Jaypee Institute of Information Technology

M.Tech Biotechnology

Semester I

Course Descriptions

Course Code	17M11BT111	Semester Odd	Semester VII (Integrated) / I Sem (M.Tech) **Session** 2019 -2020
			Month from July to December

Course Name	**Biomolecules and cell communication**

Credits	3	**Contact Hours**	3

Faculty (Names)	**Coordinator(s)**	Dr. Reema Gabrani
	Teacher(s) (Alphabetically)	Dr. Reema Gabrani

COURSE OUTCOMES	
C110.1	Explain the signal molecules and major cell signaling pathways
C110.2	Analyze cell signaling pathways in normal and diseased conditions
C110.3	Interpret the mechanisms and regulation of cell cycle and cell death
C110.4	Analyze the therapeutic drug targets for cancer

Module No.	Title of the Module	Topics in the Module	No. of Lectures for the module
1.	Signal molecules	Cytokines and Hormones, Growth factors, neurotransmitters, extracellular matrix components as signaling molecules; autocrine, paracrine, juxtacrine and endocrine signaling	3
2.	G-protein linked signaling pathways	G Protein-Coupled Receptors, Heterotrimeric G Proteins, Second messengers, Effector enzymes, Mechanism of transduction, Switching Off and Desensitization of Receptors, Visual transduction pathway	8
3.	Signaling mediated by enzyme linked cell surface receptor	Photoreceptor development in Drosphila, Ras to MAP kinase, Phosphoinositide-3-kinase and signaling through insulin receptor, JAK-STAT pathway, Signal Transduction via Integrins	7
4.	Nuclear receptor based signaling	Classification and Structure of Nuclear Receptors, Signaling by steroid hormones, Retinoids, Vitamin D3, and the T3-Hormone, Mechanisms of Transcriptional Regulation by Nuclear Receptors	4
5.	Bacterial Chemotaxis	Two-component signaling pathway, histidine kinase associated receptor, Adaptation, Chemotaxis in pathogenicity, symbiotic associations and biofilm	4
6.	Cell cycle regulation and cell death	Cyclin-CDK variation, Checkpoint signaling, Ubiquitin proteasome proteolytic system, Intrinsic and Extrinsic apoptotic pathways	8

7.	Malfunction of Signaling Pathways and Tumorigenesis	Hallmarks of cancer, Developmental pathways and cancer: Notch signalling from Drosophila to humans, Wnt signalling, Hedgehog pathway; Epigenetic changes in cancer, Signalling pathways as therapeutic targets, Analysis of signalling events via case studies	8	
		Total number of Lectures		**42**

Evaluation Criteria

Components	Maximum Marks
T1	20
T2	20
End Semester Examination	35
TA	25 (Presentation, Assignments)
Total	**100**

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)	
1.	ljsbrand Kramer, "Signal transduction", Academic Press, 2015 Harper
2.	Wendell Lim, Bruce Mayer, Tony Pawson, "Cell signaling", Taylor &Francis , 2014
3.	Alberts, Johnson, Lewis, Morgan, Raff, Roberts and Walter, "Molecular Biology of the Cell" Sixth Edition , Garland Science Publication, 2014
4.	Refereed papers from scientific journals for case studies

Course Code	17M11BT112	Semester Odd		Semester I Session 2019 -2020
		(specify Odd/Even)		Month from July to December
Course Name	**Molecular Modeling and Drug design**			
Credits	3		Contact Hours	LTP 3 0 0

Faculty (Names)	Coordinator(s)	Dr Chakresh Kumar Jain
	Teacher(s) (Alphabetically)	Dr Chakresh Kumar Jain

COURSE OUTCOMES		COGNITIVE LEVELS
C112.1	Explain macromolecular structures, their Mathematical representation and visualization	**Understanding** (C2)
C112.2	Explain structural modeling, simulation and dynamics	**Understanding** (C2)
C112.3	Apply computational drug designing and simulation approaches for drug discovery	**Applying** (C3)
C112.4	Compare *in-silico* ligand-target interaction methods	**Analyzing** (C4)

Module No.	Title of the Module	Topics in the Module	No. of Lectures for the module
1.	Introduction to Molecular Modeling	Introduction to structure of DNA, protein and RNA. Structure representation and visualization, Coordinate Systems, Potential Energy Surfaces, Software and Hardware for molecular modeling, Tools such as Swiss pdb viewer, Pymol, VMD etc.	5
2.	Quantum Mechanics and Force Fields	Electron methods and molecular orbital calculations, General Features of Molecular mechanics force field , Bond Stretching. Angle Bending. Introduction to Non-bonded Interactions. Electrostatic Interactions. Van der Waals Interactions. Hydrogen Bonding in Molecular Mechanics. Force Field Models for the Simulation of Liquid Water.	5
3.	Energy Minimization and computer simulations	Minimization and Related Methods for exploring the Energy Surface. Non-Derivative method, Minimization methods. Computer Simulation Methods. Simple Thermodynamic Properties and Phase Space. Boundaries. Analyzing the Results of a Simulation and Estimating Errors.	5
4.	Molecular Dynamics and simulations	Molecular Dynamics Simulation Methods. Molecular Dynamics Using Simple Models. Metropolis Method. Monte Carlo methods, Web Based Resources, Databases and tools such as GROMACS, AMBER, & CHARMM.	6
5.	Structure Prediction	Principles of structure prediction, comparative modeling and protein folding, Comparative and *ab-inito* modeling, CASP, validations, Projects such as ROSETTA, protein	6

		folding at home.	
6.	Drug designing	Introduction to drug discovery and drug development, Rational approach to drug design, Approaches to lead optimization such as conformation restriction, pharmacophore etc. Designing drugs against enzymes and receptors, Computer Aided Drug Design methods. ADMET, QSAR Tools and databases such as AUTODOCK, MOLEGRO, Drug Bank etc.	16
		Total number of Lectures	**43**

Evaluation Criteria

Components	Maximum Marks
T1	20
T2	20
End Semester Examination	35
TA	25 (Assignment-1, MCQ, Project, Presentation)
Total	**100**

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)

1.	Andrew R leach, V.J Gillet, "An introduction to Chemoinformatics" Springer pumodel of publication, 2007
2.	Gasteiger Johann, "Chemoinformatics A text book "John Wiley, 2008
3.	Andrew R. Leach, "Molecular Modeling principles and applications" Pearson Education, Second edition, 2001

Course Code	17M12BT114	Semester Odd	Semester I Session 2019 -2020
			Month from July to December
	Enzyme Technology		
Credits	3	Contact Hours	3

Faculty (Names)	Coordinator(s)	Dr. Priyadarshini
	Teacher(s) (Alphabetically)	Dr. Priyadarshini, Dr. Smriti Gaur

COURSE OUTCOMES	
CO1	Explain enzyme kinetics and its regulation.
CO2	Outline the purification and characterization strategies for industrial enzymes.
CO3	Plan the production of metabolites in biological system .
CO4	Apply acquired knowledge for commercialization of products.

Module No.	Title of the Module	Topics in the Module	No. of Lectures for the module
1.	**Fundamentals of Enzymology**	Objectives and strategies of Enzyme purification, Introduction to enzyme Kinetics, Mechanism of enzyme action and control of enzyme activity with examples related to control of metabolic pathways .	8
2.	**Sources of industrial enzymes**	Natural & recombinant), enzymes in the cell and in organized systems, enzyme turnover, correlation between rate of turnover and structure and function of enzymes	6
3.	**Enzyme immobilization**	Preparation and kinetics of immobilized enzymes, enzyme reactors, membrane reactors, packed bed reactors, continuous flow reactors, stirred tank reactor, fluidized reactors, along with their application in dairy, cereal, fruit juice, oil and fat industry, and their safety aspects , use of immobilized raffinase, lipase, invertase and lactase in industry Recent advances in enzyme technology .	3
4.	**Enzymes as commercial products**	The large-scale use of enzymes	4
5.	**Enzymes in plant fiber based industry**	Biopulping Paper and Pulp industry , Textile industry and in Laundry detergents	4
6.	**Enzymes in Waste remediation**	Explosives, Organophosphates in Pesticide Residues and Nerve Gas, Oil and Gas Desulfurization	4
7.	**Enzymes in Animal nutrition and in Food production**	Pig husbandry, Chicken feed, cattle fodder like Milk and Cheese industries, Sugar industry, Meat industry, Oil, Fat, Flavor and Fragrance industry	4

8.	**Enzymes as therapy targets and Pharmaceuticals**	Proteases, Cycloxygenase, Antivirals,and reverse transcriptase, Polyketide Synthases in Pharmaceutical processing, FDA-Approved Enzyme Drugs and research and development products.	**4**
9.	**Introduction to Metabolic engineering**	Analysis of sequence of reactions and Stoichiometry, Synthesis of primary and secondary metabolites, The genetic switch in E.coli illustrating the dynamic nature of the genome, Metabolic Flux analysis and Metabolic control analysis, Case studies.	**7**
		Total number of Lectures	**42**

Evaluation Criteria

Components	Maximum Marks
T1	20
T2	20
End Semester Examination	35
TA	25 (Assignment 1, Assignment 2)
Total	**100**

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)	
1.	Industrial enzymes and their applications Helmut Uhlig, John Wiley and sons.
2.	Biochemical engineering and Biotechnology Atkins and Mavituna 2nd edition Stockton Press New york
3.	Industrial Enzymology . Godfrey T. West ,S.(eds) 1996, Mac millan Press London
4.	Industrial Application of Immobilized enzymes . Tanaka , A . Tosa , T . and Kobayashi, T .(eds).1993 Marcel Dekker , New York
5.	Gerharts W, "Enzyme Industry-Production and Applications"
6.	Tailor, R.F., "Protein immobilisation-Fundamentals and application"
7.	Zubay G., "Biochemistry"

Detailed Syllabus
Lecture-wise Breakup

Subject Code	17M12BT119	Semester ODD	Semester I Session 2019-2020
			Month from July to December

Subject Name	PHYTOTHERAPEUTICS AND PHARMACOLOGY		
Credits	3	Contact Hours	3

Faculty (Names)	Coordinator(s)	1. Dr.Vibha Rani
	Teacher(s) (Alphabetically)	1. Dr.Vibha Rani

COURSE OUTCOMES		COGNITIVE LEVELS
CO130.1	Analyze the existing biotechnological techniques to develop plant based therapeutics	Analyzing (C4)
CO130.2	Evaluate the classes, synthesis and structure functional relationship of phytomolecules	Evaluating (C5)
CO130.3	Explain the therapeutic applications of phytochemicals	Understanding (C2)
CO130.4	Identify the current aspects of phytomedicines on toxicity and clinical trials	Applying (C3)
CO130.5	Case studies to analyze Ayurpharmacoepidemiology	Analyzing (C4)
CO130.6	Use of bioinformatics tools and approaches to predict the molecular function of novel bioactive molecules	Creating (C6)

Module No.	Subtitle of the Module	Topics in the module	No. of Lectures for the module
1	Introduction		2
2	Medicinal Plants Metabolites	Introduction to metabolites Secondary metabolites, properties and beneficial aspects.	4
3	Isolation technique extraction procedure	Isolation from medicinal plants. Isolation from aromatic plants.	4
4	Characterization technique	Qualitative and quantitative Analysis Gas Chromatogrophy High Performance Liquid Chromatography: (HPLC) High Performance Thin Layer Chromatography: (HPTLC)	4
5	Structure functional relationship	Mechanism of Action Unidentified Therapeutic Intakes Factors That Affect Metabolism	4
6	Therapeutic Application	Plants used in respiratory system. Plants used in urinary system. Plants used with antimicrobial activity. Plants used with Plants used in dermatology.	8

		Plants used in cardiovascular system. Plants used in romatology.	
7	**Toxicity Issue and Clinical Trials**	Current aspects of phytomedicine on toxicity and clinical trials	6
9	**Case studies**	Related to phytotherapeutics	8
10	**Potential risks associated and future aspects**	Discussion	2
12			
		Total number of Lectures	**42**

Evaluation Criteria

Components	Maximum Marks
T1	20
T2	20
End Semester Examination	35
TA	25 (Class Test-1, Assignment-1&2, Case studies 1, 2& 3)
Total	**100**

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Papers, Reports, Websites etc. in the IEEE format)

1.	Plant Bioactives and Drug Discovery: Principles, Practice, and Perspectives. Valdir Cechinel- Filho (Ed.). 2012 John Wiley & Sons, Inc.
2.	Phytotherapeutics (Recent Progress in Medicinal Plants). S. K. Sharma, J. N. Govil, V. K. Sing. 2005. Studium Press.
3.	Phytotherapies: Efficacy, Safety, and Regulation. Iqbal Ramzan (Ed.) 2015 John Wiley & Sons, Inc.
4.	Recent research articles and reviews related to each module.

Course Code	17M15BT111	Semester Odd		Semester I Session 2019 -2020
		(specify Odd/Even)		**Month from** July to December
Course Name	**Biotechniques Lab-I**			
Credits	3		**Contact Hours**	6

Faculty (Names)	Coordinator(s)	Dr. Reema Gabrani
	Teacher(s) (Alphabetically)	Dr. Chakresh K. Jain, Dr. Indira P. Sarethy, Dr. Priyadarshini, Dr. Reema Gabrani, Dr. Sujata Mohanty, Dr. Vibha Gupta, Dr. Vibha Rani

COURSE OUTCOMES	
C111.1	Apply basic analytical techniques in biotechnology
C111.2	Develop skills in molecular biology techniques
C111.3	Examine and analyse gene expression
C111.4	Make use of purification techniques for natural products

Module No.	Title of the Module	List of Experiments	CO
1.	Analytical techniques	To explore drug-protein interactions	2
2.	Molecular biology techniques	Cloning strategy: Virtual lab, Screening of recombinants: isolate recombinant plasmid DNA from bacterial cells; Restriction enzyme digestion, separate and visualize DNA bands by agarose gel electrophoresis	4
3.	Gene expression techniques	Designing primers for amplification of gene of interest by PCR, PCR amplification, analyze PCR products; Analysis of a recombinant protein by polyacrylamide gel electrophoresis	3
4.	Purification techniques	To obtain antimicrobial compound from bacterial culture; to purify the antimicrobial compound by column chromatography; use of bioactivity-guided fractionation to analyse and quantify the compound	3
		Total	**12**

Evaluation Criteria

Components	Maximum Marks
Mid-Term Viva	20
Day-to-Day (Lab record, attendance, performance)	60
Final Viva	20
Total	**100**

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)	
1.	Introduction to Biotechnology, Laboratory Manual: http://www.austincc.edu/awheeler/Files/BIOL%201414%20Fall%202011/BIOL1414_Lab%20

	Manual_Fall%202011.pdf
2.	Frederick M. Ausubel, Roger Brent, Robert E. Kingston, David D. Moore, J.G. Seidman, John A. Smith, Kevin Struhl (eds.) Current Protocols in Molecular Biology. John Wiley & Sons Inc; ringbou edition (December 4, 2003)
3.	Molecular Biology web book- http://www.web-books.com/MoBio/
4.	Methods standardized in lab

Detailed Syllabus

Lecture-wise Breakup

Course Code	18M11GE11	Semester Odd	Semester I Session 2019 -2020
			Month from July to December

Course Name	Research Methodology & Intellectual Property Rights

Credits	2		Contact Hours	2-0-0

Faculty (Names)	Coordinator(s)	Prof. B.P. Chamola
	Teacher(s) (Alphabetically)	Prof. B.P. Chamola

COURSE OUTCOMES		COGNITIVE LEVELS
After pursuing the above mentioned course, the students will be able to:		
CO1	understand the basic concepts and types of research	Understanding Level (C2)
CO2	define a research problem, its formulation, methodologies and analyze research related information	Analyzing Level (C4)
CO3	follow research ethics, understand IPR, patents and their filing related to their innovative works.	Understanding Level (C2)
CO4	understand and analyze the statistical data and apply the relevant test of hypothesis in their research problems	Analyzing Level (C4)

Module No.	Title of the Module	Topics in the Module	No. of Lectures for the module
1.	Research	What is research? Types of research. What is not research? How to read a Journal paper?	3
2.	Report writing	How to write report? Use of Mendeley in report writing. How to write a research paper? Problem identification and solving.	4
3.	Ethics, IPR and Research methodologies	Research ethics, patents, intellectual property rights, plagiarism regulation 2018. Steps in research process and common methodologies to attempt solution to research paper.	8
4.	Basics of statistics and probability distributions	Basic statistical concepts. Handling of raw data, Some common probability distributions.	7
5.	Test of hypothesis and regression	Hypothesis testing. Parametric and non-parametric data, Introduction to regression analysis.	8

	analysis		
	Total number of Lectures (Course delivery method: open ended discussion, guided self-study, lectures)		**30**

Evaluation Criteria

Components	Maximum Marks
Viva –1 before T2 1 Exam	15
Viva –2 after End Sem.	20
End Semester Examination	35
Assignments	30 (Quiz, Assignments)
Total	**100**

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)

1.	**Stuart Melville and Wayne Goddard**, Research methodology: An Introduction for Science & Engineering Students, Kenwyn, South Africa : Juta& Co. Ltd., 1996.
2.	**Kothari, C.R.,** Research Methodology: Methods and Techniques, New Age International, New Delhi, 2009.
3.	**Kumar, Ranjit,** Research Methodology: A Step by Step Guide for Beginners, 2nd Edition, Sage Publications Ltd., 2005.
4.	**Ramappa, T.,** Intellectual Property Rights Under WTO, S. Chand, New Delhi, 2008.
5.	**Wayne Goddard and Stuart Melville,** Research Methodology: An Introduction, Kenwyn, South Africa : Juta& Co, 2001.

Course Code	18M12BT211	Semester Odd (specify Odd/Even)	Semester I Session 2019 -2020 Month from July To December
Course Name	**PUBLIC HEALTH ECONOMICS AND POLICY**		
Credits	3	Contact Hours	3

Faculty (Names)	Coordinator(s)	DR. ASHWANI MATHUR
	Teacher(s) (Alphabetically)	DR. ASHWANI MATHUR

COURSE OUTCOMES		COGNITIVE LEVELS
C141.1	Explain Government policies , socio-economic conditions and research methods in Public Health	Understanding (Level 2)
C141.2	Explain fundamentals of disease epidemiology	Understanding (Level 2)
C141.3	Applying computational tools for determining health indicators from primary and secondary data	Applying (Level 3)
C141.4	Analysis of the role of health care in policy making	Analyzing (Level 4)

Module No.	Title of the Module	Topics in the Module	No. of Lectures for the module
1.	Importance of Public Health	Introduction to Public Health, Health Promotion and Disease Prevention, Relevance of policy response in public health, Public health research methods – qualitative and quantitative methods, Role of ethics in research	6
2.	Basic Epidemiology	Introduction to Fundamentals of Epidemiology; Disease-History, prevention and intervention; measurement of occurrence, effect and impact; cohort studies	7
3.	Statistical Tool in Public Health	Introduction to probability, Probability Distribution, Hypothesis testing, Baye's Theorem, Continuous and categorical outcome	5
4.	Health Economics and micro economics	Economics and Health; Use and understanding of Universal indicators, HDI, LE, Mortality and Morbidity; Principles of economics in health	6
5.	Economic Evaluation	Welfare economics, monetary value of health changes; revealed and expressed preference approach, cost benefit analysis, cost effectiveness analysis	6
6.	Health Policy Analysis	Policy analysis process; health care and health policy; Role of government in policy making; Policy analysis process-identification, evaluation (technology assessment; economic viability)	7
7.	Health financing	Cost behaviour and break even analysis, depreciation concept, health as inventory and investment	5
		Total number of Lectures	42

Evaluation Criteria

Components   **Maximum Marks**

T1	20
T2	20
End Semester Examination	35
TA	25 (Assignment / Class Test-1 & 2)
Total	**100**

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)	
1.	Schneider, M-J. Introduction to Public Health. Jones and Bartlett Publishers, USA, 5th Edition, 2020
2.	Bhattacharya, J., Hyde, T., Tu, P. Health Economics. Palgrave Macmillan, 2006
3.	Drummond M., et al. Methods for the Economic Evaluation of health care programmes. Oxford University Press, 2015

Course Code	19M12BT113	Semester: Odd	Semester: DD X & M.Tech-I
			Session 2019-2020
			Month July to December
Course Name	Sustainable Agriculture		
Credits	3	Contact Hours	3

Faculty (Names)	Coordinator(s)	Prof. S Krishna Sundari
	Teacher(s) (Alphabetically)	Prof. S Krishna Sundari

COURSE OUTCOMES	
CO131.1	• Interpret various practices in sustainable agriculture and sustainable food systems
CO131.2	• Examine methods to promote soil health, minimize water use, and decrease pollution in farm soils
CO131.3	Outline appropriate certification guidelines and Economic Rules that apply for organic farming and biotechnological farm inputs
CO131.4	• Recommend strategies to avoid degradation of soils on a farm through implementation of sustainable management practices in agriculture

Module No.	Title of the Module	Topics in the Module	No. of Lectures for the module
1.	Soil health	Major types of soil, Soil structure and composition, problems in soils & Soil life	4
2.	Soil degradation	Soil structural decline, factors contributing to soil degradation, mechanisms of soil degradation	4
3.	Plant nutrition	Essential requirements for plant growth, micro and macro nutrients, principles of fertilization	4
4.	Synthetic crop chemicals	Types of chemical inputs in modern agriculture, fertilizers, pesticides, insecticides, weedicides, role and mechanism	2
5.	Phytotoxicity	Factors contributing to phyto toxicity, chemical toxicity, soil pollutants, soil antagonists	4
6.	Pest and diseases in Plants	Major categories of plant diseases and associated crop issues, Pest control & Preventative measures, integrated pest management	4
7.	Sustainable ways of farming	Different methods for Sustainable ways of farming, processes involved, advantages, strategy for implementation, Introduction to Land Management programs	6
8.	Organic farming	Natural farming, Safe Cultivation techniques, Cover crops, biofertilizers, biopesticides, bioinoculants, zero chemical input agriculture	5
9.	Tools for Sustainable farming	Irrigation systems & sustainability, Weed Management, cropping seasonal variations, plantation times, crop rotation, energy farming, restoring marginal lands and brown field	3
10	Agriculture	Economic principles of agriculture, Financial sustainability	3

	economics	& planning, Integrated farmer community dynamics	
11	Agriculture regulatory matters	Certification & guidelines for crop inputs (organic, biological inputs, hormones and others), IPR in agriculture, Role of Regulatory bodies	3
		Total number of Lectures	**42**

Evaluation Criteria

Components	Maximum Marks
T1	20
T2	20
End Semester Examination	35
TA	25 (…)
Total	**100**

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)	
1.	Sustainable Agriculture– Beyond Organic Farming, editor: Sean Clark, MDPI, Basel, Switzerland, 2016
2.	Technical reports of USDA, UNDP, ICAR, 2017, 2018
3.	Articles from Journals such as: Journal of Sustainable Agriculture; Agriculture, ecosystem & Environment; Agroecology and Sustainable Food Systems

Course Code	14M1NBT334/17 M12BT118	Semester Odd	Semester I Session 2019 -2020 Month from July to December
Course Name	**Product Development in Biotechnology**		
Credits	3	Contact Hours	3

Faculty (Names)	Coordinator(s)	Prof. Neeraj Wadhwa
	Teacher(s) (Alphabetically)	Prof. Neeraj Wadhwa

COURSE OUTCOMES	
CO1	Outline various processes relevant for Biobusiness
CO2	Compare marketing techniques and related ethics
CO3	Select appropriate technology for the production of Biological products
CO4	Explain financial, regulatory, health policy aspects for biobased industries

Module No.	Title of the Module	Topics in the Module	No. of Lectures for the module
1.	**Biotechnology Industries overview**	Biotechnology as a function of science and business , Functional units Company structure and functions Emerging technology and technical convergences issues	5
2.	**Business in the context of biotechnology Entrepreneurship-**	Science/development, the idea and its development , Plant tissue culture lab-equipment- glasswares chemical requiremen--construction,techniquesin culturing and export abroad, Vermitechnology, Mushroom cultivation, single cell protein, Biofertilizer technology-production, Textile processing, leather treatment, leather industry set up Detergent industry, bakery, Unit processes in food industry	14
3.	**Product development**	a. Production of commercially important primary metabolites like organic acids, amino acids and alcohol & Production processes for various classes of secondary metabolites: Antibiotics, Vitamins and Steroids. b.Production of Industrial Enzymes, Biopesticides, Biofertilizers, Biopreservatives, Biopolymers, Pulp and Paper , SINGLE CELL PROTEIN & Mushroom culture, Bioremediation. Bioprocess strategies in Plant Cell organ culture and Animal Cell culture.	12
4.	**Biobusiness plans**	Concerns and oppurtunities, Environmental clearances requirement from government, Quality checks and validation certificates,	6

5.	**Bioremediation Bioethics and legal issues**	Packaging concerns, Policy and regulatory concerns, Product development, Sustainability, Environmental concerns of product and their waste.	5
		Total number of Lectures	**42**

Evaluation Criteria

Components	Maximum Marks
T1	20
T2	20
End Semester Examination	35
TA	25 (Assignment)
Total	**100**

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)	
1.	Jordan, J. F. (2014). Innovation, Commercialization, and Start-Ups in Life Sciences. London: CRC Press.
2.	Desai, V. (2009). The Dynamics of Entrepreneurial Development and Management. New Delhi: Himalaya Pub. House.
3.	Cruger,Wulf and Anneliese Crueger, "Biotechnology: A Textbook of Industrial Microbiology", 2nd Edition, Panima Publishing, 2000
4	Karthikeyan,S and Arthur Ruf." Biobusiness"MJP Publication Chennai India 2009

Course Code	17M12BT111	Semester Odd (specify Odd/Even)	Semester MTech I Session 2019 -2020 Month from Jan
Course Name	Biosensors		
Credits	3	Contact Hours	3

Faculty (Names)	Coordinator(s)	Prof. Sudha Srivastava
	Teacher(s) (Alphabetically)	Prof. Sudha Srivastava

COURSE OUTCOMES		COGNITIVE LEVELS
CO1	Explain principle and working of biosensors and characterization techniques	Understand Level(C2)
CO2	Evaluate different methods of immobilization and their effect on biosensor performance	Evaluate Level (C5)
CO3	Analyze performance of a biosensor for disease diagnosis, environmental pollution, pathogen quantification	Analyze Level (C4)
CO4	Design strategy for fabrication of a given biosensor with high sensitivity and wide detection range	Create Level (C6)

Module No.	Title of the Module	Topics in the Module	No. of Lectures for the module
1.	**Introduction:**	Sensors and biosensors, definitions, types of sensors, markets, target analytes, glucose and other medical sensors	2
2.	**Biosensor Advancements and nanotechnology**	First-, second-, third generation biosensors, Nanotechnology and present day biosensors	3
3.	**Basic Design Considerations**	Calibration, dynamic Range, signal to noise, sensitivity, selectivity, interference.	3
4.	**The biological component**	Whole cell sensors, enzymes – sensing substrates or inhibitors, antibodies (Mab, Fab). And other binding proteins, oligonucleotides and aptamers.	3
5.	**Types of biosensors**	Optical biosensors, Electrochemical biosensors, Piezoelectric biosensor, Calorimetric biosensors	8
6.	**Immobilization method**	Non-covalent immobilization - entrapment and multipoint electrostatic attachment. Covalent attachment via thiol, amino and hydroxyl groups. Affinity interactions - avidin/biotin, , complementary oligonucleotides.	4
7.	**Techniques for sensing : Physical and chemical**	Absorbance, fluorescence, chemi/bioluminescence and phosphorescence, Surface Plasmon Resonance (SPR), quartz crystal microbalance, cyclic voltammetry	8
8.	**Sensor stabilization**	Storage and operational stability. Polyols, polymers and low Mw compounds as stabilizing agents for drying and long	3

9.	**Applications**	Pharmaceutical**,** agricultural, food safety, biomedical applications, food processing: state of the field, market potential, unique design criteria and needs, current sensors in use.	8
		Total number of Lectures	**42**

Evaluation Criteria

Components	Maximum Marks
T1	20
T2	20
End Semester Examination	35
TA	25 (Class Test, Presentation)
Total	**100**

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)

1.	Ligler, F.S. and Rowe Taitt, C.A. 2002. Optical Biosensors: Present & Future. Elsevier, The Netherlands. ISBN: 0-444-50974-7.
2.	Yang, V.C. and T.T. Ngo. 2000. Biosensors and Their Applications. Kluwer Academic/Plenum Publishers, New York, NY. ISBN: 0-306-46087-4.
3.	Recent research articles

Course Code	17M12BT116	Semester Odd	Semester II Session 2019-20
			Month from January to June

Course Name	Regulatory Affairs		
Credits	3	Contact Hours	3

Faculty (Names)	Coordinator(s)	Dr Shweta Dang
	Teacher(s) (Alphabetically)	Dr Shweta Dang

COURSE OUTCOMES	
C120.1	Explain regulatory markets and agencies; preclinical and clinical trials
C120.2	Analyze the guidelines for approvals of new drugs/biologics
C120.3	Compare innovator and generic pharmaceutical industry with Patent and Non patent exclusivity
C120.4	Interpret ICH guidelines applicable to drugs and biotechnology based therapeutic products.
C120.5	Assess regulatory approvals via related case studies

Module No.	Title of the Module	Topics in the Module	No. of Lectures for the module
1.	**Introduction To Regulatory agencies**	CDSCO, India USFDA, USA EMEA, Europian Union TGA, Australia	2
2.	**Introduction To Pharmacopoeias and Monographs**	Indian Pharmacopoeia (IP) British Pharmacopoeia (BP) United Sates Pharmacopoeia (USP) International Pharmacopoeia (Int. Ph.) European Pharmacopoeia (Eur. Ph.)	2
3.	**Safety and efficacy of drugs/biologics, preclinical studies, Clinical phases**	Case studies of safety issues in history, Preclinical requirements, acute and chronic toxicity, dose determination, NOAEL, phases of clinical trials (I,II III)	4
4.	**Approval pathways for Drugs/ biologic/ biopharmaceuticals in USFDA**	FDA,CDER, CBER, IND, NDA, BLA, recalls, Phase IV, filing procedures	7
5.	**Approval pathways for Drugs/ biologic/ biopharmaceuticals in europe**	EMEA, market authorization application. Centralized, Decentralized, National, Mutual recognition	4

		procedure. CTD, eCTD, Nees Submissions, ICH M4	
6.	**Approval pathways for Drugs/ biologic/ biopharmaceuticals in India and Japan**	Central Drug Standard Control Organization, INDIA, Pharmaceutical and Medical Devices Agency of Japan	**3**
7.	**Generics and Biosimilars**	Hatch Wax man Act (Para I,II,III and IV filings), BPCI act USA, CDSCO guildines, EMEA guidelines, Status of guidelines	**6**
8.	**Non Patent Exclusivities**	Orphan Drug law, Market exclusivity, Pediatrics exclusivity, First to file exclusivity	**5**
9.	**ICH Guidelines for Biologics and Good Clinical Practices**	Overview of ICH guidelines, ICH QSEM, ICH Q5 ,Q6,. ICH E6, ICH Q8,9,10	**5**
11.	**Case Studies**	Relevant Case studies	**4**
	Total number of Lectures		**42**

Evaluation Criteria

Components	**Maximum Marks**
T1	20
T2	20
End Semester Examination	35
TA	25 (Class Test, Assignment I and II)
Total	**100**

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)	
1.	FDA Regulatroy Affairs, David Mantos, Taylor and Francis; 2014 (3rd edition)
2.	Biosimilars Regulatory, Clinical, and Biopharmaceutical Development Editors: Gutka, Hiten J., Yang, Harry, Kakar, Shefali, Springer 2018
3.	The common technical document (CTD), Internet: http://www.ich.org/
4.	ICH Guideline: The Common Technical Document for the Registration of Pharmaceuticals for Human Use: Quality - M4Q; Quality Overall Summary of Module 2, Module 3: Quality, Internet: http://www.ich.org/MediaServer.jser?@_ID=556&@_MODE=GLB

Course Code	17M12BT115	Semester Odd	Semester VII (Integrated) / Ph.D.
			Session 2019 -2020
			Month from July-December

Course Name	Environmental Biotechnology		
Credits	3	Contact Hours	3

Faculty (Names)	Coordinator(s)	Dr. Susinjan Bhattacharya
	Teacher(s) (Alphabetically)	Dr. Susinjan Bhattacharya

COURSE OUTCOMES		COGNITIVE LEVELS
C113.1	Interpret conventional and modern methods to understand dynamics of microbial communities	Level II (Understanding Level)
C113.2	Apply and analyze environmental issues associated with industry and agriculture	Level III (Applying Level)
C113.3	Prioritize, and recommend environmentally safe practices for sustainable environmental management	Level V (Evaluating Level)
C113.4	Compare environmental laws, regulations, enviornmental impact assessment for project implementation and report	Level II (Understanding Level)

Module No.	Title of the Module	Topics in the Module	No. of Lectures for the module
	Significance of Global environmental problems and solutions from Biotechnology	Global environmental issues and remedies from genetic manipulation of plants & microbes, Global warming, Green house gases and carbon sequestering	3
	Pollution of natural resources, causes & concerns	Water pollution, land pollution, sources of pollution, risks of bioaccumulation, implications on biotic life & human health Biodegradable and non – biodegradable matter, toxicity testing, Biosensors, Bioindicators of pollution	5
	Land degradation & Biotechnologies for land restoration	Land restoration and soil health, Engineering stress tolerant & herbicide & disease/pest resistant crops, Biotechnology of nitrogen fixation, Composting, Biofertilizers	5
	Bioremediation & Phytoremediation	Bioremediation & Microbes, Degrees of biodegradation, Factors needed for biodegradation and adaptation, types of bioremediation (*in situ / ex situ*), GMOs superbugs, Biosorption, Biostimulation, Bioaggumentation, , Oil spills - degradation of xenobiotics application of bioremediation in various environments/ecosystems; Effluent and water treatment; Phytoremediation and its applications	4

	Management of waste and Industrial refuse	Waste management (solid & liquid wastes), treatment of urban wastes, industrial wastes, Hospital wastes, Power plant wastes, Electronic waste, mineral wastes & radiological wastes.	4
	Alternate energy sources and other applications	Renewable Bioenergy, Biofuels, Biomass applications, Applications of Biotechnology in various industries: paper & pulp, tanneries, distilleries, food processing & diary industry, Biofilters, Bioplastics, Biofilms in industry & environment, Case studies.	5
	Metagenomics - Invisible microbial Communities	Limitations of Pure Culture, Microbial Diversity and Variation in different extreme environments including human systems, Molecular tools to study diversity, Microarray techniques, application of genomics, transcriptomics and metabolomics to understand functional diversity of microbes	4
	Procedures in Metagenomics studies	Methods of Obtaining meta DNA from diverse environments, Habitat Selection 16S rRNA based amplification and Phylogenetics, Functional Sequencing, whole genome sequencing methods, use of phylogenetic markers for diversity analyses, Significance of Bioinformatics in understanding and analysis of Genomic Data, Databases and Software available for analysis of Metagenomic Data	4
	Metagenomics & Environmental Biotechnology	Function-Based Analyses of Microbial Communities, Acid Mine Drainage project, Sargasso Sea Metagenomic Survey, applying function based metagenome analysis to remediation etc.	4
	Environmental laws & Regulations	Environmental regulations for industry, EPA, ISO standards for environmental management	4
		Total number of Lectures	**42**

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)	
1.	"Environmental Biotechnology" by **A. Sragg**, Oxford University Press, Second edition Reprint 2005, ISBN 0-19-926867-3
2.	"Enviornmental Biotechnology and Application" by **G. Evans**, J.C. Furlong, John Wiley and Sons Ltd.
3.	"Environmental Biotechnology: Basic concepts and Applications" by **Indu Shekhar Thakur**, IK International, 2006
4.	"Principles of Gene manipulation and Genomics", by SB Primrose & RM Twyman, Seventh edition, Blackwell publishing
5.	"The New Science Of Metagenomics Revealing The Secrets Of Our Microbial Planet", The National Academies Press, Washington, Dc
6.	Refereed papers from scientific journals for case studies