

**M.Sc. Microbiology**  
**Semester IV**

## DISSERTATION

<b>Course Code</b>	19M27BT211	<b>Semester EVEN</b>	<b>Semester: IV</b> <b>Session: 2022-23</b>
<b>Course Name</b>	<b>Dissertation</b>		
<b>Credits</b>	1 6	<b>Contact Hours</b>	3 2

<b>Faculty (Names)</b>	<b>Coordinator(s)</b>	Dr. Vibha Gupta
	<b>Teacher(s) (Alphabetically)</b>	Dr. Vibha Gupta

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

## PREBIOTICS AND PROBIOTICS

<b>Course Code</b>	21M22BT211	<b>Semester:</b> Even (specify Odd/Even)	<b>Semester</b> IV <sup>sem</sup> <b>Session</b> 22-23 Month from January to June
<b>Course Name</b>	Prebiotics and Probiotics		
<b>Credits</b>	3	<b>Contact Hours</b>	3

<b>Faculty (Names)</b>	<b>Coordinator(s)</b>	Dr. Smriti Gaur
	<b>Teacher(s) (Alphabetically)</b>	Dr. Smriti Gaur

COURSE OUTCOMES		COGNITIVE LEVELS
<b>CO1</b>	Explain the composition and criteria for categorization of prebiotics and probiotics	Understand (C2)
<b>CO2</b>	Identify the health benefits of prebiotics and probiotics	Apply (C3)
<b>CO3</b>	Assess the impact of prebiotics and probiotics on human gut	Evaluate (C5)
<b>CO4</b>	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 : $\beta$ -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 <i>Helicobacter pylori</i> , 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)
<b>Total</b>	<b>100</b>

**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. <i>Handbook of Prebiotics</i> , CRC press, 2008.
2.	Lee Y K, SalminenS , <i>Handbook of Probiotics and Prebiotics</i> . A John Willey and Sons Inc. Publication, 2009
3.	Rao V. and Rao L., <i>Probiotics and prebiotics in human nutrition and health</i> , Intech Open, 2016

## BIOSEPARATION TECHNOLOGY

<b>Course Code</b>	<b>17M22BT213</b>	<b>Semester: Even</b> <b>(specify Odd/Even)</b>	<b>Semester: IV</b> <b>Session: 2022-23Jan-June</b>
<b>Course Name</b>	<b>Bioseparation Technology</b>		
<b>Credits</b>	<b>3</b>	<b>Contact Hours</b>	<b>3</b>

<b>Faculty (Names)</b>	<b>Coordinator(s)</b>	Dr. Priyadarshini
	<b>Teacher(s) (Alphabetically)</b>	Dr. Ashwani Mathur, Dr. Priyadarshini

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

<b>Module No.</b>	<b>Modules</b>	<b>Topics in Module</b>	<b>Lecture Classes</b>
<b>1</b>	Bioseparation: Overview	Introduction to bioseparation, characteristics of biological material, strategies for removing insoluble, isolation and purification of product and polishing of final product	<b>6</b>
<b>2</b>	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 centrifuges, centrifugal filtration: designing and operation	<b>8</b>

<b>3</b>	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
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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
<b>TOTAL</b>			<b>42</b>
<b>Evaluation Criteria</b>			
<b>Components</b>		<b>Maximum Marks</b>	
T1		20	
T2		20	
End Semester Examination		35	
TA		25 (Class Test, assignment, quiz, PBL)	
<b>Total</b>		<b>100</b>	
<b>Project Based Learning:</b> 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			

<b>Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. ( Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)</b>	
1.	P.F. Stanbury, A. Whitaker and S.J. Hall. <i>Principles of Fermentation Technology</i> . Oxford, U.K.: Butterworth-Heinemann, 1994.
2.	P.A. Belter, E.L. Cussler, W-S. Hu. <i>Bioseparations: Downstream processing for Biotechnology</i> . USA: A Wiley- Interscience Publication, 1988
3.	ML. Schuler and F. Kargi. <i>Bioprocess Engineering</i> . Prentice Hall, 1992
4.	B. Atkinson and F. Mavituna. <i>Biochemical Engineering and Biotechnology handbook</i> . U.K: Macmillan Publishers Ltd., The Nature Press, 1983.

## MICROBIOMICS

<b>Course Code</b>	<b>19M22BT21 3</b>	<b>Semester: Even (specify Odd/Even)</b>	<b>Semester: IV Session: 2022-23Jan-June</b>
<b>Course Name</b>	<b>Microbiomics</b>		
<b>Credits</b>	<b>3</b>	<b>Contact Hours</b>	<b>3</b>

<b>Faculty (Names)</b>	<b>Coordinator(s)</b>	1. Dr. Chakresh Kumar Jain
	<b>Teacher(s) (Alphabetically)</b>	Dr. Chakresh Kumar Jain

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



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

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

**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

<b>Recommended Reading material:</b> Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Papers, Reports, Websites etc. in the IEEE format)	
<b>1.</b>	Vassilios fanos, “Metagenomics and microbiomics”, 2016, pp 144, Academic press. ISBN 9780128053058
<b>2.</b>	Pierre Baldiand SørenBrunak“Bioinformatics The Machine Learning Approach” , February 2001, The MIT Press, Cambridge, London
<b>3.</b>	Research papers and online resources

## IPR IN BIOTECHNOLOGY

<b>Course Code</b>	18M12BT116	<b>Semester:</b> Even (specify Odd/Even)	<b>Semester: IV</b> <b>Session:</b> January to June
<b>Course Name</b>	<b>IPR in Biotechnology</b>		
<b>Credits</b>	3	<b>Contact Hours</b>	3

<b>Faculty (Names)</b>	<b>Coordinator(s)</b>	Prof. Shweta Dang
	<b>Teacher(s) (Alphabetically)</b>	Dr. Indira P. Sarethy, Prof. Shweta Dang

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

<b>Module No.</b>	<b>Title of the Module</b>	<b>Topics in the Module</b>	<b>No. of Lectures for the module</b>
1	<b>Introduction</b>	Intellectual Property Rights - their Relevance, Importance and Business Interest to Industry, Academia, Protection of Intellectual Property, Relationship of IPRs with biotechnology	2 [CO1]
2	<b>Types of Intellectual Property Rights</b>	Patents, Trademarks, Copyrights, Industrial Designs, Geographical Indications, Trade secrets, non-disclosure agreements	2 [CO1]
3	<b>Patents</b>	General Introduction to Patents, Patent Terminology, Patent Claims, Patent Life and Geographical Boundaries, Utilization of Intellectual Patents, Licensing of patents	4 [CO1, CO2]

<b>4</b> .	<b>Elements of patentability</b>	Invention/Discovery, What constitutes Patentable subject matter, the Utility, novelty and non-obviousness of an invention, Patentability in	<b>2</b> [CO 2, CO3 ]
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		Biotechnological Inventions: Case studies	
5 .	<b>Preparation and Process for Patenting</b>	Procedural steps to grant of a patent, Process of filing patents in India, PCT application, protocols of application, pre-grant & post-grant opposition	3 [CO 2, CO3 ]
6 .	<b>Patent Search</b>	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 [CO 2, CO3 ]
7 .	<b>IPR laws</b>	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 .	<b>Patent issues in Drugs and Pharmaceuticals</b>	Generics, Compulsory Licensing, Exclusive Marketing Rights (EMR), Bolar provision, Bayh-Dole act, Second medical use	2 [CO 2, CO3 ]
9 .	<b>Worldwide Patent Protection, WTO &amp; TRIPS Agreement</b>	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]
1 0 .	<b>Gene patents</b>	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 Act	9 [CO 3, CO4 ]

<p>1 1 .</p>	<p><b>Protection of Plant Varieties /Seeds</b></p>	<p>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 &amp; Treaties, plant patents, Plant Varieties Protection Act, Plant Breeders' Rights, UPOV, benefit sharing, <i>sui generis</i> systems Case studies</p>	<p>4 [CO 3, CO4 ]</p>
<p>1 2 .</p>	<p><b>Traditional Knowledge and Intellectual</b></p>	<p>The importance and relevance of Traditional Knowledge for developing nations, The various approaches to protecting TK, The local, national and</p>	<p>4 [CO 3, CO4 ]</p>

	<b>Property Rights</b>	global dimensions of the issues in TK and IPRs, Traditional Medicine & IP Protection, Folklore, Patenting of Health Foods: Case studies	
<b>1 3 .</b>	<b>Patent Infringement and Commercializing Intellectual Property Rights</b>	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	<b>4 [CO4]</b>
<b>Total number of Lectures</b>			<b>42</b>
<b>Evaluation Criteria</b>			
<b>Components</b>		<b>Maximum Marks</b>	
T1		20	
T2		20	
End Semester Examination		35	
TA Presentation 1)		25 (Assignments 1 (PBL based 5 Marks), Assignments 2.	
<b>Total</b>		<b>100</b>	

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

<b>Recommended Reading material:</b> Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)	
<b>1.</b>	USPTO Web Patent Databases at: <a href="http://www.uspto.gov/patft">www.uspto.gov/patft</a>
<b>2.</b>	Government of India's Patents Website: <a href="http://patinfo.nic.in">patinfo.nic.in</a>
<b>3.</b>	Intellectual property India: <a href="http://www.ipindia.nic.in">www.ipindia.nic.in</a>
<b>4.</b>	“Indian Patent Law: Legal and Business Implications” by AjitParulekar, Sarita D'Souza Macmillan India publication, 2006
<b>5.</b>	“Agriculture and Intellectual Property Rights”, edited by: Santaniello, V., Evenson, R.E., Zilberman, D. and Carlson, G.A. University Press publication, 2003
<b>6.</b>	Research papers and Reports provided from time to time

## MARKET RESEARCH AND DATA ANALYSIS

<b>Course Code</b>	22M22BT211	<b>Semester Summer</b>	<b>Semester Summer Even Sem</b> Session 2022-23 Month from Jan - July
<b>Course Name</b>	Market Research and Data Analysis		
<b>Credits</b>	<b>3</b>	<b>Contact Hours</b>	<b>42</b>

<b>Faculty (Names)</b>	<b>Coordinator(s)</b>	Dr. Ashwani Mathur
	<b>Teacher(s) (Alphabetically)</b>	Dr. Ashwani Mathur

<b>COURSE OUTCOMES</b>		<b>COGNITIVE LEVELS</b>
<b>CO1</b>	Understand Market Research in context to its application in entrepreneurial and start-up initiatives	<b>Understand level (C2)</b>
<b>CO2</b>	Interpret Segmentation and market sizing and their role in Market Research design	<b>Apply Level (C3)</b>
<b>CO3</b>	Demonstrate knowledge / use software for data collection and analysis	<b>Apply Level (C3)</b>
<b>CO4</b>	Design market research reports on collected or available segmented data	<b>Analyze level (C4)</b>

<b>Module No.</b>	<b>Title of the Module</b>	<b>Topics in the Module</b>	<b>No. of Lectures for the module</b>
1.	<u>I</u> <u>n</u> <u>t</u> <u>r</u> <u>o</u> <u>d</u> <u>u</u> <u>c</u> <u>t</u> <u>i</u> <u>o</u> <u>n</u>	Introduction of Market Research, Market Research Industry size and potential, future prospects of Market Research sector	
2.	Entrepreneurship in Market Research	Understand independent market research strategy, knowledge of market potential	3
3.	Market research – Categorization and strategic approach	Types of Market research based on problem statements (Ambiguous, somewhat defined and well defined problem), Market Research based on data source (Primary and Secondary data), Based on strategic approach (Exploratory and Descriptive Research)	4 Employability
4.	Data collection strategy	Identifying and formulating the problem, Methods of Data collection, Nature of Data: primary data, secondary data, big data.	5 Employability



		Familiarize with data sources and approach to collect data for market sizing, company profiling	
5.	Company profiling	Knowledge of competitor analysis based on Market Share, Understanding company revenue and market share, demographic analysis of competitor	5 Employability
6.	Product analysis	Categorization of products, analysis of market share of biological / therapeutic products based on available databases, data collection and analysis.	4 Employability
7.	Customer and Market segmentation	Diffusion of innovation theory, knowledge of Anstoffs matrix for exploring potential market, Knowledge of different attributes of market segmentation.	4 Employability
8.	Data collection and analysis	Familiarization with different databases used for collection of data for market research report, data collection through LinkedIn scouting, sample size estimation, Questionnaire designing and familiarizing with classification, open ended and close ended question	6 Employability
9.	Statistical tools and Data analysis softwares	Inferential statistical approaches for data analysis (hypothesis testing using student T-test, F- test) for data collected for the assigned PBL project, Use of MS Excel, SPSS and Tableau software. Understanding of ODK tool for primary survey (data collection).	4 Employability
10.	Preparation of Report	Report preparation template, components of Market Research report, Data presentation layout	4
<b>Total number of Lectures</b>			<b>42</b>
<b>Evaluation Criteria</b>			
<b>Components</b>		<b>Maximum Marks</b>	
T1		20	
T2		20	
End Semester Examination		35	
TA		25 (Market Research Report preparation)	
<b>Total</b>		<b>100</b>	

**Project Based Learning:** Students will understand the importance of Market Research in start-up ecosystem and entrepreneurial initiatives. They will learn different strategies of segmentation, data collection databases, primary data collection strategies and prepare a segmented market research report

<b>Recommended Reading material:</b> Author(s), Title, Edition, Publisher, Year of Publication etc. ( Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)	
1.	<b>A concise guide to market research by Marko Sarstedt and Erik Mooi, Springer Publication, 2020</b>
2.	<b>The market research tool box by Edward F McQuarrie, Sage Publication, 2015</b>
3.	<b>Entrepreneurship in Independent Market Research &amp; Strategic Digital Marketing by Mirdul Amin Sarkar, Evincepub Publishing, 2020</b>
4.	<b>Recent Market Research reports (available online)</b>

