Jaypee Institute of Information Technology

M.Sc. Microbiology

Course Descriptions

SEMESTER 4

DISSERTATION

Course Code	**17M17BT216**	**Semester** ODD	**Semester:** IV **Session: 2021-22** June to December
Course Name	**Dissertation**		
Credits	16	**Contact Hours**	32

Faculty (Names)	**Coordinator(s)**	Dr. Vibha Gupta
	Teacher(s) (Alphabetically)	Dr. Vibha Gupta

COURSE OUTCOMES		**COGNITIVE LEVELS**
C213.1	Identify the research problem and select suitable scientific methods to solve the given research problem	Apply (Level 3)
C213.2	Formulate the plan and test for hypothesis	Create (level 6)
C213.3	Assess the key findings and interpret the data	Evaluate (Level 5)
C213.4	Compose the written scientific report and effectively present the data	Create (Level 6)

Project Based Learning: In this course, students work on various research projects under the guidance of the faculty mentors of our department. Therefore, the learning from this course is completely Project-based.

Employability: Students expose themselves to various novel techniques and disciplines during execution of their project work and the outcome of these research projects facilitates them in cultivating innovation, R&D aspect and also motivates them towards right Employability.

STRUCTURAL BIOLOGY

Course Code	**17M12BT128**	**Semester:** Even **(specify Odd/Even)**	**Semester: IV** **Session: 2021-22** Jan-June
Course Name	**Structural Biology**		
Credits	3	**Contact Hours**	3

Faculty (Names)	**Coordinator(s)**	1. Vibha Gupta
	Teacher(s) (Alphabetically)	2. Vibha Gupta

Course Outcome: Upon completion of the course students will be able to:

Course S. No.	**Course Outcomes**	**Outcomes**
CO1	Describe the modern methods for determination of structure of biological molecules particularly proteins	**C2**
CO2	Relate knowledge of the three-dimensional structures of proteins with their functions	**C4**
CO3	Apply modern bioinformatic tools for visualizing structures and for drug designing	**C4**
CO4	Read and critique a structure paper	**C5**

Pre-requisite : NA

Module No.	**Subtitle of the Module**	**Topics in the module**	**No. of Lectures for the module**
1.	Biological Macromolecules	Type of macromolecules, Structural architecture	**4**

2.	Structure Analysis Methods	X-ray crystallography, NMR, small-angle X-ray and neutron scattering (SAXS/SANS), cryo-electron microscopy, mass spectrometry, Circular Dichroism, Fluorescence spectroscopy, Static and Dynamic Light scattering, Differential Scanning Calorimetry and Isothermal Titration Calorimetry, Surface Plasma Resonance, analytical ultracentrifugation	**7**
3.	Structural bioinformatics	Biological Sequence and Structural data banks – PDB, NDB, RNA Structure Database, CSD, bioinformatic approach for prediction of secondary and tertiary structures of proteins and nucleic acids, molecular modeling and threading	**3**
4.	Structural chemistry of biological macromolecules	Characterization of forces acting in biology, protein folding, binding interfaces, protein dynamics, misfolding and human disease	**4**
5.	Biomolecular recognition	Protein Interactions: Substrate recognition by DNA polymerases; antigen antibody interaction; RNA-RNA recognition in vivo; DNA-DNA interactions (DNA Microarray); Cell-cell interactions**:** receptor-mediated recognition in immune system surveillance, macrophage- B-Cell collaboration, T-Cell and natural killer cell function, Phage display	**10**
6.	Structure and function	Macromolecular structure and function case studies in relation to transcription, translation, folding and other fields of cell (G-protein coupled receptors, nuclear pore complex, transporters,ion channels myosin, signal transduction proteins, membrane proteins etc)	**10**
7.	Structure assisted Drug Designing	Steps in drug designing for known as well as unknown targets	**4**
Total number of Lectures			42

Evaluation Criteria	
Components	**Maximum Marks**
T1	20
T2	20
End Semester Examination	35
TA	25 (Class Test, assignment, quiz, PBL)
Total	**100**

Project Based learning: Students either individually or in a group of 2 will be asked to (i) choose a target disease and target protein (ii) solve protein structure by molecular modeling or threading (iii) design a novel ligand for the target molecule

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.	Bernhard Rupp "Biomolecular crystallography: principles, practice and applications to structural biology" Abingdon, New York: Garland Science, Taylor & Francis Group, 2010
2.	Leonard J. Banaszak "Foundations of Structural Biology"Academic Press
3.	Irwin H. Segel "Enzyme Kinetics: Behavior and Analysis of Rapid Equilibrium and Steady- State Enzyme Systems" Wiley
4.	Charles R. Cantor, Paul R. Schimmel's three part series – Biophysical Chemistry: Part I: The conformation of Biological Macromolecules; Part II: Techniques for the study of biological structure and function; Part III: The Behavior of Biological Macromolecules WH Freeman and Co, Oxford.
5.	Research papers and Reports

BIOSEPARATION TECHNOLOGY

Course Code	**17M22BT213**	**Semester:** Even **(specify Odd/Even)**	**Semester: IV** **Session: 2021-22** Jan-June
Course Name	**Bioseparation Technology**		
Credits	3	**Contact Hours**	3

Faculty (Names)	**Coordinator(s)**	Dr. Ashwani Mathur
	Teacher(s) (Alphabetically)	Dr. AshwaniMathur

COURSE OUTCOMES		**Level**
CO1	Understand the properties of biomolecule on choice of bioseparation techniques	Understand Level (C2)
CO2	Compare the principles of different instruments and techniques used in bioseparation	Understand Level (C2)
CO3	Apply different purification methods for product purification	Apply Level (C3)
CO4	Implement the purification strategies for bioproduct purification	Apply Level (C3)

Module No.	**Modules**	**Topics in Module**	**Lecture Classes**
1	Bioseparation: Overview	Introduction to bioseparation, characteristics of biological material, strategies for removing insoluble, isolation and purification of product and polishing of final product	6
2	Removal of Insoluble	for cell disruption: chemical methods and mechanical methods, Principle and equipment design; Sedimentation; Filtration and Microfiltration: equipment for conventional filtration, pretreatment, theory of filtration, microfiltration; Centrifugation: centrifuges, scale-up of	8

		centrifuges, centrifugal filtration: designing and operation	
3	Isolation of bioproducts	Extraction: Principle of extraction, batch, staged and differential extraction, fractional extraction. Aqueous two phase partitioning; Adsorption: chemistry, batch adsorption, adsorption in continuous stirred tank, adsorption in fixed bed.	5
4	Product Purification	Chromatography: principle, types of chromatography, properties of adsorbents, kinetics analysis, scaling up of chromatography; precipitation: precipitation with non- solvent, salt and temperature, large scale precipitation, ultrafiltration and electrophoresis: principles, electro- dialysis and isoelectric focusing	7
5	Product Polishing	Crystallization: crystal size distribution, batch crystallization, recrystallization; Drying: basic concept, drying equipment, conduction drying, adiabatic drying, lyophilization: instrument design and principle; spray drying	7
6.	Process design for purification of biomolecules	Bioseparation strategies for the purification of antibiotics (penicillin), enzymes, carotinoids, organic acids and monoclonal antibodies	5
7	Ancillary operations	Solvent recovery, waste disposal, biosafety	4
TOTAL			**42**

Evaluation Criteria

Components	**Maximum Marks**
T1	20
T2	20
End Semester Examination	35

TA	25 (Class Test, assignment, quiz, PBL)
Total	**100**

Project Based Learning: Students will learn the principles and applications of the instruments used in bioseparation strategies. Students will be able to develop the rationale behind developing a successful bioseparation strategies that may be applied to industrial and bio manufacturing sectors

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.	P.F. Stanbury, A. Whitaker and S.J. Hall. *Principles of Fermentation Technology*. Oxford, U.K.: Butterworth-Heinemann, 1994.
2.	P.A. Belter, E.L. Cussler, W-S. Hu. *Bioseparations: Downstream processing for Biotechnology*. USA: A Wiley- Interscience Publication, 1988
3.	ML. Schuler and F. Kargi. *Bioprocess Engineering*. Prentice Hall, 1992
4.	B. Atkinson and F. Mavituna. *Biochemical Engineering and Biotechnology handbook*. U.K: Macmillan Publishers Ltd., The Nature Press, 1983.

MICROBIOMICS

Course Code	**19M22BT213**	**Semester:** Even **(specify Odd/Even)**	**Semester: IV** **Session: 2021-22** Jan-June
Course Name	**Microbiomics**		
Credits	3	**Contact Hours**	3

Faculty (Names)	**Coordinator(s)**	1. Dr. Chakresh Kumar Jain
	Teacher(s) (Alphabetically)	1. Dr. Chakresh Kumar Jain, 2. Dr. Ashwani Mathur

COURSE OUTCOMES		**COGNITIVE LEVELS**
C373.1	Explain about the microbiome, diversity and relation with biological system	Understand Level (C2)
C373.2	Summarize the role of Human microbiota and environment in infectious diseases	Understand Level (C2)
C373.3	Compare different sequencing methods and perform data analysis	Analyze Level (C4)
C373.4	Summarize interaction between Gut Microbiome and human nutrition	Understand Level (C2)

Module No.	Subtitle of the Module	Topics in the module	No. of Lectures for the module
1.	**Overview of microbiomics**	Fundamentals microbiomics and applications, Which functions are expressed in the microbiome - transcriptomics	7
2.	**Microbiomic theory of life**	human 'commensal' microbiota, Human microbiome project, soil or water microbiota, their features and role in living system	5
3.	**Microbiome diversity**	16s rRNA profiling analysis, Shotgun Metagenomics, and internal Transcribed spacer (ITS), internal Transcribed region analysis, Taxonomic classification, Diversity analysis	8
4.	**Sequencing methods**	Extracting whole genomes from the microbiome - genome sequencing through PacBio, Deep sequencing, shot gun sequencing and data analysis using computational tools and pipelines, such as MG-RAST server etc.	10
5.	**Human Microbiome**	Nexus of Food, Agriculture, Human nutrition, and Gut Microbiome	7
6	**Environment and Microbiome**	Environmental influences on bacterial genomes: bacterial epigenome and its analysis	4
7.	**Applications and tools**	Human microbiota and infectious diseases, liver diseases, gastrointestinal malignancy etc.	5
Total number of Lectures			**42**

Evaluation Criteria	
Components	**Maximum Marks**
T1	20
T2	20
End Semester Examination	30
TA	25 (Assignments 1, 2 / MCQ,Attendance)
Total	**100**

PBL: Student individually or in a group of 2 to 3 will be assigned the microbiota based study on diseases and put the presentation viva/report /poster

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.	Vassilios fanos, "Metagenomics and microbiomics", 2016, pp 144, Academic press. ISBN 9780128053058
2.	Pierre Baldi and Søren Brunak "Bioinformatics The Machine Learning Approach" , February 2001, The MIT Press, Cambridge, London
3.	Research papers and online resources

IPR IN BIOTECHNOLOGY

Course Code	**15M1NBT231**	**Semester:** Even **(specify Odd/Even)**	**Semester: IV** **Session:** January to June
Course Name	**IPR in Biotechnology**		
Credits	3	**Contact Hours**	3

Faculty (Names)	**Coordinator(s)**	Prof. Shweta Dang
	Teacher(s) (Alphabetically)	Dr. Indira P. Sarethy, Prof. Shweta Dang

COURSE OUTCOMES		**COGNITIVE LEVELS**
CO1	Explain and interpret the types of intellectual property rights, related laws and systems	**Understand (C2)**
CO2	Apply specific IPR issues pertaining to medical biotechnology	**Apply (C3)**
CO3	Evaluate plant and traditional knowledge protection	**Evaluate (C5)**
CO4	Appraise commercialization of intellectual property, infringements and laws applicable	**Evaluate (C5)**

Module No.	**Title of the Module**	**Topics in the Module**	**No. of Lectures for the module**
1.	**Introduction**	Intellectual Property Rights - their Relevance, Importance and Business Interest to Industry, Academia, Protection of Intellectual Property, Relationship of IPRs with biotechnology	**2 [CO1]**
2.	**Types of Intellectual Property Rights**	Patents, Trademarks, Copyrights, Industrial Designs, Geographical Indications, Trade secrets, non- disclosure agreements	**2 [CO1]**

3.	**Patents**	General Introduction to Patents, Patent Terminology, Patent Claims, Patent Life and Geographical Boundaries, Utilization of Intellectual Patents, Licensing of patents	**4 [CO1, CO2]**
4.	**Elements of patentability**	Invention/Discovery, What constitutes Patentable subject matter, the Utility, novelty and non-obviousness of an invention, Patentability in	**2 [CO2, CO3]**
		Biotechnological Inventions: Case studies	
5.	**Preparation and Process for Patenting**	Procedural steps to grant of a patent, Process of filing patents in India, PCT application, protocols of application, pre-grant & post-grant opposition	**3 [CO2, CO3]**
6.	**Patent Search**	Invention in context of "prior art", Patent Search methods, Patent Databases & Libraries, online tools, Country-wise patent searches (USPTO, EPO, India etc.), patent mapping	**2 [CO2, CO3]**
7.	**IPR laws**	Basic features of the Indian Patent Act, the Indian Copyright Act, and the Indian Plant Varieties Protection and Farmers' Rights Act, A brief overview of other Patent Acts & Latest Amendments of Indian, European & US patent systems	**2 [CO1, CO2, CO3]**
8.	**Patent issues in Drugs and Pharmaceuticals**	Generics, Compulsory Licensing, Exclusive Marketing Rights (EMR), Bolar provision, Bayh-Dole act, Second medical use	**2 [CO2, CO3]**
9.	**Worldwide Patent Protection, WTO & TRIPS Agreement**	Brief Background of different International conventions such as Paris convention, TRIPS, WTO, PCT and Patent Harmonisation including Sui-generis system, The relationship between IPRs and international trade, Overview of WTO & TRIPS Agreement, Enforcement and dispute settlement under the TRIPS Agreement, The implication of TRIPS for developing countries in the overall WTO system	**2 [CO1, CO2, CO3]**
10.	**Gene patents**	Introduction & overview, what constitutes gene patents, Bayh-Dole Act, ESTs, Cohen-Boyer technology, PCR patents, EPO case, BRCA gene, Types of IPR involved, Genetic Use Restriction Technologies, Patenting of biologics, Hatch Waxman	**9 [CO3, CO4]**

		Act	
11.	**Protection of Plant Varieties /Seeds**	The interface between technology and IPRs in the context of plants, Key features of UPOV 1978, UPOV 1991 and TRIPS with respect to IPRs on plants, Indian Law on Protection of Plant Varieties, DUS criteria, patenting of genetically modified plants, The significance of IPRs in agricultural biotechnology, Biodiversity, Conventions & Treaties, plant patents, Plant Varieties Protection Act, Plant Breeders' Rights, UPOV, benefit sharing, *sui generis* systems Case studies	**4 [CO3, CO4]**
12.	**Traditional Knowledge and Intellectual**	The importance and relevance of Traditional Knowledge for developing nations, The various approaches to protecting TK, The local, national and	**4 [CO3, CO4]**
	Property Rights	global dimensions of the issues in TK and IPRs, Traditional Medicine & IP Protection, Folklore, Patenting of Health Foods: Case studies	
13.	**Patent Infringement and Commercializing Intellectual Property Rights**	What all are considered as patent Infringement: Case studies, defenses to infringement including experimental use, patent misuse, legal considerations, Patent Valuations, Competition and Confidentiality issues, Assignment of Intellectual Property Rights, Technology Transfer Agreements	**4 [CO4]**
Total number of Lectures			**42**

Evaluation Criteria

Components	**Maximum Marks**
T1	20
T2	20
End Semester Examination	35
TA	25 (Assignments 1 (PBL based 5 Marks), Assignments 2. Presentation 1)

Total	**100**

PBL: students will be given keywords to do prior art search from free patent databases like google patents, UPTO and they can analyse the types of patents filed under various domains

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.	USPTO Web Patent Databases at: www.uspto.gov/patft
2.	Government of India's Patents Website: patinfo.nic.in
3.	Intellectual property India: www.ipindia.nic.in
4.	"Indian Patent Law: Legal and Business Implications" by Ajit Parulekar, Sarita D'Souza Macmillan India publication, 2006
5.	"Agriculture and Intellectual Property Rights", edited by: Santaniello,V., Evenson, R.E., Zilberman, D. and Carlson, G.A. University Press publication, 2003
6.	Research papers and Reports provided from time to time

Course Code	21M22BT211	**Semester:** Even **(specify Odd/Even)**	**Semester** IV sem **Session** 21-22 **Month from** January to June
Course Name	Prebiotics and Probiotics		
Credits	3	**Contact Hours**	3

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

COURSE OUTCOMES		**COGNITIVE LEVELS**
CO1	Explain the composition and criteria for categorization of prebiotics and probiotics	Understand (C2)
CO2	Identify the health benefits of prebiotics and probiotics	Apply (C3)
CO3	Assess the impact of prebiotics and probiotics on human gut	Evaluate (C5)
CO4	Evaluate the utility of prebiotics and probiotics as a functional food	Evaluate (C5)

Module No.	**Title of the Module**	**Topics in the Module**	**No. of Lectures for the module**
1.	Prebiotics Concepts and Ingredients	Prebiotic: definition, criteria, use of Prebiotics, types and sources of prebiotics : β-Glucan, Galacto- Oligosaccharide, Xylo-Oligosaccharides, Resistant Starch, Inulin-Type Fructans, Oligofructose, Polyphenols as prebiotics.	6
2.	Health benefits of prebiotics	Decrease GI infection, mineral absorption, immune response, cancer prevention, IBD, elderly health and infant health, metabolic disorders prevention, Maintaining healthy gut	4

3.	Probiotics: Foundation and Definition	Introduction and history of Probiotics, Probiotic microorganisms, Commercially important probiotics, Mechanism of probiotics, safety of probiotic microorganisms, legal status of probiotics.	5
4	characteristics of Probiotics for selection	Key features of probiotics, Selection Criteria for isolating and defining probiotic bacteria, Technological criteria for selection of probiotics, Stresses encountered by probiotic bacteria, minimum effective dose, Production of Probiotic Cultures for Foods or Food Supplements, maintenance of probiotic microorganisms.	8
5	Health Benefits of Probiotics	Effect on Gastroenteritis, Coadministration with Antibiotics, Effects on Inflammatory Bowel Disease (IBD), Irritable Bowel Syndrome (IBS), and Other Gastrointestinal Disorders, Antiallergic effects, Anticancer Effects, Effect on *Helicobacter pylori*, Antihypertensive Effects, Lactose intolerance, Cholesterol lowering effects	6
6	Probiotics and Prebiotics for Promoting Health: Through Gut Microbiota	Human Gut Microbiota: Complexities, Diversities, Functionalities, Gut Microbiota Balance in the Triangle of Nutrition, Health, and Disease, Factors Influencing the Gut Microbiota, Prebiotics and Probiotics effects on Intestinal Microbiota and Environment.	6
7.	Enriched food products containing Health Promoting Molecules (Prebiotics and probiotics)	Functional Dairy products, beverages, snacks and confectionary, fermented food products, Infant food, and their therapeutic applications	5
8.	Product development	Enhancing functionality of prebiotics and probiotics Through product development, Current status of functional food industry.	2
		Total number of Lectures	42
Project based learning: Each student will present an idea on Enhancing functionality of prebiotics and probiotics Through product development. They will present and discuss in detail about the development of prebiotic and probiotic based products. This will enhance the student's understanding			

about various application aspects of prebiotics and probiotics. They will get an insight into how prebiotic and probiotic can be employed for Enriched food products containing Health Promoting Molecules.

Evaluation Criteria

Components	**Maximum Marks**
T1	20
T2	20
End Semester Examination	35
TA	25 (Class Test-1, PBL/ Presentation / Report)
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.	Glenn R. G. Marcel R. *Handbook of Prebiotics* , CRC press, 2008.
2.	Lee Y K, Salminen S , *Handbook of Probiotics and Prebiotics* . A John Willey and Sons Inc. Publication, 2009
3.	Rao V. and Rao L,. *Probiotics and prebiotics in human nutrition and health*, Intech Open, 2016

Subject Code	20M22BT212	**Semester :** Even **(specify Odd/Even)**	**Semester : Session : 2021-22 Month from : Jan-June**
Subject Name	Bioenergetics in Human Health and disease		
Credits	**4**	**Contact Hours**	**4**

Faculty (Names)	**Coordinator(s)**	Dr. Shalini Mani
	Teacher(s) (Alphabetically)	Dr. Shalini Mani

COURSE OUTCOMES		**COGNITIVE LEVELS**
CO1	Understand the mitochondrial biology and Bioenergetics	Understand (C2)
CO2	Analyze the significance of Mitochondria for cellular viability and its function	Analyze (C4)
CO3	Use the knowledge of mitochondria quality control pathways in understanding the pathogenesis of mitochondrial diseases	Applying (C3)
CO4	Apply advance techniques for diagnosis and therapy of mitochondrial diseases	Applying (C3)
CO5	Apply the subject knowledge in understanding the epidemiology of mitochondrial diseases and their effect on global health	Understand (C3)

Module No.	**Subtitle of the Module**	**Topics in the module**	**No. of Lectures for the module**
1.	Basic principles of mitochondrial biology and bioenergetics	Introduction to mitochondria, structure, mitochondrial biology, mt DNA, peculiarities of mt DNA and its inheritance, Threshold effect and bottleneck effect., Energy transformations in mitochondria. Mesosmes in bacteria as analogous to eukaryotic mitochondria.	4
2.	Mitochondrial quality	Biogenesis, autophagy role of TFAM and POLG, trafficking,	8

	control pathways	fission and fusion, mtDNA replication, regulation and maintenance; mutations in mtDNA, Nuclear-mitochondria cross talk.	
3	Significance of Mitochondria for cellular viability and function	Respiratory chain and ATP generation, mitochondria as sources and targets of free radicals, The vulnerability of mtDNA and consequences of oxidative damage, calcium signaling: mechanisms and functional consequences, apoptosis, necrosis and PTP.	8
4	Mitochondrial defects and disease:	Cancer, neurological disorders, Cardiac problems, diabetes, ageing, Metabolic disorders.	8
5	Diagnosis and therapy of mitochondrial disorders	Diagnosis: Microscopic techniques, molecular biology bases techniques, Biochemical studies, clinical and radiological studies; Therapy: Vitamin supplementation, mt donation by spindle transfer methods and PMT method, ethical issued associated with mt donation, Mitochondria and future of medicine.	10
6	Case studies on different mitochondrial diseases and its cure	Global prevalence of mitochondrial disorders and different case studies for their comprehensive studies.	4
Total number of Lectures			**42**
PBL: The students learn various advanced methods for diagnostics and therapeutics of rare as well as some common mitochondrial diseases. Students will be assigned projects to identify the common and overlapping clinical features of mitochondrial disease and how to select the suitable methods and approaches for diagnosis and therapy of the same.			

Evaluation Criteria

Components	**Maximum Marks**
T1	20
T2	20
End Semester Examination	35

TA	25 (Class Test, assignment, quiz, PBL)
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.	Mitochondria in Health and in Sickness. Editors: Andrea Urbani, Mohan Babu, 2019, Springer
2.	Diagnosis and Management of Mitochondrial DisordersEditors: **Mancuso,** Michelangelo, **Klopstock**, Thomas (Eds.). 2019, Springer
3.	Mitochondrial Medicine: A Primer for Health Care Providers and Translational Researchers. Author: Pankaj Prasun, 2019, Academic Press
4.	Mitochondria and the Future of Medicine: The Key to Understanding Disease, Chronic Illness, Aging, and Life Itself. Lee Know, 2018, Kindle Edition
5.	Research Papers