
3.	Gene cloning An introduction -T.A. Brown, 3rd ed. 1995, Chapman Hall.					
4.	Molecular Biotechnology: Principles and Applications of Recombinant DNA B. R. Glick J. J. Pasternak & C. L. Patten 4 th ed. 2010, ASM Press					
5.	Genetic Engineering - S.Rastogi & Pathak N. 2009, Oxford University Press.					

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M.Sc. Biotechnology- Regular						
YEAR	I	CORE			CREDIT	3
Semester	I	BTY2105 C05 Environmental Biotechnology			HOURS	45
OBJECTIVES:		The students will be made aware of the current environmental problems of air and water pollution. Emphasis on combating the issues will be discussed.				
COURSE CONTENT / SYLLABUS						
UNIT-I		Air, Water and Wastewater Microbiology Microbiology of air and monitoring air pollution. Aquatic Microbiology: Habitats and microbial communities, biofilms Microbiology of water: Microbiological examination of water, indicator microorganisms, disinfection, purification processes Waste-water treatment: Characterization of waste-water, self purification, conventional sewage treatment process, Microbiology of treatment plants, low cost plants and advances in treatment plants				7 hrs.
UNIT-II		Pollutants and microbial interactions; Bioremediation Technology Origin and dispersal of pollutants, types of pollutants-pesticides, hydrocarbons, surfactants, synthetic polymers, metals, monitoring pollutants. Biodegradation of representative pollutants and xenobiotic compounds. Bioleaching of metals. Bioremediation of soils and ground water, bioventing of petroleum hydrocarbons, bioremediation of oil spills. Phytoremediation techniques. Environmental impact assessment.				15 hrs.
UNIT-III		Products of biological origin, Global environmental Concerns Biotechnology and biofuels: biogas; bioethanol; biodiesel; biohydrogen. Production of bioplastics; Production of biosurfactants: bioemulsifiers; Paper production: use of xylanases and white rot fungi. Biofertilizers-PGPR, Bio fungicides. Probiotics, fermented foods, genetically modified foods, and GRASS microbes. Ozone layer depletion, Acid rain, Green House Effect, global warming. Response to global warming – Kyoto protocol and its outcome. Environmental laws.				15 hrs.
REFERENCES						
1.	Environmental Microbiology -R. M. Maier, I. L. Pepper & C. P. Gerba 2000 ,Academic press.					
2.	Microbial Ecology –Fundamentals and applications. R. M Atlas, R.Bartha & D. Atlas . 4th ed. 1998 , Benjamin Cummings					
3.	Biodegradation and Bioremediation-A.Martin 1994 ,Academic Press					
4.	Biotechnology,A Multi-volume Comprehensive Treatise- H. J. Rehm & G. Reed, 2001, Vol. 11, 2nd Ed., VCH Publishers Inc.					
5.	Environmental Biotechnology: Theory and Applications- G. M. Evans and J. C. Furlong,2003, Wiley Publishers					
6.	Environmental Biotechnology: Principle & Applications-B. Ritmann and P. L. McCarty, 2nd Ed. 2000, McGraw Hill Science					
7.	Environmental Biotechnology- A. Scragg 2005, Pearson Education Limited.					
8.	Environmental Engineering-H. S. Peavy, D. R. Rowe and G. Tchobanoglous, 2013, McGraw-Hill Inc.					

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<u>M.Sc. Biotechnology : Regular</u>						
YEAR	I	CORE BTY2201 C01 Bioanalytical techniques and Biostatistics			CREDIT	3
Semester	II				HOURS	45
OBJECTIVES:		To introduce the students to biophysical, immunological and microscopic techniques. To introduce the students to concepts of Biostatistics				
COURSE CONTENT / SYLLABUS						
UNIT-I	Biophysical and Immunological Techniques				15 hrs.	
	Structural determination and analysis of biomolecules, Introduction to spectroscopic techniques, UV-Visible absorption spectroscopy, IR, ESR, Raman spectroscopy and other optical techniques like fluorescence; Circular dichroism. Immunological techniques-Techniques for measuring antibody response - RIA, ELISA, Western blotting, ELISPOT assay, Advanced immunological techniques, Immunofluorescence, flow cytometry and immunoelectron microscopy.					
UNIT-II	Microscopic and staining techniques				15 hrs.	
	History, General principles and optics of bright field, phase contrast, dark field, fluorescence, differential interference, Polarising, Inverted microscopes etc. Electron microscope & advanced microscopes (Confocal laser scanning, Environmental scanning electron, Scanning tunneling, Atomic force, Cryoelectron, microscope etc.) Digital microscopy Advanced Fluorescence Microscopy Techniques—FRAP, FRET etc. Optical Tweezers. Sample preparation & staining in electron microscopy, Shadowing, Freeze fracture & etching etc. Staining techniques –Simple, differential and special staining.					
UNIT-III	Biostatistics				15 hrs.	
	Distributions - normal, binominal and Poisson; Mean, variance, standard deviation and standard error; Coordination and regression; Tests of significance; Analysis of variance 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, Applications in population genetics.					
REFERENCES						
1.	Biophysical Techniques- I. D. Campbell 2012, Oxford University Press.					
2.	Principles and Techniques of Biochemistry and Molecular Biology- K. Wilson & J. Walker 7th ed. 2010, Cambridge University press.					
3.	Becker's World of the Cell- W. M. Becker, L. J. Kleinsmith & J. Hardin 6th ed. 2012, Pearson Education.					
4.	Microbiology -L. Prescott, J.P. Harley & D.A. Klein 4th ed. 1999, McGraw-Hill.					
5.	Biostatistics for Health Sciences- R.C. Blair & R.A. Taylor 2008, Pearson.					
6.	Biostatistics, a Foundation for Analysis in the Health Sciences - W. W. Daniel 1987, Wiley.					
7.	Fundamentals of Biostatistics-B. Rosner, 8th ed. 2015, Cengage Learning Inc.					
8.	An introduction to statistics-S. Rasmussen, reprinted ed. 2006, Cengage Learning Inc.					
9.	Fundamentals of Biostatistics- B. Rosner 2000, Duxbury Press.					
10.	Kuby Immunology- J.A. Owen, J. Punt & S.A. Stranford, & P. Jones 7th ed. 2013, W. H. Freeman and Co.					
11.	Roitt's Essential Immunology- I. M. Roitt & P. J. Delves 10th ed. 2001, Blackwell Science.					
12.	Physical Biology of the Cell. New York-, R. Phillips, J. Kondev, & J. Theriot 2009, Garland Science.					
13.	Biological Physics: Energy, Information, Life - P. C. Nelson, M. Radosavljević & S. Bromberg 2004, W.H. Freeman.					

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M.Sc. Biotechnology : Regular					
YEAR	I	CORE BTY2202 C02 Developmental Biology, Neurobiology, Evolution		CREDIT	3
Semester	II			HOURS	45
OBJECTIVES:		To introduce the students to concepts of animal development, model organisms to study development, basics of neurobiology and evolution			
COURSE CONTENT / SYLL ABUS					
UNIT-I	Animal development - General principles and concepts				15 hrs.
	Developmental potential, determination and differentiation; Communication and signalling in development; Positional information and pattern formation; Morphogens in development; Induction and organizers Mesoderm induction and axis patterning in <i>Xenopus</i> Mesoderm inducing factors in <i>Xenopus</i> ; Cortical rotation, the Nieuwkoop Centre and Spemann’s Organizer; “Dorsalising” and “ventralising signals; Dorsal axis formation				
UNIT-II	<i>Dictyostelium</i> and <i>Drosophila</i> as a developmental system				15 hrs.
	<i>Dictyostelium</i> development: Chemotaxis and signalling during aggregation; Pattern formation in aggregates; The <i>Dictyostelium</i> slug; Cell movements and chemical signals; Culmination <i>Drosophila</i> development: Introduction to <i>Drosophila</i> development; Maternally acting genes and primary embryonic axes: Dorsoventral and anterior-posterior axis development; Segmentation genes - gap, pair-rule and segment polarity genes; Homeotic genes				
UNIT-III	Introduction to Neurobiology and Evolution				15 hrs.
	Nerve cells; Properties of excitable membranes – Resting potential, excitatory and inhibitory potentials, action potential; Voltage-gated channels; Chemical synapses, neurotransmitter release and post synaptic potentials; Modification of synaptic properties and memory Evolution : History of evolutionary theory; Evidences for evolution; Processes and mechanisms of evolution; Non-Darwinian factors; Speciation; Evolvability; Molecular and genomic evolution				
REFERENCES					
1.	<i>Gilbert. S F. (2013) Developmental Biology. Sunderland, Mass.: Sinauer Associates Inc.</i>				
2.	<i>Slack JM (2013). Essential Developmental Biology. Oxford: Wiley-Blackwell.</i>				
3.	<i>Wolpert L, Tickle C (2011). Principles of Development. Oxford and New York: Oxford University Press.</i>				
4.	Bear, M. F.; B. W. Connors; M. A. Paradiso (2006). Neuroscience: Exploring the Brain(3rd ed.). Philadelphia: Lippincott.				
5.	Kandel, ER; Schwartz JH; Jessell TM (2012). <i>Principles of Neural Science</i> (5th ed.). New York: McGraw-Hill.				

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M.Sc. Biotechnology : Regular					
YEAR	I	CORE BTY2203 C03 Metabolism and clinical Biochemistry		CREDIT	3
Semester	II			HOURS	45
OBJECTIVES:		The objectives of this course are to build upon undergraduate level knowledge of biochemical principles with specific emphasis on different metabolic pathways. Information about metabolic disorders, clinical biochemistry and tests in clinical biochemistry will be covered.			
COURSE CONTENT / SYLLABUS					
UNIT-I	Carbohydrate Metabolism				15 hrs.
	Glycolysis, gluconeogenesis, TCA cycle, ED pathway, HMP shunt, Glyoxylate bypass. History, reactions, enzymes involved, regulation, distribution and energetics. Coordinated regulation of glyoxylate bypass and TCA cycle.				
UNIT-II	Biochemical basis of disease pathogenesis, diagnosis and advancements				15 hrs.
	Metabolic disorders, Organ Specific Disorders, Diseases related to carbohydrate metabolism, Diabetes mellitus, Diseases related to amino acid and nucleic acid metabolism Phenylketonuria, hypo- and hyperuricemia, Diseases related to lipid metabolism, Liver Function tests, Metabolism of bilirubin Technical advancements in biochemical diagnosis: New techniques: Autoanalyzers [continuous flow analysis (CFA), Segmented Flow Analysis (SFA)], Nephelometer, Blood gas analyzer, High throughput methods, Clinical data management softwares				
UNIT-III	Principles and applications of basic biochemical techniques				15 hrs.
	Electrophoresis, isoelectric focusing, Centrifugation, and ultracentrifugation, Chromatographic techniques (thin layer, column, size exclusion, ion exchange and affinity chromatography; Gas chromatography and HPLC), Radioisotopes, X-ray crystallography. NMR spectroscopy etc..				
REFERENCES					
1.	Lehninger Principles of Biochemistry- Nelson D.L & Cox M.M, 4 th edition; 2004				
2.	Biochemistry- Zubey G.L, 4 th edition; 1998				
3.	Outlines of Biochemistry- Conn E. E & Stumpf P.K, 7 th edition; 1987				
4.	Enzymes: Biochemistry, Biotechnology, Clinical Chemistry - T. Palmer & P. L Bonner, 2 nd edition 2008				
5.	Fundamentals of Enzymology- N. C. Price, L. Stevens, 2 nd edition; 1998				
6.	Principles and techniques of biochemistry and molecular biology- K. Wilson & J. Walker, 7 th edition; 2010				
7.	Michael Murphy, Rajeev Srivastava, Kevin Deans. Clinical Biochemistry (6th Edition).Elsevier				
8.	Nessar Ahmed. Clinical Biochemistry (Fundamentals of Biomedical Science (2nd Edition) Oxford Press.				
9.	Peter Rae, Mike Crane, Rebecca Pattenden. Clinical Biochemistry. John Wiley & Son.				
10.	Lee W Janson, PH.D., Marc Tischler. Medical Biochemistry: The Big Picture. Mc Graw Hill.				
11.	J G Salway. Medical Biochemistry at a Glance. Wiley Blackwell.				

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M.Sc. Biotechnology : Regular					
YEAR	I	CORE BTY2204 C04 Molecular Biology I		CREDIT	3
Semester	II			HOURS	45
OBJECTIVES:		To introduce the students with concepts of DNA replication, transcription, its regulation and translation processes.			
COURSE CONTENT / SYLLABUS					
UNIT-I	Structure of DNA, genetic code and DNA replication				15 hrs.
	DNA as the genetic material – history; The Watson-Crick model, structure and properties of B-form DNA; Alternative DNA structures; DNA denaturation and hybridisation; DNA super coiling The Genetic Code - General features; Elucidation of the genetic code; The genetic code table and organization of the code; Deviations from the standard code DNA replication in prokaryotes: <i>E. coli</i> and phages; and eukaryotes				
UNIT-II	Transcription And Regulation of transcription in bacteria				15 hrs.
	Transcription in bacteria, General features; Structure & function of RNA polymerase, promoters properties and diversities The operon concept; Positive and negative regulation; Operon models: <i>lac</i> , <i>ara</i> , <i>trp</i> and <i>gal</i> operons; Transcription Attenuation in diverse operons				
UNIT-III	Translation				15 hrs.
	Translation in prokaryotes and eukaryotes; The translational machinery; ribosomal organization; structure and functions of tRNA, rRNA and ribosomal proteins; Translational regulation. Post transitional modification.				
REFERENCES					
1.	Molecular Biology of Cell- H. Lodish, A. Berk, C. A. Kaiser, M. Krieger, A. Bretscher, H. Ploegh, A. Amon, M.P. Scott & K. Martin, 6th ed. 2007, W.H.Freeman and Co.				
2.	Molecular Biology of the Gene- J.D. Watson,T.A.Baker,S.P.Bell,A.Gann,M.Levine &R.Losick 5th edition; 2004, Benjamin Cummings.				
3.	Genes X- B. Lewin, Benjamin Lewin, Jocelyn Krebs, Stephen Kilpatrick & Elliott Goldstein international ed.2011, Jones and Bartlett.				
4.	Molecular Biology of Cell- B. Alberts, A. Johnson, J. Lewis, M. Raff, K.Roberts & P. Walter 5th ed. 2008, Garland Science.				
5.	Molecular Biology, Genes to Proteins- B. E. Tropp, 3rd ed. 2008, Jones and Bartlett.				

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M.Sc. Biotechnology : Regular					
YEAR	I	CORE BTY2205 C05 Plant and Animal Biotechnology		CREDIT	3
Semester	II			HOURS	45
OBJECTIVES:		The objectives of this course are to introduce students to the principles, practices and application of animal biotechnology, plant tissue culture, genetic transformation and molecular breeding of plants and animals.			
COURSE CONTENT / SYLLABUS					
UNIT-I	Plant Biotechnology				20hrs
	Plant tissue culture: totipotency; organogenesis; Somatic embryogenesis; Callus culture, cell suspension culture, nutrients and plant hormones; applications of tissue culture - micropropagation; somaclonal variation; androgenesis and its applications in genetics and plant breeding; germ plasm, synthetic seed production; protoplast culture and somatic hybridization applications; cybrids and somatic cell genetics; plant cell cultures for secondary metabolite production Plant genetic manipulation: Agrobacterium mediated gene delivery; cointegrate and binary vectors and their utility, Direct gene transfer methods- PEG mediated, electroporation, etc. Characterization of transgenics; chloroplast transformation; marker-free methodologies; genome editing; molecular pharming - concept of plants as biofactories, Examples of transgenic plants				
UNIT-II	Animal Biotechnology				15 hrs
	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, application of cell culture technology in production of human and animal viral vaccines and pharmaceutical proteins Animal genetic manipulation: Animal cloning - basic concept, cloning for conservation for conservation endangered species; Applications of transgenic animal technology; CRISPR technology for genetic manipulation				
UNIT-III	Animal reproductive biotechnology				10hrs
	Animal reproductive biotechnology: structure of sperms and ovum; cryopreservation of sperms and ova of livestock; artificial insemination; super ovulation, embryo recovery and <i>in vitro</i> fertilization; culture of embryos; cryopreservation of embryos; embryo transfer technology; transgenic manipulation of animal embryos.				
REFERENCES					
1.	Chawla, H. S. (2000). <i>Introduction to Plant Biotechnology</i> . Enfield, NH: Science.				
2.	Razdan, M. K. (2003). <i>Introduction to Plant Tissue Culture</i> . Enfield, NH: Science.				
3.	Slater, A., Scott, N. W., & Fowler, M. R. (2008). <i>Plant Biotechnology: an Introduction to Genetic Engineering</i> . Oxford: Oxford University Press.				
4	Glick, B. R., & Pasternak, J. J. (2010). <i>Molecular Biotechnology: Principles and Applications of Recombinant DNA</i> . Washington, D.C.: ASM Press.				
5	Pörtner, R. (2007). <i>Animal Cell Biotechnology: Methods and Protocols</i> . Totowa, NJ: Humana Press.				

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<u>M.Sc. Biotechnology- Regular</u>						
YEAR	I	ELECTIVE BTY2208C08 : Clinical Immunology & Vaccinology			CREDIT	2
Semester	II				HOURS	30
OBJECTIVES:		Students will get exposure to the clinical aspects of immunology and immune therapy. This course will provide students with an overview of current developments in different areas of vaccines.				
COURSE CONTENT / SYLLABUS						
UNIT-I		Clinical Immunology & Immunotherapeutics			15 hrs.	
		Basic concept of tolerance, immune regulation, Immuno-modulation, immunosenescence Clinical immunology: Autoimmunity: Major autoimmune diseases, their pathogenesis and approved therapies; Oncoimmunology: Immune responses during cancer, concept of Immunomodulation, Cancer immunotherapy; -Transplantation Immunology: Types and mechanism of graft rejection, HLA typing, immunosuppressive therapies; - immunodeficiency: primary immunodeficiencies, acquired or secondary immunodeficiencies Immunotherapeutics: Monoclonal antibody, Concept of ScFv and nanobodies, Antibody engineering and related advancements				
UNIT-II		Vaccinology			15 hrs.	
		Basics of Vaccinology: History of vaccines, Concept of immunological memory for vaccine development, Active and passive immunization, Role and properties of adjuvants Types: Conventional vaccines; Bacterial vaccines; Viral Vaccines; Live attenuated and inactivated vaccine; Subunit Vaccines, conjugate vaccines and Toxoids; Peptide Vaccine, recombinant DNA and protein based vaccines, plant-based vaccines. Vaccine technologies: New Vaccine Technologies such as reverse vaccinology; Rationally designed Vaccines, Engineering virus vectors for vaccination Vaccine Delivery systems: Disease specific vaccine design: Tuberculosis Vaccine; Malaria Vaccine; HIV/AIDS vaccine; New emerging diseases and vaccine needs (Ebola, Zika).				
REFERENCES						
1.	Kindt, T. J., Goldsby, R. A., Osborne, B. A., & Kuby, J. (2006). <i>Kuby Immunology</i> . New York: W.H. Freeman.					
2.	Brostoff, J., Seaddin, J. K., Male, D., & Roitt, I. M. (2002). <i>Clinical Immunology</i> . London: Gower Medical Pub.					
3.	Murphy, K., Travers, P., Walport, M., & Janeway, C. (2012). <i>Janeway's Immunobiology</i> . New York: Garland Science.					
4	Goding, J. W. (1996). <i>Monoclonal Antibodies: Principles and Practice: Production and Application of Monoclonal Antibodies in Cell Biology, Biochemistry, and Immunology</i> . London: Academic Press.					
5	Kaufmann, S. H. (2004). <i>Novel Vaccination Strategies</i> . Weinheim: Wiley-VCH.					
6	Journal Articles (relevant issues) from: Annual Review of Immunology, Annual Review of Microbiology, Current Opinion in Immunology, Nature Immunology, Expert review of vaccines.					

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<u>M.Sc. Biotechnology- Regular</u>					
YEAR	I	ELECTIVE BTY2209C08 : Nano Biotechnology		CREDIT	2
Semester	II			HOURS	30
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.			
COURSE CONTENT / SYLLABUS					
UNIT-I		Overview			10 hrs.
		Introduction to Nanobiotechnology; Concepts, historical perspective Types of Nanomaterials- Different formats of nanomaterials: Nano-films, Nanoparticles: Synthesis and characterization of different nanomaterials			
UNIT-II		Applications			20 hrs.
		Applications of Nanomaterials: Diagnosis, Imaging, Drug delivery system, Cancer Therapy, Nanobiocatalysts, Nanoscaffolds, Nanobodies Nano-toxicity: Basics of nanotoxicity, Models and assays for Nanotoxicity assessment, Ecotoxicity models and assays			
REFERENCES					
1.	GeroDecher, Joseph B. Schlenoff, (2003); <i>Multilayer Thin Films: Sequential Assembly of Nanocomposite Materials</i> , Wiley-VCH Verlag GmbH & Co. KGaA				
2.	David S. Goodsell, (2004); <i>Bionanotechnology: Lessons from Nature</i> ; Wiley-Liss				
3.	Neelina H. Malsch (2005), <i>Biomedical Nanotechnology</i> , CRC Press				
4	Greg T. Hermanson, (2013); <i>Bioconjugate Techniques</i> , (3rd Edition); Elsevier				
5	Steyaert, J., & Kobilka, B. K. (2011). <i>Nanobody Stabilization of G Protein-Coupled Receptor Conformational States</i> . Current Opinion in Structural Biology, 21(4), 567-572. doi:10.1016/j.sbi.2011.06.011.				
6	Vincke, C., & Muyldermans, S. (2012). <i>Introduction to Heavy Chain Antibodies and Derived Nanobodies</i> . Single Domain Antibodies, 15-26. doi:10.1007/978-1-61779-968-6_2.				

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<u>M.Sc. Biotechnology : Regular</u>						
YEAR	II	CORE BTY2301 C01 Molecular Biology II			CREDIT	3
Semester	III				HOURS	45
OBJECTIVES:		To familiarize students with fundamental aspects of Molecular Biology, Eukaryotic genome organization, transcription, splicing and RNA processing will be covered in detail.				
COURSE CONTENT / SYLLABUS						
UNIT-I	Mutations, transposable elements and DNA damage & repair				15 hrs.	
	Chemical and physical bases of mutations and mutagenesis; Types of mutations, spontaneous, induced, reverse, suppressor & adaptive mutations etc.; Mutations and disease; Site directed mutagenesis. Classification of transposable elements, IS elements, composite transposons, TnA family, mechanism of transposition. DNA damage and repair: Types, mechanism and genetics.					
UNIT-II	Genome organization and transcription eukaryotes				15 hrs.	
	The nucleus and chromatin; The nucleosome; Chromatin structure, modifications and regulation; Position effect variegation; Polycomb group and Trithorax group complexes and cell memory; DNA methylation and imprinting . General features of transcription; Structure assembly and function of eukaryotic RNA polymerase I, II, III; and associated Eukaryotic promoters and enhancers; General Transcription factors; TATA binding proteins (TBP) and TBP associated factors (TAF) DNA elements; Transcriptional assembly and regulation in eukaryotes; Salient classes of DNA binding proteins.					
UNIT-III	RNA processing				15 hrs.	
	Post transcriptional RNA modification: Splicing of hnRNA, tRNA, rRNA; organellar mRNA and organelle rRNA splicing, 5'-Cap formation; 3'-end processing; polyadenylation; mRNA stability; RNA editing; Catalytic RNA, Role of maturases , Intron evolution, mobile introns, exon shuffling, RNA editing, Non-coding RNA, RNA silencing.					
REFERENCES						
1.	An Introduction to Genetic Analysis- A. J. F. Griffiths, S. R. Wessler, R. C. Lewontin, W. D. Fixsen & S. B. Carroll, 9th edition; 2008, W. H. Freeman and Co.					
2.	Molecular Genetics of Bacteria- L. Snyder & W. Champness, 2nd ed. 2003, ASM press.					
3.	Microbial Genetics- S. R. Maloy, J. E. Cronan & D. Freifelder, 2nd ed. 1994, Jones and Bartlett.					
4.	Molecular Biology- R. Weaver, 5th ed. 2012, McGraw-Hill.					
5.	Molecular Biology, Genes to Proteins- B. E. Tropp, 3rd ed. 2008, Jones and Bartlett.					
6.	Molecular Biology of the Gene- J.D. Watson,T.A.Baker,S.P.Bell,A.Gann,M.Levine &R.Losick 5th ed. 2004, Benjamin Cummings					
7.	Lewin’s Genes X- J. E. Krebs, B. Lewin & S. T. Kilpatrick 10th ed. 2009.					

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<u>M.Sc. Biotechnology : Regular</u>						
YEAR	II	CORE BTY2302 C02 Bioprocess Engineering and Fermentation Technology			CREDIT	3
Semester	III				HOURS	45
OBJECTIVES:		The objectives of this course are to educate students about the fundamental concepts of bioprocess technology and its related applications, thus preparing them to meet the challenges of the new and emerging areas of biotechnology industry.				
COURSE CONTENT / SYLLABUS						
UNIT-I	Fermentation principles and microbial processes				15 hrs.	
	Principles of fermentation; Bioprocess optimization; Fermentation media; Bioreactor design and its modifications; Large-scale plant and animal cell culture screening and strain improvement; Production, optimization, Downstream processing Recombinant DNA products					
UNIT-II	Scale Up				15 hrs.	
	Sterilization of air and fermentation media; Aeration and agitation in bioprocesses; Scale-up of fermentation processes; Instrumentation and process control in bioprocesses					
UNIT-III	Industrial fermentations				15 hrs.	
	Amino acid biosynthesis and regulation; Industrial production of glutamate; Fermentation kinetics; Production of penicillin, streptomycin, citric acid, ethanol etc. Industrial enzyme technology – production, recovery, and formulation of bacterial and fungal enzymes like amylases, proteases, penicillin acylase and glucose isomerase, Immobilized enzymes and cell-based bio-transformations of steroids.					
REFERENCES						
1.	Principles of fermentation technology- P.F Stanbury, A. Whittaker & S. J . Hall, 2 nd ; 1995					
2.	Industrial Microbiology- L. E. Casida, 3rd ed. 1987, John Wiley & sons.					
3.	Biotechnology- A multi-volume comprehensive treatise-Eds. H. J. Rehm, G. Reed & J. Klein; 1991, Wiley.					
4.	Comprehensive Biotechnology-Ed. M. M. Young, 3rd ed.2019, Pergamon press.					
5.	Biochemical Engineering Fundamentals- J. E. Bailey & D. F Ollis. 1986, McGraw-Hill.					
6.	Fermentation Microbiology and Biotechnology- M. El-Mansi, & C. F. Bryce 2007, CRC/Taylor & Francis.					

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<u>M.Sc. Biotechnology- Regular</u>					
YEAR	II	CORE BTY2303 C03 Cell Biology and Enzymology I		CREDIT	3
Semester	III			HOURS	45
OBJECTIVES:		To familiarize the students with the cell organization, transport and cycle; Oxidative phosphorylation & photosynthesis and Enzyme kinetics.			
COURSE CONTENT / SYLLABUS					
UNIT-I	Dynamic organization of cell, transport and cell cycle				17 hrs.
	Universal features of cells; chemical organization of cells; internal organization of the cell - cell membranes: structure of cell membranes and compartmentalization in eukaryotic cells; intracellular organelles in detail and functions. 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. Cell division: mitosis, meiosis, and cytokinesis; cell differentiation: stem cells, their differentiation into different cell types and organization into specialized tissues				
UNIT-II	Oxidative phosphorylation and photosynthesis				12 hrs.
	Electron transport systems in bacteria, mitochondria and chloroplast. Uncouplers and inhibitors; Theories of oxidative phosphorylation; ATPases- Structure and function. Photosynthesis in bacteria and plants: Organization, apparatus, electron donors, accepters and energetics				
UNIT-III	Enzyme kinetics				15 hrs.
	Steady state kinetics; Michaelis-Menten equation, Derivation, Significance of kinetic constants, linear plots, single substrate kinetics, inhibition kinetics, Two substrate kinetics, pre steady state kinetics				
REFERENCES					
1.	Molecular Cell Biology-H. Lodish, A. Berk, C. A. Kaiser, M. Krieger,M.P. Scott, A. Bretscher, H. Ploegh, & P. Matsudaira 6 th ed. 2008, W.H.Freeman and Co.				
2.	Molecular Biology of the Cell- B. Alberts, A. Johnson, J. Lewis, M. Raff, K. Roberts, & P. Walter 5 th ed.2008, Garland Science.				
3.	The Cell: a Molecular Approach- G. M., Cooper, & R. E Hausman 6 th ed. 2013, ASM Press.				
4.	Becker's World of the Cell -J. Hardin. G. Bertoni, L. J. Kleinsmith, & W. M Becker 8 th ed. 2012 , Benjamin Cummings.				
5.	Kuby Immunology- J.A. Owen, J. Punt & S.A. Stranford,& P. Jones 7 th ed. 2013, W. H. Freeman and Co.				
6.	Fundamentals of Enzymology- N. C. Price & L. Stevens, 3 rd ed. 2006, Oxford University Press.				
7.	Lehninger ,Principles of Biochemistry- D.L. Nelson & M.M. Cox 7 th ed. 2017, W. H. Freeman and Co.				
8.	Biochemistry - J. M. Berg, J.Tymoczko & L. Stryer, 7 th ed. 2010 ,W.H.Freeman and Co				
9.	Biochemistry- G.L. Zubay 4 th ed. 1998 ,McGraw-Hill.				
10.	Fundamentals of Enzymology- N. C. Price & L. Stevens, 3 rd ed. 1999 ,Oxford University Press.				
11.	Biochemistry- D. Voet & J. G. Voet, 4 th ed. 2011, John Wiley & Sons.				
12.	ENZYMES : Biochemistry, Biotechnology, Clinical Chemistry- T. Palmer & P. L Bonner,2 nd ed.20				

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M.Sc. Biotechnology: Regular					
YEAR	II	CORE BTY2304 C04 Genomics, proteomics, Bioinformatics		CREDIT	3
Semester	III			HOURS	45
OBJECTIVES:		To familiarize the students to principles of genomics, transcriptomics, proteomics and their functional and applied aspects. To introduce students to Bioinformatics concepts and methods.			
COURSE CONTENT / SYLLABUS					
UNIT-I	Genomics,				10 hrs.
	Genome mapping, Physical mapping, RFLP mapping, pulse field gel electrophoresis, FISH mapping, genome sequencing & annotation, functional genomics, comparative bacterial genomics				
UNIT-II	Transcriptomics and Proteomics				10hrs
	Techniques for studying gene expression: SABRE, SAGE, microarrays, etc Aims, strategies and challenges in proteomics; proteomics technologies: 2D-PAGE, isoelectric focusing, mass spectrometry, MALDI-TOF, yeast 2-hybrid system, proteome databases.				
UNIT-III	Functional omics				10 hrs.
	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-III	Bioinformatics				15 hrs.
	Basic concepts; Internet resources and databases; Protein and nucleic acid databases, Search tools. NCBI; publicly available tools; resources at EBI; resources on web; Database mining tools. Submitting DNA sequences to databases and database searching; sequence alignment; Bioinformatics methods for analysis of sequence and structural data - BLAST, multiple sequence alignment- CLUSTAL W, phylogenetic analysis, Protein structure.				
REFERENCES					
1.	Bioinformatics in Post Genomic Era- J. Augen, 1 st edition; 2004, AddisonWesley Professional.				
2.	Bioinformatics: A Pratical guide to Analysis of Genes and Proteins- A. D. Baxevanis & B. F. F. Ouellette, 3 rd edition; 2004, j.Wiley and sons.				
3.	Principles of Gene Manipulation: An Introduction to Genetic Engineering - S. B. Primrose, R. M. Twyman & R. W. Old, 6 th ed. 2004, Blackwell Science.				
4.	Introduction to Proteomics: Tools for the New Biology- D. C. Liebler, 2002, Humana Press.				
5.	Discovering Genomics, Proteomics, and Bioinformatics- A. M., Campbell & L. J. Heyer 2003,Benjamin Cummings.				
6.	Introduction to Bioinformatics - A. M. Lesk, 2002, Oxford University Press.				
7.	Bioinformatics: Sequence and Genome Analysis- D. W. Mount, 2001, Cold Spring Harbor Laboratory Press.				
8.	Bioinformatics and Functional Genomics - J. Pevsner 2015, Wiley-Blackwell.				
9.	Structural Bioinformatics - J. Gu and P. E. Bourne and 2009, Wiley-Liss.				

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M.Sc. Biotechnology: Regular						
YEAR	II	CORE BTY2305 C05 Eukaryotic Genetics			CREDIT	3
Semester	III				HOURS	45
OBJECTIVES:		The objectives of this course are to take students through basics of genetics and classical genetics, yeast and drosophila genetics and population genetics.				
COURSE CONTENT / SYLLABUS						
UNIT-I		Classical Genetics and bacterial genetics				15hrs.
		Brief history; Mendel's laws; Linkage and recombination; Linkage mapping; Complementation analysis; Gene organization; Mutations and their uses in genetic analysis Transformation: Discovery, competence development, molecular mechanism of DNA uptake, mapping. Conjugation: History, Conjugation in Gram-ve bacteria, mechanism, Hfr transfer, linkage mapping, F-plasmid and conjugative plasmids structure and function. Conjugation in Gram +ve bacteria, Agrobacterium tumifaciens conjugation. Transduction: Generalized, restricted, linkage and mapping, strain construction and problems in genetics				
UNIT-II		Yeast genetics and Drosophila genetics				15 hrs.
		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. 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-III		Population genetics and genetics of evolution				15 hrs.
		Principles of population genetics, Hardy-Weinberg law and its application for autosomal and X-linked genes. Epigenetics, mitochondrial inheritance. Inherited human diseases, single gene diseases, complex traits, Statistical methods for genetic analysis of complex traits.				
REFERENCES						
1.	Hartl, D. L., & Jones, E. W. (1998). <i>Genetics: Principles and Analysis</i> . Sudbury, MA: Jones and Bartlett.					
2.	Pierce, B. A. (2005). <i>Genetics: a Conceptual Approach</i> . New York: W.H. Freeman.					
3.	Tamarin, R. H., & Leavitt, R. W. (1991). <i>Principles of Genetics</i> . Dubuque, IA: Wm. C. Brown.					
4.	Smith, J. M. (1998). <i>Evolutionary Genetics</i> . Oxford: Oxford University Press.					
5.	Rasmus Nielsen and Montgomery Slatkin An Introduction to Population Genetics: Theory and Applications					
6.	Matthew William Hahn. Molecular Population Genetics Oxford University Press, 2018					
7.	Daniel L. Hartl. A Primer of Population Genetics and Genomics. Oxford University Press June 2020					

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<u>M.Sc. Biotechnology: Regular</u>					
YEAR	II	ELECTIVE BTY2301E01 Pharmaceutical Biotechnology		CREDIT	2
Semester	III			HOURS	30
OBJECTIVES:		On completion of this course students will get exposed to the concept of pharmaceutical biotechnology and regulatory aspects of QC and QA, formulation of therapeutics etc.			
COURSE CONTENT / SYLLABUS					
UNIT-I	Basic Concepts of Pharmaceutical Biotechnology: Terminologies, Target identification and molecular Modeling, Lead optimization, Preclinical Development. PK, PD, ADME, Bioavailability, Basic toxicology, Phases and process of drug discovery				10 hrs.
UNIT-II	Quality assurance, Quality control, Regulatory aspects of biotechnological products usage as pharmaceuticals Concept of Pharmacoepidemiology, Bioterrorism, and Pharmacovigilance				10 hrs
UNIT-III	Pharmaceutical applications of Genomics using example of FDA approved RNAi based drugs against rare genetic disease hereditary transthyretin-mediated amyloidosis and acute hepatic porphyria RNAi based therapeutics for gene silencing: siRNA/shRNA design, formulation development, <i>in- vitro</i> , <i>ex-vivo</i> and <i>in vivo</i> evaluation and related challenges Pharmaceutical applications of Proteomics using example of peptide (Insulin) and monoclonal antibody (Cetuximab or any other eg): Peptide therapeutics: Design, evaluation, and formulation of peptides for therapeutics. Examples of FDA approved products Pharmaceutical applications of microbial technology Industrial microbes (<i>Streptomyces</i> sp., Yeast) as efficient cloning and expression hosts for biologicals production; Generating diversity and introduction of desirable properties in industrially important microbes Concept of Microbial cell factories; Downstream processing approaches used in industrial production process (<i>Streptomyces</i> sp., Yeast).				10 hrs
REFERENCES					
1.	Nally, J. D. (2006) <i>GMP for Pharmaceuticals</i> . 6th edition. CRC Press				
2.	Moo-Young, M. (2011). <i>Comprehensive Biotechnology</i> . Amsterdam: Elsevier.				
3.	Ed. Robertson DE, Noel JP, (2004), <i>Protein Engineering Methods in Enzymology</i> , 388, Elsevier Academic Press				
4.	Glick, B. R., & Pasternak, J. J. (2010). <i>Molecular Biotechnology: Principles and Applications of Recombinant DNA</i> . Washington, D.C.: ASM Press.				

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<u>M.Sc. Biotechnology- Regular</u>					
YEAR	II	ELECTIVE BTY2302E02 Protein Engineering		CREDIT	2
Semester	III			HOURS	30
OBJECTIVES:		The aim of this course is to introduce methods and strategies commonly used in protein engineering.			
COURSE CONTENT / SYLLABUS					
UNIT-I	Introduction				10 hrs.
	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, <i>etc.</i> Protein engineering with unnatural amino acids and its applications.				
UNIT-II	Stability of protein structure				10 hrs.
	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. Forces stabilizing proteins – Van der waals, electrostatic, hydrogen bonding and weakly polar interactions, hydrophobic effects; Entropy – enthalpy compensation				
UNIT-III	Applications				10 hrs.
	Experimental methods of protein engineering: directed evolution like gene site saturation mutagenesis; Module shuffling; Guided protein recombination, <i>etc.</i> , Optimization and high throughput screening methodologies like GigaMetrix, High throughput microplate screens <i>etc.</i> , 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.				
REFERENCES					
1.	Edited by T E Creighton, (1997), <i>Protein Structure: a Practical Approach</i> , 2nd Edition, Oxford university press.				
2.	Cleland and Craik, (2006), <i>Protein Engineering, Principles and Practice</i> , Vol 7, Springer Netherlands.				
3.	Mueller and Arndt, <i>Protein Engineering Protocols</i> , 1st Edition, Humana Press.				
4	Ed. Robertson DE, Noel JP, (2004), <i>Protein Engineering Methods in Enzymology</i> , 388, Elsevier Academic Press.				
5	J Kyte; (2006), <i>Structure in Protein Chemistry</i> , 2nd Edition, Garland publishers.				

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<u>M.Sc. Biotechnology- Regular</u>					
YEAR	II	CORE BTY2401 C01 Cancer Biology and Enzymology		CREDIT	3
Semester	IV			HOURS	45
OBJECTIVES:		To familiarize the students with topics in cancer biology and enzymology.			
COURSE CONTENT / SYLLABUS					
UNIT-I	Cancer biology			15 hrs.	
	Molecular Basics of Oncogenesis: Oncogenes, Tumor Suppressor Genes, Cell Cycle Dysregulations, Cell Signaling dysregulations, Common mutations Cancer Genomics: Mutation detection, GWAS approaches, Concepts and Techniques in Cancer Genetics Cancer Research Techniques: Ex plant, 3D cultures, Patient Derived Xenograft models Cancer Epidemiology: Epidemiology of various cancers, therapy non responsiveness, and related etiology Clinical Oncology: Diagnosis and Principles of Cancer Therapy				
UNIT-II	Cell biology			10 hrs.	
	Cell junction and cell adhesion, extracellular matrix composition, diversity. Cell-ECM and cell-cell interaction, cell receptors and transmembrane signaling; cell motility, cell migration, cell death: different modes of cell death and their regulation.				
UNIT-III	Mechanism of enzyme action and Allostery			20hrs.	
	Transition state theory, active site mapping. Case studies of chymotrypsin, lysozyme, Allostery. Hill, Adair, MWC, KNF models. Case studies of aspartate transcarbamylase, hemoglobin.				
REFERENCES					
1.	Molecular Cell Biology-H. Lodish, A. Berk, C. A. Kaiser, M. Krieger,M.P. Scott, A. Bretscher, H. Ploegh, & P. Matsudaira 6th ed. 2008 W.H.Freeman and Co.				
2.	Molecular Biology of the Cell- B. Alberts, A. Johnson, J. Lewis, M. Raff, K. Roberts & P. Walter 5th ed.2008, Garland Science.				
3.	The Cell: a Molecular Approach- G. M., Cooper & R. E Hausman 6th ed. 2013, ASM Press.				
4	Becker's World of the Cell -J. Hardin. G. Bertoni, L. J. Kleinsmith, & W. M Becker 8th ed. 2012, Benjamin Cummings.				
5	Fundamentals of Enzymology- N. C. Price & L. Stevens, 3rd ed. 2006, Oxford University press.				

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<u>M.Sc. Biotechnology- Regular</u>					
YEAR	II	CORE		CREDIT	3
Semester	IV	BTY 2402 C02 Drug Discovery, Molecular Medicine, Regulatory affairs		HOURS	45
OBJECTIVES:		To familiarize the students with basics of drug discovery and molecular medicine. They will be exposed to intellectual property, bioethics and bioenterpreunership.			
COURSE CONTENT / SYLLABUS					
UNIT-I		Drug discovery Basics and terminologies, Target identification and molecular Modeling, Lead optimization, Preclinical Development and: Common Preclinical animal models for major therapeutic areas, Clinical trial design Pharmacogenomics, Biomarkers: concept & applications			10 hrs.
UNIT-II		Molecular Medicine Understanding the molecular and cellular basis of disease pathogenesis; applications in diagnosis, treatment, and prevention; examples in translational aspects of human/animal health. Control of bacterial virulence, Immune evasion/subversion by microbial pathogens. Targeting of virulence genes for therapeutic interventions, Antibiotics, mode of action and Antimicrobial resistance, Gene networks pathways and genome polymorphisms. Metabolite profile for biomarker detection the body fluids/tissues in various metabolic disorders by making using LCMS & NMR technological platforms. 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.			10 hrs.
UNIT-III		IPR, Bioethics & Bioenterpreunership IPR : Introduction and type of intellectual property, IP in field of biotechnology R&D (Case studies); Plant variety protection and farmers rights act; concept of ‘prior art’ in context of invention Patenting: Basics of patents: types of patents;, Patent application filing, Types of patent applications, Publication of patents, Patent infringement, Commercialization of patented innovations, Licensing, Patenting by research students and scientists-university/organizational rules in India and abroad, collaborative research - backward and forward IP Patent Acts & Treaties, Patent Organizations and their roles, Patent databases. 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. Innovation and entrepreneurship in bio-business: Introduction and scope in Bio-entrepreneurship, Types of bio-industries (e.g. pharmaceuticals vs. Industrial biotech). Strategy and operations of bio-sector firms Entrepreneurship development programs of public and private agencies (MSME, DBT, BIRAC, Make In India). Bio markets - Business strategy and marketing, Pricing strategy, Challenges in marketing in bio business, Basic contract principles, different types of agreement and contract,			25hrs.

	Dispute resolution skills. Finance and accounting: Business plan preparation including statutory and legal requirements, Business feasibility study. Technology management: Technology – assessment, development & up gradation, Managing technology transfer, Knowledge centers and Technology transfer agencies, Understanding of regulatory compliances and procedures (CDSCO, NBA, GCP, GLA, GMP).	
REFERENCES		
1.	Biopharmaceutical Drug Design and Development Editors: Wu-Pong , Susanna, Rojanasakul , Yo; 2008	
2.	Krogsgaard-Larsen <i>et al.</i> <i>Textbook of Drug Design and Discovery</i> . 4th Edition. CRC Press.	
3.	Brody, T. (2016) <i>Clinical Trials: Study Design, Endpoints and Biomarkers</i> , Drug Safety, and FDA and ICH Guidelines. Academic Press.	
4	Ganguli, P. (2001). <i>Intellectual Property Rights: Unleashing the Knowledge Economy</i> . New Delhi: Tata McGraw-Hill Pub.	
5	<i>National IPR Policy</i> , Department of Industrial Policy & Promotion, Ministry of Commerce, GoI	
6	Karen F. Greif and Jon F. Merz, <i>Current Controversies in the Biological Sciences -Case Studies of Policy Challenges from New Technologies</i> , MIT Press	
7	Guidelines for Safety Assessment of Foods Derived from Genetically Engineered Plants. 2008.	
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	Guidelines and Standard Operating Procedures for Confined Field Trials of Regulated Genetically Engineered Plants. 2008. Retrieved from http://www.igmoris.nic.in/guidelines1.asp	
11	Alonso, G. M. (2013). <i>Safety Assessment of Food and Feed Derived from GM Crops: Using Problem Formulation to Ensure “Fit for Purpose” Risk Assessments</i> . Retrieved from http://biosafety.icgeb.org/inhousepublicationscollectionbiosafetyreviews .	

PRACTICAL SYLLABUS

SEMESTER- I:

Basics of Lab management and instruments: Introduction to asepsis, introduction to instruments, Calibration of micropipette, graduated pipette, pH meter, UV-Vis spectrophotometer,

Basics of calculations: Normality, Molarity, pH, buffers, percentage dilutions etc.

Microbiology: Isolation, cultivation and preservation of microorganisms, screening of amylase and protease producers, growth kinetics of bacteria, Isolation of Rhizobia from the nodules of Trigonella plants, measurement of size of microorganisms, determination of BOD and COD of effluent samples, Standard analysis of water samples, study of various bacteriophages, plaque forming assay for titration, isolation, identification and pure culture studies of microorganisms as per Bergey's manual, Special staining techniques employed for microbial structures.

Biochemistry: protein estimation, carbohydrate estimation, Titration of an amino acid, Determination of pK₁ and pK₂ Two dimensional paper chromatography of amino acids, TLC of amino acids.

Molecular biology: DNA spectrophotometer, Estimation, DNA denaturation and effects of chemical denaturants on DNA.

SEMESTER- II

Biochemistry: Assay of enzyme activity, effect of pH and temperature on enzyme activity and stability, determination of activation energy of an enzyme, V_{max} and K_m .

Immunology: Mancini/Radial Immunodiffusion to estimate Ag-Ab titer, Ouchterlony immunodiffusion to titer Ag/Ab, Ouchterlony immunodiffusion for Ag/Ab pattern, agglutination (blood group determination, handling and euthanization of mouse), demonstration of IP, IV, oral routes of dosing, Demonstration of primary and secondary lymphoid organs, Splenocyte isolation, Cell counting.

Molecular Biology: Mutagenesis, isolation and characterization of bacterial/yeast mutants, Bacterial conjugation and its use in genome analysis, Transformation, Plasmid isolation by different methods, Restriction digestion of DNA and molecular weight determination, Transduction, Short gun cloning, PCR.

Plant Tissue Culture: Basics of plant tissue culture, Development of callus from meristem.

Genetics: Genetic crosses in yeast and segregation analysis, Drosophila culture and morphology, Mutations and genetic markers in Drosophila, genetics and recombination mapping problems, preparation of Drosophila embryos for visualisation of cuticle markers.

SEMESTER-III

Biochemistry: Purification of antibodies (IgG) from human blood using protein A magnetic beads, Gel filtration Column chromatography of proteins.

Immunology: methods of blood collection, serum / plasma separation and storage, PBMC isolation, Cell proliferation assay, Sandwich ELISA, Indirect ELISA, various methods of cell lysate preparation and protein quantification, SDS-PAGE, Western Blotting.

Molecular Biology: RNA isolation, Southern/ Northern blotting, Real Time- PCR.

Genetics: Chromosome preparations from cultured animal cells and blood (karyotyping).

Animal cell culture: Cell culture medium preparation, demonstration of subculturing of adherent and non-adherent cell lines, Demonstration of Immunophenotyping by FACS, Cell cycle analysis by FACS, Attempt animal cell fusion using PEG.

Industrial biotechnology: Immobilization of whole cells, standardization of culture load, standardization of bead size, standardization of alginate percentage, immobilization of enzymes by crosslinking (CLEA), Immobilization of enzyme by glutaraldehyde, to determine OTR and K_L , to determine mixing time of fermentation, to study fluid flow behaviours.

Bioinformatics: Primer design for complete genes/ structural genes -Data mining, Blast analysis, Pair wise/ clustal W alignments of nucleic acid and proteins and their significance, RNA structure interaction analysis, protein structure viewer, NGS Data Tools -Genome assembly, Mapping assembly, SNP identification, Phylogenetic trees.