MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES

(Deemed to be university under section 3 of the UGC Act 1956)

CURRICULUM
AND
SCHEME OF EXAMINATION

M.Sc

MICROBIOLOGY

2023-25

School of Engineering & Technology
Department of Biotechnology
Faridabad-121006, Haryana.

FOREWORD

This is to certify that this booklet contains the entire Curriculum and Scheme of Examination of M.Sc. Microbiology being offered at Department of Biotechnology, Faculty of Engineering and Technology of this University. This has been duly vetted and finally approved by the Academic Council of the University vide agenda item 40.13.02 of 40th AC held on 10th May, 2022 and changes, if any deemed appropriate, shall be duly incorporated after the necessary approval by the Academic Council.

This Curriculum and Scheme of Examination M.Sc (H) Microbiology shall be implemented w.e.f. AY 2023-24.

Prof. (Dr.) Naresh Grover
Dean-Academics, MRIIRS

Preamble

Microbiology domain refers to the study of microscopic organisms, also called microorganisms or microbes which include bacteria, viruses, fungi, algae, cyanobacteria, protozoa and prions. Micro-organisms are ubiquitous and showcase a huge range of diverse activities such as causation of deadly diseases in humans, animals and plants, production of highly useful products like antibiotics, enzymes, alcohol, fermented foods, and recycling of dead and decaying organic matter in the nature. Microorganisms influence almost every aspect of human life such as health, environment, agriculture and industry. This necessitates the study of Microbiology at undergraduate level so that students develop sound understanding of microbiological processes, their importance and utilization for scientific and economic growth.

The Choice Based Credit System (CBCS) curriculum for Microbiology at the undergraduate level has now been developed into a new system called Learning Outcome Curriculum Framework (LOCF) under the recommendations and guidance of University Grants Commission (UGC). The LOCF approach first envisioned the programme learning outcomes of the M.Sc. program in Microbiology as well as the learning outcomes of the courses being taught under this programme, keeping in view the graduate attributes of the subject. The curriculum was then developed in tune with the learning outcomes. It is envisaged that the students trained under this curriculum will have the required attributes of knowledge, skills, temperament and ethics related to the subject of Microbiology. Besides the contents of the curriculum, the teaching learning processes have also been designed to achieve these attributes. A variety of learning assessment tasks have been included in the curriculum. Besides assessing the knowledge/skills acquired by the students, these tasks would also help to supplement the teaching learning processes.

The compulsory courses encompass all important aspects of the discipline of Microbiology and are all compulsory courses. The choice based Discipline Specific Elective (DE) courses are designed to enhance the expanse of the subject. DE also give the students a chance to apply their knowledge of microbiology to study societal problems and suggest solutions in the form of small project under the mentorship of their teachers. These are also designed to expose the students to leaders / innovators in the areas related to microbiology for inspiration. A number of Skill based Elective Courses (SEC), 4 Credits each would give the students option to develop skills in areas which have direct relevance to employability in diagnostics, health, food and pharmaceutical industries, agriculture and environment-related job opportunities in Microbiology.

Learning Outcomes based approach to Curriculum Planning:

Learning Outcome based approach to curriculum planning is almost a paradigm shift in the whole gamut of higher education such that it is based on first and foremost identifying the outcomes of the learning required for a particular subject of study, and then planning all components of higher education so as to achieve these outcomes. The learning outcomes are the focal point of the reference to which all planning and evaluation of the end learning is

compared and further modifications are made to fully optimize the education of the individuals in a particular subject. For the subject of Microbiology the outcomes are defined in terms of the understanding and knowledge of the students in microbiology and the practical skills the students are required to have to be competitive microbiologist so that they are able to play their role as microbiologist wherever required in the society such as the diseases caused by the microbes, their diagnosis and remedies; the role of microbiologists in the biotechnology industry and how they may be able to fit the bill in the industry. The students are also trained in such a way that they develop critical thinking and problem solving as related to the microbiology. The curriculum developed and the teaching and the evaluation tasks are such that the students are able to apply their knowledge and training of microbiology to solve the problems of microbiology as these exist or appear from time to time in the society. The curriculum envisions that the student, once graduate as specialists in a discipline, have an important role to play in the newer developments and innovations in the future in the subject for advancement of the discipline.

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DEPARTMENT OF BIOTECHNOLOGY

VISION

Our vision is to produce competent biotechnologists who can employ premium processes and applications which will profoundly influence existing paradigm of agriculture, industry, healthcare and restoration of environment providing sustainable competitive edge to present society.

MISSION

- To provide Biotechnology educational program with impetus to generate quality workforce
- To create awareness about potentials of Biotechnology with socio-ethical implications.
- To instill spirit of innovation and creativity in young minds with sound research aptitude.
- To nurture confident individuals who are effective contributors towards growth of the nation.

ABOUT THE DEPARTMENT

The Department of Biotechnology was set up in the year 2002 at Manav Rachna Campus. The department offers various programmes at uder-graduate, post-graduate and doctoral levels, viz. B.Tech (4 Years), M.Tech (2 Years) and M.Sc (2 Years) in Biotechnology as well as PhD in Biotechnology and allied areas. Highly qualified teaching faculty with Doctoral and M.Tech qualifications in different areas of Biotechnology is the highlight of this Department. Faculty members are consistently involved in quality research. Their dedicated efforts have resulted in more than 250 publications in National and International journals of high repute including proceedings of seminars/ conferences. The Department has a wide range of laboratories namely Cell Biology Lab, Microbiology Lab, Fermentation Technology Lab, Molecular Biology Lab, Environment Biotechnology Lab, Bioinformatics equipped with world class instrument facilities like HPLC, Atomic Absorption Spectroscopy, IR Spectroscopy, Fermenter, Gel Doc System, PCR, etc. A state-of art research level laboratory has been established as 'Molecular Biosciences Research Lab'. It is fully equipped with animal cell culture facility and houses major instruments like CO2 incubator, fluorescence microscope, deep freezer, fume hood etc. This laboratory is meant for advanced research in molecular biology, animal biotechnology, enzyme technology and other allied areas. B.Tech Biotechnology offered by Department of Biotechnology has been accredited by NBA in the year 2018.

Department of Biotechnology has MoUs with industry and premium research organizations of India to facilitate academics and research and reinforce an environment of knowledge sharing and dissemination. The focus of these collaborations is to facilitate students and faculty in R&D, joint projects, trainings, utilizing high end instrumentation facilities. One of the biggest achievements of the Department of Biotechnology is the Startup Company-"TRICHO AGRONICA Pvt. Ltd. The Department of Biotechnology has developed a bioformulation 'Bioelixir' which is a remedy for Bull's eye pathogen causing early blight disease in tomato (*Lycopersicon esculentum* Mill.) crop. This product is low cost and completely organic i.e. consisting of no chemical compound and acts as a growth stimulator as well as bio-fungicide against the pathogen *Alternaria solani*. This Startup has been setup under Indian oil start up scheme (IOSUS), a "Start-up India" initiative and has been granted a funding of Rs.1.72 Crores.

The immense potential for placements in Biotechnology is evident from the success stories of alumni of the department. The pass out students of Biotech have bagged excellent placements in leading companies, viz, Agilent Technology, Covedien, Imperial Life Sciences, LifeCell International, Totipotent RX, Sagacious Research, CHC Health Care, e4e Health Group, Link Biotech, Ozone Biotech, CPM, Panacea Biotech, Medox Diagnostics, TCS (Biotech Division), Infosys (Biotech Division), IDS, L&T Infotech, IFBI and HCL, SCOTT EDIL & Kelly Services India Pvt. Ltd, Boston Scientific, etc. Many pass outs have opted for higher studies in both national and International universities after qualifying in competitive exams. National institutes include IIT- Delhi, IIT- Kharagpur, IIT, Kanpur, IIT, Guwahati, NIT, Surthkal, NIT- Kurukshetra, VIT, Vellore, BITS- Pilani, BHU, Banaras and Anna University, Chennai etc. International institutions where the alumni of Biotech have pursued their higher education are University of Minnesota, USA, University of Buffalo, USA, University of Pennsylvania, USA, John Hopkins, USA, Nottingham Trent, UK, Sydney University, Australia, Arizona State Univ, USA, Baltimore Univ, USA, Florida Inst Of Tech, USA, Worcestor Polytech, USA, Imperial College - London, Monash Univ. Australia, University of Kuopio, Finland etc.

And the journey continues…

M. Sc in Microbiology

PROGRAM EDUCATIONAL OBJECTIVES (PEO)

1. To develop the capability to work as microbiology experts and achieve high positions in reputed companies at national and international level.

2. To inculcate the capability to work as entrepreneurs and techno managers with strong ethics and communication skills.

3. To equip the students to pursue doctoral and post-doctoral research.

PROGRAMME OUTCOMES (PO)

PO1.Knowledge: Capable of demonstrating comprehensive disciplinary knowledge of fundamental and advanced areas in Microbiology
PO2.Critical Thinking: Capability to ask relevant/appropriate questions for identifying, formulating and analyzing the problems and to draw conclusion from the analysis
PO3 Individual and Team Work: Capable to learn and work effectively as an individual, and as a member or leader in diverse teams, in multidisciplinary settings.
PO4. Modern Tool usage: Ability to use and learn techniques, skills and modern tools for scientific practices
PO5 Ethics: Capability to identify and apply ethical issues related to one's work, avoid unethical behaviour such as fabrication of data, committing plagiarism and unbiased truthful actions in all aspects of work
PO6.Environment and Sustainability: Understand the issues of environmental contexts and sustainable development
PO7.Self-directed and Life-long Learning: Aptitude to apply knowledge and skills that are necessary to engage in independent and life-long learning in the broadest context of technological change

PROGRAMME SPECIFIC OUTCOMES (PSOs)

1. Acquire knowledge and skills in the domain of microbiology to become capable of performing significant role in industry, academia or as entrepreneurs.

2. Enable the students to develop innovative technologies for betterment of society.

3. Empower the students to pursue Progressive Career/Higher Studies/ Competitive Exams

MAPPING OF PEO WITH PO AND PSO

PEOs	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PSO 1	PSO 2	PSO 3
1	3	3	3	3	3	3	3	3	3	3
2	3	3	3	3	3	3	3	3	3	3
3	3	3	3	3	3	3	3	3	3	3

M. Sc in Microbiology

SEMESTER SYSTEM AND CHOICE BASED CREDIT SYSTEM

Credit based system of study and student's performance/progress is measured by the number of credits that he/she has earned, i.e. completed satisfactorily. Based on the course credits and grade obtained by the student, grade point average is calculated

(a) Course credits assignment
Each course has a certain number of credits assigned to it depending upon its duration in periods for lecture, tutorial and laboratory/clinical practice in a week.

(b) Earning of credits
At the end of every course, a letter "Grade" shall be awarded in each course for which a student has registered. On obtaining a minimum Pass Grade, student shall accumulate the course credits as Earned Credits. A student's performance shall be measured by the number of credits that he/she has earned and by the weighted grade point average. Grades obtained in the audit courses shall not be counted for computation of grade point average, however shall be mandatory to pass as a partial fulfillment of award of degree.
For Award of Degree of a programme in M.Sc- Microbiology, he/she has to earn minimum **80 Credits** during the **2 year duration** of the programme in **4 semesters**.

The total credits required to be earned have been further classified under two baskets of courses: "Compulsory Courses Basket", and "Elective Courses Basket". The **total 68 credits** required to be earned under "Compulsory Courses Basket" and **12 credits** under "Elective Courses Basket".

All courses under "Compulsory Courses Basket", are required to be qualified and cleared/pass by each and every students enrolled under the programme and are semester-wise listed in the study scheme along with credits assigned to each course.

Under Elective Courses Basket, there will be two types of courses:

- Semester-wise courses offered by the department itself
- Massive Open Online Courses (MOOCs) available on SWAYAM Platform or any other platform as recommended by UGC/AICTE and notified from the office of Dean-Academics.

Each course shall have credits assigned to it. Student shall be required to register courses every semester for as many courses/credits specified under "Elective Courses Basket" depending upon his/her interest, capability/pace of learning and availability of time slot (without any clash in time table) so as to earn all required total credits under the "Elective Courses Basket" during the entire programme duration.

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES, FARIDABAD

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SCHEME OF STUDIES

M.Sc IN MICROBIOLOGY BATCH 2023-25

SEMESTER-I											
Course Type	Subject Code	Subject	PERIODS/WEEK				MARKS			Duration of External Exams	Credits
			L	T	P	Total	Continuous Assessment	End Semester Examination	TOTAL		
		I SEMESTER									
Core	MS-BT-101	Cell & Molecular Biology	3	0	0	3	100	100	200	3 hrs.	3
Core	MS-BT-102	Microbial Physiology & Genetics	3	0	0	3	100	100	200	3 hrs.	3
Core	MS-MB-101	Clinical Biochemistry	3	0	0	3	100	100	200	3 hrs.	3
Core	MS-BT-104	Bioanalytical Techniques	3	0	0	3	100	100	200	3 hrs.	3
Core	MS-BT-105	Biostatistics	3	0	0	3	100	100	200	3 hrs.	3
Core	MS-BT-151	Cell Biology Lab	0	0	3	3	50	50	100	3 hrs.	1.5
Core	MS-BT-152	Molecular Biology Lab	0	0	3	3	50	50	100	3 hrs.	1.5
Core	MS-BT-153	Microbiology Lab	0	0	3	3	50	50	100	3 hrs.	1.5
Core	MS-BT-154	Bioanalytical Techniques Lab	0	0	3	3	50	50	100	3 hrs.	1.5
Seminar	MS-BT-100	Independent Study Seminar	0	1	0	1	50	0	50	-	1
TOTAL	**TOTAL**		**15**	**1**	**12**	**28**	**750**	**700**	**1450**		**22**
II SEMESTER											
Compulsory Course											
Core	MS-MB-201	Systematic Bacteriology	3	0	0	3	100	100	200	3 hrs.	3
Core	MS-BT-202	Bioprocess Technology	3	0	0	3	100	100	200	3 hrs.	3
Core	MS-BT-203	Bioinformatics & Computational Biology	3	0	0	3	100	100	200	3 hrs.	3
Core	MS-MB-204	Molecular Immunology and Immunogenetics	3	0	0	3	100	100	200	3 hrs.	3
Core	MS-BT-252	Fermentation Technology Lab	0	0	3	3	50	50	100	3 hrs.	1.5

Core	MS-BT-253	Bioinformatics Lab	0	0	2	2	50	50	100	3 hrs.	1
Project	MS-MB-200	Project Phase-I	0	0	4	4	50	50	100		2
TOTAL	**TOTAL**		**12**	**0**	**9**	**21**	**550**	**550**	**1100**	**0**	**16.5**
Elective Courses*											
Elective	MS-BT-221	Bioethics, Biosafety & IPR	3	0	0	3	100	100	200	3 hrs.	3
Elective	MS-MB-222	Plant-Pathogen interactions	3	0	0	3	100	100	200	3 hrs.	3
Elective	MS-BT-223	Human Genome	3	0	0	3	100	100	200	3 hrs.	3
Elective	MS-MB-224	Virology, Mycology & Parasitology	3	0	0	3	100	100	200	3 hrs.	3

* Under Elective Courses, beside the mentioned Domain Specific Elective Courses, other Inter- disciplinary, Generic, on-line Courses (MOOCs etc) and other approved courses shall be offered, which shall be notified well before start of the semester. The student shall be required and allowed to opt the courses out of offered courses as per prescribed limit for maximum credits in a semester and for the category of Elective Courses under University Rules.

III SEMESTER											
Compulsory Course											
Core	MS-MB-301	Clinical Microbiology and Vaccinology	3	0	0	3	100	100	200	3 hrs.	3
Core	MS-MB-302	Microbial Pathogenicty	3	0	0	3	100	100	200	3 hrs.	3
Core	MS-MB-303	Synthetic Biology	3	0	0	3	100	100	200	3 hrs.	3
Core	MS-MB-351	Immuno Techniques Lab	0	0	3	3	50	50	100	3 hrs.	1.5
Core	MS-MB-352	SystemS Biology Lab	0	0	2	2	50	50	100	3 hrs.	1
Project	MS-MB-300	Project Phase-II	0	0	4	4	200	100	300		2
TOTAL	**TOTAL**		**9**	**0**	**9**	**18**	**600**	**500**	**1100**		**13.5**
Elective Courses*											
Elective	MS-MB-321	Food and Dairy Microbiology	3	0	0	3	100	100	200	3 hrs.	3
Elective	MS-MB-322	Pharmaceutical Technology	3	0	0	3	100	100	200	3 hrs.	3
Elective	MS-BT-321	Genomics and Proteomics	3	0	0	3	100	100	200	3 hrs.	3
Elective	MS-BT-324	Stem Cell & Regenerative Medicine	3	0	0	3	100	100	200	3 hrs.	3

* Under Elective Courses, beside the mentioned Domain Specific Elective Courses, other Inter-disciplinary, Generic, on-line Courses (MOOCs etc) and other approved courses shall be offered, which shall be notified well before start

of the semester. The student shall be required and allowed to opt the courses out of offered courses as per prescribed limit for maximum credits in a semester and for the category of Elective Courses under University Rules.

IV SEMESTER								
Project	MS-PROJ-400	Dissertation * In case of national emergencies like Covid Pandemics,following alternative will be implemented i) Review article ii) Presentation	Minimum 16 weeks	300	200	500		16
	TOTAL						**500**	**16**

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MS-BT-101: CELL & MOLECULAR BIOLOGY

Periods/week	Credits	Max. Marks	: 200
L: 3 T: 0	3	Continuous Assessment	: 100
Duration of Examination: 3 Hrs		End Semester Examination	: 100

Course Outcomes:

The students will be able to-

MS-BT-101.1 recognize the basic structure and organization of a cell and in prokaryotes and eukaryotes.
MS-BT-101.2 explain the structure, organization and functions of genetic elements.
MS-BT-101.3 distinguish the phenomena of replication, transcription, translation, transposition and regulation.
MS-BT-101.4 compare the complex processes involved in function and regulation of genetic elements.
MS-BT-101.5 apply the knowledge of basic mechanisms for solution of modern day problems.
MS-BT-101.6 integrate the molecular processes to understand vital life functioning.

Unit 1: Cell Membrane & Cell Cycle Control

1.1 Cell Structure, Lipid bilayer, membrane proteins,
1.2 Carrier protein and their functions, ion channels and the membrane potentials
1.3 Protein sorting: Organelle Biogenesis & Protein Secretion,
1.4 Cell Signaling and Communication.
1.5 Convergence, Divergence and crosstalk among different signaling pathway
1.6 Calcium and NO as intracellular messenger

Unit 2: The World of DNA

2.1 DNA replication: Prokaryotic and Eukaryotic,
2.2 Enzymes and accessory proteins involved in DNA replication.
2.3 DNA repair and recombination.
2.4 Transcription: Prokaryotic transcription and Eukaryotic transcription.
2.5 Post transcriptional Modifications
2.6 Splicing and editing

Unit 3: From DNA to Genome

3.1 Translation: Prokaryotic and Eukaryotic
3.2 Post translation modification of proteins.
3.3 Molecular mechanism of antisense molecules, inhibition of splicing, polyadenylation and translation.
3.4 Disruption of RNA structure and capping.
3.5 Genome sequencing strategies
3.6 Genomic libraries, YAC, BAC libraries, applications in identification of defective genes.

Text Books/Reference Books:

1. DNA structure and function:, Academic Press Publication, (2006), 12th Edition.
2. Genes XII: Lewin B, Oxford University Press Publication, (2017), 12th Edition.
3. Molecular Cell Biology: Bruce Alberts, James D. Watson, Garland Publication, (2017), 6th Edition.
4. The cell – a molecular approach: Cooper, A.S.M. Press Publication, (2015), 7th Edition.

5. Cell & Molecular biology , Concepts & experiments: Gerald Karp , John Wiley & Sons Publication, (2013), 8th Edition.
6. Genomes: T.A. Brown, John Wiley & Sons Pvt. Ltd Publication, (2016), 7th Edition.

Instruction for paper setting: Seven questions are to be set in total. First question will be conceptual and will be compulsory to attempt. Rest of the six questions will cover entire syllabus and consist of two questions from each unit. Student needs to attempt four more questions, selecting at least one question from each unit. Each question will be of 20 marks.

Distribution of Continuous Assessment

Sessional I	**30%**
Sessional II	**30%**
Assignments	**20%**
Class Performance	**10%**
Class Attendance	**10%**

Assessment Tools:
Assignment/Tutorials
Class Performance
Sessional Examinations
End Semester Examination

Course Articulation Matrix

CO (MS-BT-101)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO 1	PSO 2	PSO 3
MS-BT-101.1	3	3	2	2	2	-	-	3	3	2
MS-BT-101.2	3	3	3	3	3	2	2	2	2	1
MS-BT-101.3	3	1	-	2	2	-	-	-	1	1
MS-BT-101.4	3	3	2	2	2	2	2	2	2	1
MS-BT-101.5	3	3	2	2	2	3	2	2	1	-
MS-BT-101.6	3	3	2	2	2	3	2	2	1	-

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MS-BT-102: MICROBIAL PHYSIOLOGY AND GENETICS

Periods/week	Credits		
L: 3 T: 0	3	Continuous Assessment	: 100
Duration of Examination: 3 Hrs		End Semester Examination	: 100

Course Outcomes:

The students will be able to-

MS-BT-102.1 identify the diversity of microbes and recognize their role in ecosystems.

MS-BT-102.2 explain the theoretical basis of the tools, technologies and methods common to microbiology.

MS-BT-102.3 relate the processes used by microorganisms for their growth, replication, survival, and interaction with their environment, hosts, and host populations.

MS-BT-102.4 analyze the different types of metabolic reactions taking place in bacteria.

MS-BT-102.5 summarize basic bacterial genetic principles and analyze consequences of mutation and genetic recombination.

MS-BT-102.6 formulate the strategies for control of microorganisms leading to laboratory contamination, infectious diseases and food spoilage.

Unit 1: Introduction

1.1 Beginning of Microbiology Discovery of the microbial world by Antony van Leeuwenhoek: Controversy over spontaneous generation and developments of microbiology in the twentieth century.

1.2 Methods in Microbiology Pure culture techniques.

1.3 Principles of microbial nutrition, culture media.

1.4 New approaches to bacterial taxonomy.

1.5 Nomenclature and Bergey's Manual.

Unit 2: Prokaryotic Cells

2.1 Structure & function Cell wall of eubacteria (peptidoglycan and outer membrane).

2.2 Cell wall and cell membrane synthesis.

2.3 Flagella and motility.

2.4 Cell inclusions like endospores, gas vesicles.

2.5 Mycobacteria: Rickettsia's, Chlamydia's and Mycoplasma.

2.6 Archaea: Archaea as earliest Life forms: Halophiles; Methanogens;' Hyper thermophilic Archaea; Thermoplasma.

2.7 Growth: mathematical expression of growth, growth curve, measurement of growth and growth yields.

2.8 Synchronous growth, Continuous culture, Factors affecting growth.

2.9 Overview of Basic Metabolism & Microbial Nutrition.

Unit 3: Control of Microbes & Microbial Genetics

3.1 Control of Microbes by various physical agents.

3.2 Antibiotics: Penicillin and Cephalosporin.

3.3 Bacterial Genetic System Transformation, Conjugation, Transduction.

3.4 Viruses and Their Genetic System: Phage lambda and its life cycle.

3.5 Antibiotic Resistance: resistance mechanisms, origin of resistance plasmids.

3.6 Spread of antibiotic resistance.
3.7 Overcoming Drug resistance.

Text Books/ Reference Books:

1. Brock Biology of Microorganisms: M. T. Madigan;J. M. Martinko and J. Parker. Prentice Hall IntInc Publication, 13th Edition.
2. Microbiology: Concepts and Application: Pelczar et al, Tata McGraw Hill Publication, (2009) 10th Ed.
3. Microbiology : Prescott et al., McGraw Hill Publication, (2017), 10th Edition
4. Microbiology An Introduction: Tortora, Funke, Case. Benjamin- Cummings Publishing Company, (2015), 12th Edition.
5. General Microbiology: Stainier RY, Ingraham JL, Wheelis ML, Painter PR. McMillan Publications, (1992), 5th Edition.

Instruction for paper setting: Seven questions are to be set in total. First question will be conceptual and will be compulsory to attempt. Rest of the six questions will cover entire syllabus and consist of two questions from each unit. Student needs to attempt four more questions, selecting at least one question from each unit. Each question will be of 20 marks.

Distribution of Continuous Assessment

Sessional I	**30%**
Sessional II	**30%**
Assignments	**20%**
Class Performance	**10%**
Class Attendance	**10%**

Assessment Tools:
Assignment/Tutorials
Class Performance
Sessional Examinations
End Semester Examination

Course Articulation Matrix

CO (MS-BT-102)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO 1	PSO 2	PSO 3
MS-BT-102.1	1	1	-	1	-	1	-	2	2	1
MS-BT-102.2	1	1	1	1	-	1	-	3	2	2
MS-BT-102.3	1	1	-	2	-	-	-	2	1	1
MS-BT-102.4	1	1	2	2	2	2	1	2	2	1
MS-BT-102.5	1	1	2	2	2	2	1	2	2	1
MS-BT-102.6	1	1	2	2	2	2	2	2	1	2

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MS-MB-101: CLINICAL BIOCHEMISTRY

Periods/week	Credits	Max. Marks	: 200
L: 3 T: 0	3	Continuous Assessment	: 100
Duration of Examination: 3 Hrs		End Semester Examination	: 100

Course Outcomes:

The students will be able to:

MS-MB-101.1 describe the molecular structures of basic biomolecules.
MS-MB-101.2 paraphrase the hierarchical organization of complex biomolecules.
MS-MB-101.3 illustrate the anabolic and catabolic pathways of various biomolecules.
MS-MB-101.4 appraise the significance of enzymes in metabolism of all the biomolecules.
MS-MB-101.5 evaluate the role of body fluids and their components in homeostasis.
MS-MB-101.6 assess various metabolic disorders and draw their clinical relevance.

Unit 1: Essentials of biochemistry

1.1 Chemical foundations of Biology – Water and its properties, pH, pK, acids, bases, buffers, weak bonds, covalent bonds. Principles of thermodynamics. Classes of organic compounds, functional groups-atomic and molecular dimensions.

1.2 Amino acids and peptides-classification, chemical reactions, physical properties and classification. Proteins purification and criteria of homogeneity, end group analysis, Hierarchy in structure, Ramachandran maps.

1.3 Sugars - classification and reactions. Polysaccharides - types, structural features, methods for compositional analysis. Lipids- classification, structure and functions. Heterocyclic compounds- and secondary metabolites in living systems - nucleotides, pigments, isoprenoids.

Unit 2: Metabolism-I

2.1 Enzymes and Coenzymes
2.2 Body fluids – pH and acid base balance and their importance in clinical biochemistry
2.3 Blood clotting
2.4 Hormone Biochemistry

Unit 3: Metabolism-II

3.1 Carbohydrate Metabolism and Oxidative Phosphorylation
3.2 Clinical relevance of Carbohydrate Metabolism
3.3 Amino acid Metabolism
3.4 In born errors of Nitrogen metabolism
3.5 Lipid Metabolism
3.6 Clinical relevance of Lipid Metabolism

Text Books/Reference Books:

1. Principles of Boichemistry: A.L. Lehninger, D.L. Nelson, M.M. Cox, Worth Publication, (2017), 7th Edition.
2. Biochemistry: L. Stryer, J.M. Berg, J.L. Tymoezko, W.H. Freeman and Co. Publications, (2015) 8th Edition

3. Harper's Biochemistry: R.K. Murray, P.A. Hayes, D.K. Granner, P.A. Mayes and V.W. Rodwell, Prentice Hall International Publications, (2018), 31st Edition.
4. Fundamentals of Biochemistry: Donald Voet and Judith G Voet , John Wiley & Sons Publications, (2016), 5th Edition.
5. Biochemistry: Mathews, Pearson Ed Publications, (2012), 4thEdition.

Instruction for paper setting: Seven questions are to be set in total. First question will be conceptual and will be compulsory to attempt. Rest of the six questions will cover entire syllabus and consist of two questions from each unit. Student needs to attempt four more questions, selecting at least one question from each unit. Each question will be of 20 marks.

Distribution of Continuous Assessment

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Class Performance	**10%**
Class Attendance	**10%**

Assessment Tools:
Assignment/Tutorials
Class Performance
Sessional Examinations
End Semester Examination

Course Articulation Matrix

CO (MS-MB-101)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO 1	PSO 2	PSO 3
MS-MB-101.1	2	2	-	-	-	-	-	2	2	1
MS-MB-101.2	3	3	2	1	1	2	1	2	2	1
MS-MB-101.3	3	3	2	2	2	2	1	2	2	2
MS-MB-101.4	3	3	3	3	2	3	2	2	2	2
MS-MB-101.5	3	3	3	3	2	3	2	3	3	3
MS-MB-101.6	3	3	3	3	2	3	2	3	3	3

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES, FARIDABAD

(Deemed to be University under section 3 of the UGC Act 1956)

MS-BT-104: BIOANALYTICAL TECHNIQUES

Periods/week	Credits	Max. Marks	: 200
L: 3 T: 0	3	Continuous Assessment	: 100
Duration of Examination: 3 Hrs		End Semester Examination	: 100

Course Outcomes:

The students will be able to-

MS-BT-104.1 know the application of various analytical instruments for bioanalysis.

MS-BT-104.2 interpret and distinguish the images using of different microscopes to understand their usage.

MS-BT-104.3 apply appropriate bioanalytical technique for identification, separation, isolation and purification of biomolecules.

MS-BT-104.4 perform qualitative and quantitative analysis of biomolecules after their separation or isolation.

MS-BT-104.5 evaluate and trouble shoot the problems commonly encountered during bioanalysis.

MS-BT-104.6 design and integrate different techniques with upstream and downstream biotechnological processes.

Unit 1: Microscopy & Centrifugation Techniques

1.1 **Microscopy**: Principle, technical arrangement and working of instrument: Light Microscopy- Bright Field, Dark Field and Phase Contrast microscopy, Fluorescence microscopy, Electron microscopy- Scanning & Transmission.

1.2 **Centrifugation**: Principles of Sedimentation, types of centrifuges and their applications, Differential, and Density Gradient centrifugation.

Unit 2: Chromatography & Electrophoresis

2.1 **Chromatography**: General principles, Adsorption, Partition, Ion-exchange, Molecular Exclusion and Affinity Chromatography, Paper Chromatography and Thin Layer Chromatography, High Pressure Liquid Chromatography, Gas Chromatography.

2.2 **Electrophoresis**: Principles of Electrophoresis, electrophoresis of proteins and nucleic acids, Immuno-electrophoresis, Isoelectric Focusing, Two-dimensional gel electrophoresis.

Unit 3: Spectroscopy & Radioisotope Techniques

3.1 **Spectroscopy**: Basic concepts, U.V./Visible spectroscopy, X-ray spectroscopy, Spectrofluorimetry, Infra-red and Raman spectroscopy, Nuclear Magnetic Resonance and Electron Spin Resonance.

3.2 **Radioisotope Techniques**: Nature of radioactivity, properties of α, β and γ rays, detection and measurement of radioactivity, Geiger Muller and Scintillation counting, Auto-radiography, Safety aspects and radio-waste management.

Text Books/Reference Books:

1. Principles and techniques of Practical Biochemistry: K. Wilson and J. Walker (2000), Cambridge University Press Publication, 5th Edition.
2. Bioanalytical Techniques: Abhilasha Shourie and Shilpa S. Chapadgaonkar (2015), TERI Publications, 1st Edition.
3. Physical Biochemistry: D. Friefelder, W. H. Freeman and company Publication, 12th Edition.

4. Separation and Purification Techniques in Biotechnology: Frederick J. Dechow, Standard Publishers (2005). 1st Edition
5. Physical Biochemistry: K. E. Vanholde (1999), Prentice Hall Inc. Publication,
6. Introduction to Instrumental Analysis: Robert. D. Braun (2012), McGraw Hill International Edition, Chemistry Series Publication. 2nd Edition

Web links:
http://nptel.ac.in/courses/102107028/
http://nptel.ac.in/courses/102103044/

Instruction for paper setting: Seven questions are to be set in total. First question will be conceptual and will be compulsory to attempt. Rest of the six questions will cover entire syllabus and consist of two questions from each unit. Student needs to attempt four more questions, selecting at least one question from each unit. Each question will be of 20 marks.

Distribution of Continuous Assessment

Sessional I	**30%**
Sessional II	**30%**
Assignments	**20%**
Class Performance	**10%**
Class Attendance	**10%**

Assessment Tools:
Assignment/Tutorials
Class Performance
Sessional Examinations
End Semester Examination

Course Articulation Matrix

CO (MS-BT-104)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO 1	PSO 2	PSO 3
MS-BT-104.1	2	2	1	3	1	-	2	2	2	3
MS-BT-104.2	3	3	-	1	1	2	1	2	2	3
MS-BT-104.3	3	3	1	2	1	2	1	2	2	2
MS-BT-104.4	3	3	3	2	1	3	2	2	2	2
MS-BT-104.5	3	3	3	3	2	3	2	3	3	3
MS-BT-104.6	3	3	3	2	1	3	2	3	3	3

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES, FARIDABAD

(Deemed to be University under section 3 of the UGC Act 1956)

MS-BT-105: BIOSTATISTICS

Periods/week	Credits		
L: 3 T: 0	3	Continuous Assessment	: 100
Duration of Examination: 3 Hrs		End Semester Examination	: 100

Course Outcomes:

The students will be able to-

MS-BT-105.1 define the basic concepts of statistics involved in analyzing biological data.
MS-BT-105.2 calculate summary statistics from raw data.
MS-BT-105.3 apply statistical methods to make predictions of the outcomes.
MS-BT-105.4 analyze randomness and uncertainty through probability models, random variables and their distributions, and conditional thinking.
MS-BT-105.5 apply statistical tools in deciphering science, engineering concepts, and everyday life.
MS-BT-105.6 design independently the experimental set ups using statistical tools.

Unit 1: Introduction

1.1 Types of Data, Data representations, Histogram, Frequency polygon, frequency curve, relative frequency curve, pie chart, stem plot, box plot.
1.2 Measure of Central Tendency: Mean, mode, median, Harmonic mean, Geometrical mean, Measure of Diversity.
1.3 Measure of dispersion: Range, Quartile deviation, mean deviation, standard deviation and, Coefficient of variation, measures of skew ness and kurtosis
1.4 Fundamentals of Probability, Probability Distributions: Rules of probability, Binomial, Poisson and Normal

Unit 2: Sampling

2.1 Introduction to sampling, Types of Sampling, Sampling Distribution, Standard Error, Significance level, Confidence limits.
2.2 Estimation, Hypothesis testing, z-test, Student's t-test, Chi-square test, F-test, Nonparametric methods, Wilcoxon pair test, sign test, Advantages and disadvantages of Nonparametric and parametric methods. Analysis of Variance (ANOVA).

Unit 3: Correlation and Regression

3.1 Introduction to correlation
3.2 Rank's Correlation methods
3.3 Introduction to regression lines, linear and nonlinear fitting (least square method)
3.4 Multiple regressions
3.5 Advantages and disadvantages of Correlation and regression.

Text Books/ Reference Books:

1. Mathematical Statistics: S C Gupta and V K Kapoor, 2014, Sultan Chand & Sons Publication, 11th Edition.
2. Bio-statistical Analysis: J H Zar, 2010, Pearson Publication, 5th Edition.
3. Bio-statistical Methods: Khan &Khanum, 2008, Unkar Publication, 5th Edition.

4. Text Book of Biostatistics II: A.K. Sharma, 2005, Discovery Publishing House.
5. Fundamentals of Biostatistics: Bernard A. Rosner, 2015, Thomson Brooks/Cole Publication, 8th Edition.
6. Statistics-An Introductory Analysis: Taro Yamane, 1964, Harper and Row Publication

Instruction for paper setting: Seven questions are to be set in total. First question will be conceptual and will be compulsory to attempt. Rest of the six questions will cover entire syllabus and consist of two questions from each unit. Student needs to attempt four more questions, selecting at least one question from each unit. Each question will be of 20 marks.

Distribution of Continuous Assessment

Sessional I	**30%**
Sessional II	**30%**
Assignments	**20%**
Class Performance	**10%**
Class Attendance	**10%**

Assessment Tools:
Assignment/Tutorials
Class Performance
Sessional Examinations
End Semester Examination

Course Articulation Matrix

CO (MS-BT-105)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO 1	PSO 2	PSO 3
MS-BT-105.1	2	2	-	-	-	1	-	1	2	2
MS-BT-105.2	3	3	2	1	1	2	1	2	2	2
MS-BT-105.3	3	3	2	2	1	2	1	2	2	2
MS-BT-105.4	3	3	3	3	1	1	1	2	2	2
MS-BT-105.5	3	3	3	3	1	2	1	3	3	3
MS-BT-105.6	3	3	3	3	1	-	3	2	3	3

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES, FARIDABAD

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MS-BT-151: CELL BIOLOGY LAB

Periods/week	Credits	Max. Marks	: 100
P: 3	1.5	Continuous Assessment	: 50
Duration of Examination: 3 Hrs		End Semester Examination	: 50

Course outcomes:

The students will be able to-

MS-BT-151.1 identify various microscopic objects and artifacts in the biological specimen using microscope

MS-BT-151.2 demonstrate practical skills in staining the biological samples for observing morphology and histology of cells and tissues.

MS-BT-151.3 Apply the technique of cytometry to determine the cell size, number and viability.

MS-BT-151.4 distinguish various cellular organelles on the basis of their size and molecular weight.

MS-BT-151.5 compare different stages of cell division and evaluate the mitotic index.

MS-BT-151.6 combine the methods of isolation, fixation and staining of cells for cytological analyses.

List of Experiments:

1. To study the compound microscope and observe common interfering objects.
2. To study and observe the structure of prokaryotic cell and eukaryotic cell.
3. To isolate lactobacillus from curd sample.
4. To study the process of cell staining.
5. To calibrate ocular micrometer and measure the size of cell.
6. To count the number of cells using haemocytometer.
7. To study the cell membrane properties.
8. To study the morphology of nuclei in human leucocytes.
9. To determine cell viability using Trypan Blue.
10. To study cellular division in onion root tip & calculate mitotic index (MI).
11. To perform isolation and sub fractionation of cell organelle.
12. To study the process of fixation and cryofixation.

Distribution of Continuous Assessment

Viva I	**30%**
Viva II	**30%**
File/Record Keeping	**20%**
Class Performance	**10%**
Class Attendance	**10%**

Text Books/Reference Books:

1. Introductory Practical Biochemistry: S.K.Sawhney & Randhir Singh, Narosa Publishing House, (2005), 5th Edition.
2. Cytological Technique: John R. Baker, Methuen & Co. Publication. ((1960)
3. Practical skills in Biomolecular Sciences: Reed, Pearson Publication, (2016), 5thEdition.

Course Articulation Matrix

CO (MS-BT-151)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO 1	PSO 2	PSO 3
MS-BT-151.1	3	3	1	2	1	-	3	1	2	3
MS-BT-151.2	3	3	1	1	2	-	3	2	1	3
MS-BT-151.3	3	3	1	2	2	-	3	2	1	1
MS-BT-151.4	3	3	1	1	2	-	3	2	1	3
MS-BT-151.5	3	3	1	1	2	-	3	2	3	3
MS-BT-151.6	3	3	1	1	2	-	3	2	3	3

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES, FARIDABAD

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MS-BT-152: MOLECULAR BIOLOGY LAB

Periods/week	Credits	Max. Marks	: 100
P: 3	1.5	Continuous Assessment	: 50
Duration of Examination: 3 Hrs		End Semester Examination	: 50

Course Outcomes:

The students will be able to:

MS-BT-152.1 describe the techniques involved in molecular biology
MS-BT-152.2 demonstrate skills in isolation, quantification and purification of DNA.
MS-BT-152.3 compare the variants of PCR and their applications
MS-BT-152.4 apply the molecular biology techniques for genetic testing
MS-BT-152.5 analyze DNA sequencing Data.
MS-BT-152.6 design molecular biology techniques for novel applications

List of Experiments:

1. Isolation of prokaryotic DNA
2. Isolation of DNA from Yeast
3. Isolation of DNA from Plant cells.
4. Isolation of plasmid DNA
5. Molecular weight characterization of a given DNA sample using Agarose Gel Electrophoresis
6. To perform the technique of Gel Extraction of DNA.
7. To study and perform the basic scheme of Polymerase Chain Reaction
8. To study and perform the basic scheme of Reverse Transcciption Polymerase Chain Reaction
9. Isolation of protein fraction from different sources.
10. To study the technique of SDS-PAGE
11. To study and perform the technique of Restriction mapping
12. To study DNA sequencing Data Analysis.

Distribution of Continuous Assessment

Viva I	**30%**
Viva II	**30%**
File/Record Keeping	**20%**
Class Performance	**10%**
Class Attendance	**10%**

Text/ Reference Books:

1. Molecular Cloning- a laboratory manual: J. Sambrook and D.W. Russell, Cold Spring Harbor Laboratory Press Publication, (2013), 4th Edition.
2. Laboratory Techniques in Biochemistry and Molecular Biology Series, P C Vandervliet and S. Pillai, lsevier Publications, (2008); 1st edition.

Course Articulation Matrix

CO (MS-BT-152)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO 1	PSO 2	PSO 3
MS-BT-152.1	3	3	2	2	2	-	1	3	3	2
MS-BT-152.2	3	3	2	2	3	2	2	2	2	1
MS-BT-152.3	3	1	1	2	2	-	2	-	2	1
MS-BT-152.4	3	3	2	2	2	2	2	2	2	1
MS-BT-152.5	3	3	2	2	2	2	2	2	2	2
MS-BT-152.6	3	3	2	2	2	3	2	2	3	2

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES, FARIDABAD

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MS-BT-153: MICROBIOLOGY LAB

Periods/week	Credits	Max. Marks	: 100
P: 3	1.5	Continuous Assessment	: 50
Duration of Examination: 3 Hrs		End Semester Examination	: 50

Course Outcomes:

The students will be able to-

MS-BT-153.1 identify various microorganisms and classify them on the basis of their characteristic features.

MS-BT-153.2 enumerate and estimate microorganisms isolated from different sources.

MS-BT-153.3 demonstrate skills for culture and growth of microorganisms in laboratory.

MS-BT-153.4 compare the characteristics of microorganisms on the basis of qualitative and quantitative tests.

MS-BT-153.5 evaluate the efficiency of methods of microbial culture.

MS-BT-153.6 develop the strategies for disinfection and growth inhibition of specific microbial strains.

List of Experiments:

1. To study commonly used techniques and equipments in a microbiology laboratory.
2. Preparations of liquid and solid media for growth of microorganisms.
3. To learn pure culture techniques: pour plating, spread plating, streaking and serial dilution methods.
4. Isolation & enumeration of microflora in soil and water.
5. To learn simple staining technique of bacterial culture.
6. To learn differential staining techniques of bacterial culture.
7. To study of Phase Contrast Microscopy Technique.
8. Study of Differential Centrifugation Technique.
9. To study Antibiotic Sensitivity Test by Disc Diffusion Method.
10. Bacteriological Examination of Water by Multiple Tube Fermentation Test.
11. Microbiological Examination of Milk.
12. To isolate heavy metal resistant bacteria and determine minimum inhibitory concentration

Distribution of Continuous Assessment

Viva I	**30%**
Viva II	**30%**
File/Record Keeping	**20%**
Class Performance	**10%**
Class Attendance	**10%**

Text/Reference Books:

1. Experiments in Microbiology, Plant Pathology, Tissue Culture & Biotechnology: Aneja K.R, New Age International Publication, (2017), 5th Edition.
2. Microbiology –A Lab manul: Cappucinno J. & Sherman N, Addison Wesley Publication, 11th Edition.
3. Microbiology: Tortora, Pearson Publication, 12th Edition.

Course Articulation Matrix

CO (MS-BT-153)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO 1	PSO 2	PSO 3
MS-BT-153.1	3	3	2	2	2	-	1	3	3	2
MS-BT-153.2	3	3	2	2	3	2	2	2	2	1
MS-BT-153.3	3	1	1	2	2	-	2	-	2	1
MS-BT-153.4	3	3	2	2	2	2	2	2	2	1
MS-BT-153.5	3	3	2	2	2	2	2	2	2	2
MS-BT-153.6	3	3	2	2	2	3	2	2	3	2

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES, FARIDABAD

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MS-BT-154: BIOANALYTICAL TECHNIQUES LAB

Periods/week	Credits	Max. Marks	: 100
P: 3	1.5	Continuous Assessment	: 50
Duration of Examination: 3 Hrs		End Semester Examination	: 50

Course Outcomes:

The students will be able to-

MS-BT-154.1 identify the usage of various bioanalytical instruments and select them appropriately for an experiment.

MS-BT-154.2 estimate the type and amount of biomolecules through biochemical tests and assays.

MS-BT-154.3 interpret the results obtained through various techniques.

MS-BT-154.4 select suitable chromatographic or electrophoretic system for efficient separation and characterization of different biomolecules.

MS-BT-154.5 evaluate the use of spectroscopic techniques in bioanalyses.

MS-BT-154.6 combine various techniques for complete qualitative and quantitative analyses of biomolecules

List of Experiments:

1. To study phase contrast microscopy technique.
2. To fractionate leaf cell using differential centrifugation technique.
3. To separate biomolecules using paper/ thin layer chromatography.
4. To partially purify protein by ion exchange chromatography.
5. To determine molecular weight of a biomolecule by gel filtration.
6. To separate proteins by SDS-PAGE.
7. To prepare an absorption spectrum and determine the molar extinction coefficient of NADH using spectrophotometer.
8. To perform measurements of volume, weight, concentrations, pH and prepare buffers.
9. To perform qualitative and quantitative estimation of proteins.
10. To perform qualitative and quantitative estimation of lipids.
11. To perform qualitative and quantitative estimation of carbohydrates,
12. To quantitatively determine the amount of DNA and RNA by spectrophotometric method

Distribution of Continuous Assessment

Viva I	**30%**
Viva II	**60%**
File/Record Keeping	**20%**
Class Performance	**10%**
Class Attendance	**10%**

Reference Books:

1. Principles & Techniques of Practical Biochemistry: K.Wilson & J.Walker, Cambridge University Press Publication, (2018), 8th Edition.
2. Introductory Practical Biochemistry: S.K.Sawhney & Randhir Singh, Narosa Publising House, (2005), 5th Edition.
3. An introduction to Practical Biochemistry: David T. Plummer, McGraw Hill Book Company Publication, (2017), 3th Edition.

Course Articulation Matrix

CO (MS-BT-154)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO 1	PSO 2	PSO 3
MS-BT-154.1	3	3	2	2	2	-	1	3	3	2
MS-BT-154.2	3	3	2	2	3	2	2	2	2	1
MS-BT-154.3	3	1	1	2	2	-	2	-	2	1
MS-BT-154.4	3	3	2	2	2	2	2	2	2	1
MS-BT-154.5	3	3	2	2	2	2	2	2	2	2
MS-BT-154.6	3	3	2	2	2	3	2	2	3	2

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES, FARIDABAD

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MS-BT-100: INDEPENDENT STUDY SEMINAR

Periods/week Credits — Max. Marks : 50
T: 1 1 — Continuous Assessment : 50
Duration of Examination: 1 Hrs

Pre-requisites: None
Course Type: Seminar

MS-BT-100.1 Able to assimilate the relevant information from various sources
MS-BT-100.2 Able to prepare effective powerpoint presentation
MS-BT-100.3 Demonstrate the knowledge within the given time.
MS-BT-100.4 Develop the presentation skills
MS-BT-100.5 Able to communicate on the scientific themes
MS-BT-100.6 Improve on interpersonal skills

Independent Study Seminar provides opportunity to the students to enhance their presentation skills and the technical knowledge on the relevant field. It is a technical seminar based on presentations and discussions of discipline specific topics pertaining to the research & development. Each student shall be allocated a research domain depending upon the area of his/ her interest. In further course of time the student will perform the literature survey and assimilate the relevant information. Every student will present a seminar on the allocated topic and will be evaluated through Seminar Presentations.

Continuous Assessment:
Presentation - 25 Marks
Report - 25 Marks

Course Articulation Matrix

CO (MS-BT-100)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO 1	PSO 2	PSO 3
MS-BT-100.1	3	3	-	3	2	2	3	3	3	3
MS-BT-100.2	2	1	2	2	2	-	3	3	-	3
MS-BT-100.3	1	1	-	-	2	-	1	1	-	2
MS-BT-100.4	1	1	1	-	1	-	2	1	-	3
MS-BT-100.5	3	3	2	-	1	-	3	3	1	3
MS-BT-100.6	2	1	2	1	1	1	3	2	2	2

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES, FARIDABAD

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MS-MB-201: SYSTEMATIC BACTERIOLOGY

Periods/week Credits	Max. Marks : 200
L: 3 T: 0 3	Continuous Assessment : 100
Duration of Ext. Exam: 3 Hrs	End Semester Examination: 100

Course Outcomes: The students will be able to

MS-MB-201.1 Understand the diversity of Gram negative bacteria
MS-MB-201.2 Compare and contrast the different bacteria based on their metabolism
MS-MB-201.3 Elucidate the diversity of Gram positive bacteria and archaebacteria
MS-MB-201.4 Differentiate bacteria w.r.t. their morphology, ecology and pathogenecity
MS-MB-201.5 Understand host parasite interactions
MS-MB-201.6 assimilate the diverse ways in which pathogens can cause disease and the mechanisms of non specific host defences

Unit 1: Prokaryotic Diversity- Gram negative bacteria Bacteria

1.1Phyogenetic Oveview of bacteria
1.2 Nitrifying bacteria
1.3 Sulfur and iron oxidixing bacteria
1.4 Hydrogen oxidizing bacteria: Energetics of hydrogen oxidation;physiology and isolation of hydrogen bacteria;Ecology
1.5 Methanotrophs and methylotrophs
1.6 Sulfate and sulfur reducing bacteria
1.7 Homoacetogenic bacteria
1.8 Budding and appendaged bacteria; gilding bacteria; sheathed bacteria
1.9 Pseudomonads; free lving nitrogen fixing bacteria;acetic acid bacteria
1.10Facultative aerobic gram negative rods
1.11 Neisseria and other Gram negative cocci

Unit 2: Prokaryotic Diversity-Gram positive bacteria and archaerbacteria

2.1 Gram positive bacteria-Cocci
2.2 Lactic acid bacteria, streptococcus and other cocci
2.3 Endospore forming Gram positive rods and cocci
2.4 Mycoplasma, Mycobacterium
2.5 Phylogenetic overview of archaebacteria- Extremely halopilic archaea
2.6 Methane producing Archaea
2.7Hyperthermophilic archaea
2.8 Thermoplasma

Unit 3: Microbial Interactions with higher organisms

3.1Normal flora of the Skin
3.2Normal flora of oral cavity
3.3Normal flora of Gastrontestinal tacts
3.4 Normal flora of other body regions
3.5 Entry of pathogen in host
3.6 Colonization and growth
3.7 Non specific Host defence

Text Books/ Reference Books:

1. Moat, A.G., Foster, J.W. and Spector, M.P. eds., 2002. *Microbial physiology*. John Wiley & Sons
2. M. T. Madigan;J. M. Martinko and J. Parker,2003 Brock Biology of Microorganisms:. Prentice Hall IntInc Publication, 13th Edition.
3. Pelczar et al Microbiology: Concepts and Application:2009 Tata McGraw Hill Publication, 10th Ed.
4. Prescott et al., Microbiology :, 2017, 10th Edition McGraw Hill Publication
5. Tortora, G.J., Funke, B.R. and Case, C.L., 2015. *Microbiology: An Introduction, Books a la Carte Edition*. Benjamin-Cummings..
6. R.Y Stanier, J.L Ingraham,., M.L Wheelis,. and P.R Painter 1992. General microbiology 5 th edition. McMillan Publications

Instruction for paper setting: Seven questions are to be set in total. First question will be conceptual and will be compulsory to attempt. Rest of the six questions will cover entire syllabus and consist of two questions from each unit. Student needs to attempt four more questions, selecting at least one question from each unit. Each question will be of 20 marks.

Distribution of Continuous Assessment

Sessional I	**30%**
Sessional II	**30%**
Assignments	**20%**
Class Performance	**10%**
Class Attendance	**10%**

Assessment Tools:
Assignment/Tutorials
Class Performance
Sessional Examinations
End Semester Examination

Course Articulation Matrix

CO (MS-BT-101)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO 1	PSO 2	PSO 3
MS-BT-101.1	3	3	-	-	-	1	-	3	3	2
MS-BT-101.2	3	3	-	-	-	1	-	3	3	2
MS-BT-101.3	3	3	-	-	-	1	-	3	3	2
MS-BT-101.4	3	3	-	-	-	1	-	3	3	2
MS-BT-101.5	3	3	-	-	-	1	-	3	3	2
MS-BT-101.6	3	3	-	-	-	1	1	3	3	2

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES, FARIDABAD

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MS-BT-202: BIOPROCESS TECHNOLOGY

Periods/week	Credits		
L: 3	T: 0	3	
Duration of Examination: 3 Hrs			

Max. Marks	: 200
Continuous Assessment	: 100
End Semester Examination	: 100

Course Outcomes:
The students will be able to-

MS-BT-202.1 describe unit operations in bioprocess technology.
MS-BT-202.2 summarize factors affecting microbial growth and product formation.
MS-BT-202.3 estimate the requirements for maximization of product formation.
MS-BT-202.4 integrate upstream and downstream process requirements for specific applications.
MS-BT-202.5 analyze main issues in bioprocessing and propose suitable solutions.
MS-BT-202.6 develop bioprocesses for novel applications.

Unit 1: Microbial Growth and Product formation
1.1 Role of bioprocess technology in biotechnology.
1.2 Unit operations in upstream processing.
1.3 Microbial growth and its measurement.
1.4 Ideal reactors.
1.5 Cell growth kinetics in ideal batch and continuous reactors.
1.6 Fed batch culture.
1.7 Microbial medium design.
1.8 Factors affecting cellular oxygen requirement.
1.9 Optimization of microbial medium and conditions.
1.10 Kinetics of product formation.

Unit 2: Design and Operation of Bioreactor
2.1 Mass transfer.
2.2 Heat transfer.
2.3 Sterilization.
2.4 Basic design and operation of a bioreactor.
2.5 Non-idealities in bioreactors.
2.6 Air lift reactor.
2.7 Fluidized bed bioreactor.
2.8 Bubble column bioreactor.
2.9 Packed bed bioreactor.
2.10 Bioreactors for culture of animal and plant cells.

Unit 3: Downstream Processing
2.1 Cell separation.
2.2 Cell Disruption.
2.3 Concentration methods.
2.4 Chromatographic methods.
2.5 Case studies on bioprocess development for commercial bioproducts.

Text Books/Reference Books:

1. Principles of fermentation technology: P F Stanbury and A Whitaker; 3rd Edition; (2016); Pergamon Press Publication.
2. Bioprocess Engineering: M L Shuller, F Kargi; 3rd Edition; (2017); Prentice Hall PTR Publications, New Jersy.
3. Bioprocess Engineering Principles: Pauline M. Doran; 2nd Edition; (2012); Academic Press Publications
4. Biochemical Engineering Fundamentals: E Bailey and D F Ollis; 2nd Edition; (2017); McGraw Hill Publication.
5. Bioprocessing Value added Products for Renewable Resources: Shany Tian Yang; (2016); Elsevier Publication.

Instruction for paper setting: Seven questions are to be set in total. First question will be conceptual and will be compulsory to attempt. Rest of the six questions will cover entire syllabus and consist of two questions from each unit. Student needs to attempt four more questions, selecting at least one question from each unit. Each question will be of 20 marks.

Distribution of Continuous Assessment

Sessional I	**30%**
Sessional II	**30%**
Assignments	**20%**
Class Performance	**10%**
Class Attendance	**10%**

Assessment Tools:

Assignment/Tutorials
Class Performance
Sessional Examinations
End Semester Examination

Course Articulation Matrix

CO (MS-BT-202)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO 1	PSO 2	PSO 3
MS-BT-202.1	3	3	-	-	-	1	-	3	3	2
MS-BT-202.2	3	3	-	-	-	1	-	3	2	2
MS-BT-202.3	3	3	-	-	-	1	-	3	2	2
MS-BT-202.4	3	3	-	-	-	1	-	3	3	2
MS-BT-202.5	3	3	-	-	-	1	-	3	3	2
MS-BT-202.6	3	3	-	1	-	1	2	3	3	2

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES, FARIDABAD

(Deemed to be University under section 3 of the UGC Act 1956)

MS-BT-203: BIOINFORMATICS & COMPUTATIONAL BIOLOGY

Periods/week	Credits		
L: 3 T: 0	3	Continuous Assessment	: 100
Duration of Examination: 3 Hrs		End Semester Examination	: 100

Course Outcomes:
The students will be able to-

MS-BT-203.1 define the basic concepts of Bioinformatics and computational biology.
MS-BT-203.2 describe the functionality of various algorithms.
MS-BT-203.3 apply commonly used sequence alignment tools and its significance.
MS-BT-203.4 connect the protein structure determination tools to prediction methods.
MS-BT-203.5 appraise the use of machine learning techniques in biological systems.
MS-BT-203.6 generalize the concepts of systems biology.

Unit 1: Historical introduction and overview
1.1 Introduction to computational biology and bioinformatics.
1.2 Role of Internet and www in bioinformatics.
1.3 Collection and storing sequences in the laboratory: Discovery of first sequencing DNA molecule.
1.4 History of sequences analysis program.
1.5 cDNA, Sequence format, and conversion of one sequence to another.
1.6 Introduction to bio-modelling.

Unit 2: Alignment of pairs of sequences
2.1 Define sequence alignment its significance and methods of sequence alignment.
2.2 Importance of database search.
2.3 Dynamic programming.
2.4 Algorithm for sequence alignment.
2.5 Use of scoring matrices in sequence alignments.
2.6 Multiple sequence alignment: Genome sequencing, Methods for multiple sequence alignment, statistical method for aiding alignment, Position specific scoring matrices.
2.7 Phylogenetic prediction: Phylogenetic analysis to sequence alignment, concept of evolutionary tree Database searching for similar sequences.

Unit 3: Genome and Proteome analysis
3.1 Genome anatomy for prokaryotic and eukaryotic sequences.
3.2 Comparative genomic.
3.3 Functional classification of gene.
3.4 Gene prediction: ORF prediction, gene prediction in microbial genomes, promoter prediction in pro and eukaryotes.
3.5 Protein classification and structure prediction: Alignment of protein structure, modeling on protein structure.

Text Books/Reference Books:
1. Bioinformatics: Sequence and Genome Analysis: D. W. Mount; 2nd Edition; (2004); Cold spring Harbour Laboratory Press Publication.

2. Essential of Genomics and Bioinformatics: C.W. Sensen, 1st Edition; (2002); John Wiley and Sons Publication.
3. Bioinformatics: Methods and Applications Genomics, Proteomics and Drug discovery: S. C. Rastogi, N. Mendiratta, P. Rastogi; 4rt Edition; (2013); Prentice Hall of India Pvt. Ltd Publication.
4. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins: A.D. Baxevanis and B.F.F.Ouellette; 2nd Edition; (2001); Wiley interscience Publication.
5. Introduction to Bioinformatics: Kothekar V., Nandi T.; 1st Edition; (2007); Duckworth Press Bio Science Publishers.
6. Discovering Genomics, Proteomics Bioinformatics: Campbell, Malcolma, Lauria; 2nd Edition; (2007); Pearson Education Publication.

Instruction for paper setting: Seven questions are to be set in total. First question will be conceptual and will be compulsory to attempt. Rest of the six questions will cover entire syllabus and consist of two questions from each unit. Student needs to attempt four more questions, selecting at least one question from each unit. Each question will be of 20 marks.

Distribution of Continuous Assessment

Sessional I	**30%**
Sessional II	**30%**
Assignments	**20%**
Class Performance	**10%**
Class Attendance	**10%**

Assessment Tools:
Assignment/Tutorials
Class Performance
Sessional Examinations
End Semester Examination

Course Articulation Matrix

CO (MS-BT-203)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO 1	PSO 2	PSO 3
MS-BT-203.1	2	3	2	2	3	-	1	3	3	3
MS-BT-203.2	3	2	1	1	2	-	1	3	2	2
MS-BT-203.3	2	3	1	2	2	1	1	3	2	2
MS-BT-203.4	3	3	1	2	2	1	1	3	2	2
MS-BT-203.5	3	3	1	2	2	-	2	3	2	2
MS-BT-203.6	3	3	1	2	2	-	2	3	2	2

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES, FARIDABAD

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MS-MB-204: MOLECULAR IMMUNOLOGY AND IMMUNOGENETICS

Periods/week Credits	Max. Marks : 200
L: 3 T: 0 3	Continuous Assessment: 100
Duration of Examination: 3 Hrs	End Semester Examination : 100

Course Outcomes:

The student will be able to

MS-MB-204.1:understand the microenvironment immune system and its components
MS-MB-204.2:learn about antibody gene and diversity
MS-MB-204.3 :know the genetics of human blood groups and types and their clinical / forensic. significance
MS-MB-204.4 :comprehend cancer genetics and expression of tumor antigens.
MS-MB-204.5:discern the immune responses against tumor antigens in humans
MS-MB-204.6: apply the knowledge to use various Immunotechniques for the identification of various disease causation

Unit 1: Introduction to Immune System

1.1 Innate and Adaptive Immune System,Immune cells, Lymphoid Organs
1.2 Microenvironment of Immune system(MALT,SALT),Complement system
1.3 Antigen(types and characteristics), Antibody structure, its functions and types
1.4 Antibody Gene and Diversity
1.5 Organization and expression of T and B lymphocyte receptor gene

Unit 2:Major Histocompatibility Complex and Immunogenetics of cancer

2.1 MHC Geneand Products
2.2 Types and Structure of MHC molecules
2.3 MHC and Antigen Presentation
2.4 Immunogenetics of cancer
2.5 Immune response and Cancer

Unit 3:Immunohematology and Immunotechniques

3.1 Genetics of Immunohematology – Genetic basis and significance of ABO and other minor blood groups in humans,
3.2 Bombay blood groups, Secretors and Non-secretors, Rh System and genetic basis of D- antigens
3.3Immunoblotting, ELISA and its Types
3.4Single radial and Ouchterlony double diffusion, Immunofluorescence,
3.5 Immunoelectrophoresis,Radio immuno assay, Complement fixation test

Text Books/ Reference Books:

1. Kuby- Immunology Punt, J, Stranford S, Jones P, Owen JA; 8th Edition; (2018); WH Freeman Publication.
2. Roitt's Essential Immunology, Delves PJ, Martin SJ, Burton DR, Roitt IM; 13th Edition; (2017); Willey-Blackwell Scientific Publications.
3. Immunogenetics,Gabriel S Panayi,Chella S. David 1st Edition (1984), Eisiver Publication NY ,10010,United State
4. Prescott's Microbiology Willey J, Sherwood L, Woolverton CJ; 9th Edition; (2013); McGraw-HillEducation

5. Antibodies A laboratory Manual Greenfield EA; 2nd Edition; (2013); Cold spring harbor laboratory Publication.

Websites:
ncyclopedia.com/science/encyclopedias-almanacs-transcripts-and-maps/immunogenetics

Instruction for paper setting: Seven questions are to be set in total. First question will be conceptual and will be compulsory to attempt. Rest of the six questions will cover entire syllabus and consist of two questions from each unit. Student needs to attempt four more questions, selecting at least one question from each unit. Each question will be of 20 marks.

Distribution of Continuous Assessment

Sessional I	**30%**
Sessional II	**30%**
Assignments	**20%**
Class Performance	**10%**
Class Attendance	**10%**

Assessment Tools:
Assignment/Tutorials
Class Performance
Sessional Examinations
End Semester Examination

Course Articulation Matrix

CO (MS-MB-204.1)	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO 1**	**PSO 2**	**PSO 3**
MS-MB-204.1	2	3	2	2	3	-	1	3	2	2
MS-BT-222.2	3	2	1	1	2	-	3-	3	2	1
MS-BT-222.3	2	3	1	2	2	1	-	3	2	1
MS-BT-222.4	3	3	1	2	2	1	1	3	2	1
MS-BT-222.5	3	3	1	2	2	-	1	3	2	1
MS-BT-222.6	3	3	1	2	2	-	1	3	2	1

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES, FARIDABAD

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MS-BT-252: FERMENTATION TECHNOLOGY LAB

Periods/week Credits	Max. Marks : 100
P: 3 1.5	Continuous Assessment : 50
Duration of Examination: 3 Hrs	End Semester Examination : 50

Course outcomes:

The students will be able to-

MS-BT-252.1 know different techniques in genetic engineering and immunology.
MS-BT-252.2 apply their subject knowledge for practical solution to the given problem.
MS-BT-252.3 acquire skills in analysis, quantification and manipulation of biomolecules for different applications.
MS-BT-252.4 acquire skills for planning experiments.
MS-BT-252.5 analyse data and present results.
MS-BT-252.6 know about quality, safety and ethical considerations about working in a laboratory.

List of Experiments:

1. Isolation and identification of industrially important microorganisms
2. To study the design and operation of a bioreactor.
3. To study batch growth kinetics and determine key kinetic parameters.
4. To study solid-state fermentation using a fungal strain.
5. To perform microbial media optimization
6. To study the production of protease by *Bacillus subtilis*.
7. To study alcohol production by *S. cerevisae* using apple juice as substrate.
8. To study the production of amylase by *Aspergillus niger* in submerged fermentation.
9. To study the technique of enzyme immobilization using Calcium alginate gel entrapment method.
10. To study the process of kinetics of batch heat sterilization.
11. To study the process of cell lysis using sonicator.
12. To carryout bacterial protein purification - ion exchange chromatography and gel filtration chromatography

Distribution of Continuous Assessment

Viva I	**30%**
Viva II	**60%**
File/Record Keeping	**20%**
Class Performance	**10%**
Class Attendance	**10%**

Reference Books:

1. Microbiology lab. Manual: Cappuccino J.&Sheeman N., Addison Wesley Publication, 12th Edition.
2. Bioprocess Engineering: Systems, Equipments and Facilities: K B Lydersen, N A D'elia and K L Nelsdon, John Wiley & Sons Publication, New York.

3. Biophyscal Chemistry: Principles and Techniques: A. Upadhyay, K Upadhyay and N Nath Himalaya Publication House, New Delhi.

Course Articulation Matrix

CO (MS-BT-252)	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO 1**	**PSO 2**	**PSO 3**
MS-BT-252.1	2	2	2	2	-	-	-	2	2	2
MS-BT-252.2	2	2	2	2	-	-	1	3	3	3
MS-BT-252.3	2	2	2	2	-	-	1	3	3	3
MS-BT-252.4	2	2	2	2	-	-	1	2	2	3
MS-BT-252.5	1	1	1	1	-	-	1	2	2	1
MS-BT-252.6	1	1	1	1	3	1	-	2	2	1

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES, FARIDABAD

(Deemed to be University under section 3 of the UGC Act 1956)

MS-BT-253: BIOINFORMATICS LAB

Periods/week	Credits	Max. Marks	: 100
P: 2	1	Continuous Assessment	: 50
Duration of Examination: 3 Hrs		End Semester Examination	: 50

Course outcomes:

The students will be able to-

MS-BT-253.1 develop a working knowledge of using various tools of bioinformatics and use of databases.

MS-BT-253.2 demonstrate the local and global alignment search tools for DNA sequence analysis

MS-BT-253.3 infer molecular modeling by Rasmol and Cn3D.

MS-BT-253.4 able to analyze, identify and characterize DNA sequences.

MS-BT-253.5 predict gene behaviour using appropriate tools.

MS-BT-253.6 compute and verify restriction map for a DNA sequence

List of Experiments:

1. To study literature searches method using Pubmed.
2. To perform DNA sequence analysis using BLAST.
3. To perform multiple sequence analysis using CLUSTAL- W.
4. To perform RNA Secondary structure modeling.
5. To find domain and pattern in protein sequences.
6. To analyze molecular weight of proteins using PROTPRAM.
7. To perform molecular modeling and study dynamics using RASMOL.
8. To perform molecular modeling and study dynamics using Cn3D.
9. To search for gene expression data using GEO.
10. To screen for vector contamination using VEC SCREEN.
11. To study inherited diseases in humans using OMIM.
12. To study gene prediction using GENSCAN.

Distribution of Continuous Assessment

Viva I	**30%**
Viva II	**60%**
File/Record Keeping	**20%**
Class Performance	**10%**
Class Attendance	**10%**

Reference Books:

1. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins: A.D. Baxevanis and B.F.F.Ouellette; 2nd Edition; (2001); Wiley interscience Publication.
2. Introduction to Bioinformatics: Kothekar V.; 1st Edition; (2007); Duckworth Press Bio Sciences Publishers.

3. Discovering Genomics, Proteomics Bioinformatics: Campbell, Malcolma, Lauria; 2nd Edition; (2007); Pearson Education Publication.

Course Articulation Matrix

CO (MS-BT-253)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO 1	PSO 2	PSO 3
MS-BT-253.1	3	3	3	2	1	1	3	3	2	2
MS-BT-253.2	3	3	1	2	1	1	3	1	2	2
MS-BT-253.3	3	3	1	2	2	1	3	1	1	2
MS-BT-253.4	3	3	2	2	1	1	3	1	1	2
MS-BT-253.5	3	3	1	2	3	1	3	1	1	2
MS-BT-253.6	2	2	2	2	1	1	3	1	1	2

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES, FARIDABAD

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MS-MB-200: PROJECT PHASE-I

Periods/week	Credits	Max. Marks	: 100
P: 4	2	Continuous Assessment	: 50
Duration of Examination: 2 Hrs		End Semester Examination	: 50

Course outcomes:

The students will be able to-

MS-MB- 200.1 survey relevant research literature.
MS-MB- 200.2 learn to communicate effectively.
MS-MB- 200.3 assimilate the purpose of research through literature survey.
MS-MB- 200.4 acquire ability to identify the gaps in research.
MS-MB- 200.5 appraise the importance of ethics in research.
MS-MB- 200.6 hypothesize the solutions to real life problems.

Every student will have to undertake a research project in the field relevant to Biotechnology. Each student will be allocated a faculty supervisor depending upon the area of his/ her interest. In further course of time the student will identify the research problem and do the literature survey. In Project Phase-I every student is expected to at least build the hypothesis, set the objectives and decide upon the work-plan for the research to be carried out in next semester under Project Phase-II. During this course of time he/she will be regularly monitored and evaluated by the Project Supervisor and the Departmental Project Committee. Continuous monitoring will include Seminar Presentations and Feedback from supervisor. At the end of the Project Phase-I, each student will have to submit a Synopsis (soft bound), deliver a presentation pertaining to the research work and will have to appear for viva during Internal Examination.

Continuous Assessment:

Continuous Performance	- 10 Marks
Literature Review	- 10 Marks
PPT & Report	- 20 Marks
Attendance	- 10 Marks

Course Articulation Matrix

CO (MS-BT-200)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO 1	PSO 2	PSO 3
MS-MB-200.1	3	-	1	3	-	2	3	3	1	3
MS-MB-200.2	2	2	2	-	1	-	2	3	3	3
MS-MB-200.3	1	3	2	3	2	1	3	3	3	3
MS-MB-200.4	1	1	1	1	1	1	2	1	1	3
MS-MB-200.5	3	3	2	3	3	2	3	3	3	3
MS-MB-200.6	1	2	1	1	1	1	1	2	2	2

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES, FARIDABAD

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MS-BT-221: BIOETHICS, BIOSAFETY & IPR

Periods/week	Credits		Max. Marks	: 200
L: 3 T: 0	3		Continuous Assessment	: 100
Duration of Examination: 3 Hrs			End Semester Examination	: 100

Course Outcomes:
The student will be able to-

MS-BT-221.1 discuss the ethical conflicts in biotechnology.
MS-BT-221.2 distinguish social, ethical, legal and economic issues in biotechnology.
MS-BT-221.3 assess biosafety issues regarding human health and environment.
MS-BT-221.4 analyse biosafety assessment procedures for genetically modified food.
MS-BT-221.5 evaluate the need of protection of intellectual property
MS-BT-221.6 design the strategy for patenting of biotechnological inventions.

Unit 1: Introduction to Bioethics
1.1 Social and ethical issues in Biotechnology.
1.2 The legal and socioeconomic impacts of biotechnology.
1.3 Public education of the processes of biotechnology, public acceptance issues in biotechnology.
1.4 Ethical conflicts in biotechnology - interference with nature, fear of unknown, unequal distribution of risks and benefits of biotechnology.
1.5 Technology transfer international relations and globalization in biotechnology.

Unit 2: Biosafety issues and regulations
2.1 Biosafety for human health and environment.
2.2 Perceptions of risks and benefits.
2.3 The GM-food debate and biosafety assessment procedures for biotech foods & pharmaceutical products such as drugs/vaccines.
2.4 Cartagena protocol on biosafety.
2.5 Laboratory associated infections and other hazards, assessment of biological hazards and levels of biosafety.
2.6 Prudent biosafety practices in the laboratory/ institution.
2.7 Handling of recombinant DNA processes and products in institutions and industries.
2.8 Biosafety assessment procedures in India and abroad.
2.9 Bio-terrorism and convention on biological weapons.

Unit 3: Intellectual Property Rights
3.1 Patents – definition, basic requirements, conditions for patentability.
3.2 Test of novelty of patents, composition of a patent, Patent claims, the legal decision – making process, the forms of IPR – Copyright, Trademark, Designs, legal implications, Disclosure requirements, Collaborative research, Competitive research.
3.3 Indian patents and Foreign patents in plant biotechnology, Plant variety protection act, The strategy of protecting plants, plant breeder's rights.
3.4 IPR issues in Indian Context- role of patent in pharmaceutical industry and agriculture.
3.5 Recent Developments in Patent System and Patentability of biotechnological inventions.

Text Books/Reference Books:

1. Biotechnology and Safety Assessment, Thomas, J.A., Fuch, R.L.; 3rd Edition, (2002); Academic Press Publication.
2. Biological safety Principles and practices, Fleming, D.A., Hunt, D.L., 4th Edition; (2006); ASM Press Publication, Washington.
3. Biotechnology - A comprehensive treatise; Vol. 12; (2001); Legal economic and ethical dimensions VCH.
4. Biotechnologies and Development: Sasson A, volume 2; (1988); UNESCO Publication.
5. Intellectual Property in the Food Technology Industry: O'Donnell, R.W., O'Malley, J.J., Huis, R.J., Halt, G.B.J; (2008); Springer.

Instruction for paper setting: Seven questions are to be set in total. First question will be conceptual and will be compulsory to attempt. Rest of the six questions will cover entire syllabus and consist of two questions from each unit. Student needs to attempt four more questions, selecting at least one question from each unit. Each question will be of 20 marks.

Distribution of Continuous Assessment

Sessional I	**30%**
Sessional II	**30%**
Assignments	**20%**
Class Performance	**10%**
Class Attendance	**10%**

Assessment Tools:

Assignment/Tutorials
Class Performance
Sessional Examinations
End Semester Examination

Course Articulation Matrix

CO (MS-BT-221)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO 1	PSO 2	PSO 3
MS-BT-221.1	1	1	-	-	2	-	-	1	-	2
MS-BT-221.2	-	1	-	-	3	-	1	1	--	2
MS-BT-221.3	-	-	1	-	1	2	-	1	-	1
MS-BT-221.4	1	2	-	1	2	1	-	1	2	2
MS-BT-221.5	1	2	-	-	1	1	1	2	1	2
MS-BT-221.6	2	3	2	2	3	1	3	2	2	3

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES, FARIDABAD

(Deemed to be University under section 3 of the UGC Act 1956)

MS-MB-222 :PLANT PATHOGEN INTERACTIONS

Periods/week	Credits	Max. Marks	:200
L: 4 T: 0	4	Continuous Evaluation	:100
Duration of Ext. Exam: 3 Hrs		End Semester Examination	:100

Course Outcomes: The students will be able to

MS-MB-222.1 Understand the basic concepts of plant pathogen interactions

MS-MB-222.2 Explain the important methods to study plant-microbe interactions

MS-MB-222.3 Differentiate the different types of plant-microbe interactions

MS-MB-222.4 Develop the skills to identify and analyze the community dynamics and population interactions

Unit 1: Introduction

1.1 Different interfaces of interactions
1.2 Plant-microbe
1.3 Microbe-microbe,
1.4 Soil-microbe
1.5 Soil-plant-microbe
1.6 Symbiotic (rhizobial, algal, actinomycetous and mycorrhizal), associative, endophytic and pathogenic interactions.

Unit 2:

2.1 Types of ecosystems: Concept and dynamics of ecosystem
2.2 Food chain and energy flow
2.3 Microbial communities in the soil
2.4 Community dynamics and population interactions employing DGGE, TGGE, TRFLP.
2.5 Quorum-sensing in bacteria
2.6 Plant-microbeFlow of signals in response to different carbon or other substrates and how signals are recognized

Unit 3: Methodology/resources to study plant-microbe interaction

3.1 Recombinant inbred lines
3.2 Biosensors
3.3 Transcriptome profiling
3.4 Metabolic profiling
3.5 Genomics, proteomics
3.6 Advanced microscopy
3.7 Spectroscopy of different interfaces

Unit 4:

4.1 Plant and microbial gene expression and signal exchange
4.2 Global and specific regulators for different interactions
4.3 Molecular diversity of microbes, plants and their interactions including transgenic microbes and plants.

Text Books/ Reference Books:

1. T. Kosuge, and E. W. Nester, 1989, Plant-Microbe Interactions: Molecular and Genetic Perspectives.

Vols I-IV. McGraw Hill., New Delhi
2. George NicholasAgrios, 2005, Plant Pathology, , .Elsevier Science Publishing Co Inc
3. R S Mehrotra and Ashok Agrawal, 2006, Plant Pathology. Tata McGrawHill , 6th reprint.
4. D.P.S. Verma, and T.H. Kohn, 1984, Genes Involved in Microbe-Plant Interactions. Springer Verlag., New York Molecular Plant-Microbe Interactions. Journal Published by APS., New York
5. U. S. Singh, A. N. Mukhopadhyay, J. Kumar and H. S. Chaube HS, 1992, Plant Diseases of International Importance. Vol. I. Diseases of Cereals and Pulses. Prentice Hall, Englewood Cliffs, New Jersey.

Instruction for paper setting: Seven questions are to be set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Three questions will be set from each PART-A and PART-B (one from each Unit). Student needs to attempt two questions out of three from each part. Each question will be of 20 marks.

Assessment Tools:
Sessional tests
Term end examination scores
Participation in class activities
Home assignments
Class attendance

CO Statement (MS-MB-222**)**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO 1**	**PSO 2**	**PSO 3**
MS-MB-222.1	2	1	-	-	-	1	-	3	2	2
MS-MB-222.2	2	1	-	2	-	-	1	3	3	2
MS-MB-222.3	2	1	-	-	-	1	-	2	2	2
MS-MB-222.4	2	2	-	2	-	1	2	3	3	2

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES, FARIDABAD

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MS-BT-223: HUMAN GENOME

Periods/week	Credits		
L: 3 T: 0	3	Continuous Assessment	: 100
Duration of Examination: 3 Hrs		End Semester Examination	: 100

Course Outcome:
The students will be able to-

MS-BT-223.1 discuss the human genome structure and properties of DNA.
MS-BT-223.2 critique the variation of genome across human population.
MS-BT-223.3 appraise the variation in context of physiological function and disease.
MS-BT-223.4 manage information sharing at research/clinical interface.
MS-BT-223.5 discuss and analyze modifications and their role in disease.
MS-BT-223.6 justify the ethical and governance frameworks that apply to medical genomics.

Unit 1: Human Genome Project
1.1 Architecture of human genome
1.2 Genetic variation within human genome.
1.3 DNA Sequence Variation: SNPs, Indels, tandem repeats.
1.4 Extent of variation in populations (hapmap).
1.5 Tools for genome analysis – PCR, RFLP, RAPD, DNA Sequencing.
1.6 Forward genetic approach, reverse genetic approach.

Unit 2: Disease Diagnosis
2.1 Genetic diseases due to defects in autosomal and sex linked genes.
2.2 Karyotype analysis.
2.3 Genotyping with fluorescence labeled, DNA/RNA Probes.
2.4 Pedigree analysis.
2.5 Epigenetics and imprinting.
2.6 Effect of variants on genotype and phenotype.

Unit 3: Ethical Regulation
3.1 Gene based therapies for genetic disorders.
3.2 Screening of genetic diseases.
3.3 Human cloning and eugenics.
3.4 Codes of practices Confidentiality/privacy.
3.5 Ethical dilemma, Human rights.
3.6 Research ethics; Medical ethics in India.

Text Books/ Reference Books:

1. Human Genetics: A modern Synthesis - Gordon Edlin, Borton; 1st Edition; (1989); Jones and Barlett publication.
2. Basic Human Genetics: Elaine Johansen Mange and Arthur P.Mange; 1st Edition; (1993); Sinauer Associates Inc. Publication, Sunderland, Massachusetts.

3. The Human Genome Project; Deciphering the blueprint of heredity: Edited by Necia Grant Cooper; 1st Edition; (1994); University Science books Publication, CA, USA.
4. Genomes: Brown TA; 3rd Edition; (2006); Garland Science.
5. Human Cytogenetics: Constitutional analysis; D.E.Rooney; 3rd Edition; (2001); Oxford University Press.

Web links:
1. www.ncbi.nlm.nih.gov
2. www.expasy.org
3. www.ebi.ac.uk

Instruction for paper setting: Seven questions are to be set in total. First question will be conceptual and will be compulsory to attempt. Rest of the six questions will cover entire syllabus and consist of two questions from each unit. Student needs to attempt four more questions, selecting at least one question from each unit. Each question will be of 20 marks.

Distribution of Continuous Assessment

Sessional I	**30%**
Sessional II	**30%**
Assignments	**20%**
Class Performance	**10%**
Class Attendance	**10%**

Assessment Tools:
Assignment/Tutorials
Class Performance
Sessional Examinations
End Semester Examination

Course Articulation Matrix

CO (MS-BT-223)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO 1	PSO 2	PSO 3
MS-BT-223.1	1	2	-	-	-	-	-	2	-	3
MS-BT-223.2	1	2	-	1	-	-	-	2	-	3
MS-BT-223.3	1	2	-	-	-	-	-	2	1	2
MS-BT-223.4	1	2	2	-	-	-	1	2	1	3
MS-BT-223.5	1	2	-	-	-	-	-	2	-	3
MS-BT-223.6	1	2	-	-	-	3	-	2	-	3

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES, FARIDABAD

(Deemed to be University under section 3 of the UGC Act 1956)

MS-MB-224: VIROLOGY, MYCOLOGY AND PARASITOLOGY

Periods/week	Credits		Max. Marks	:200
L: 4	T: 0	4	Continuous Evaluation	:100
Duration of Ext. Exam: 3 Hrs			End Semester Examination	:100

Course Outcomes:

The students will be able to-

MS-MB-224.1-learn about the chemical nature of viruses, their hosts, ecology, classification and biology.

MS-MB-224.2- describe the role of viruses in various diseases.

MS-MB-224.3- identify commonly available pathogenic and non-pathogenic fungi, knowledge of their characteristics and useful & harmful activities offungi.

MS-MB-224.4- cultivate, purify and preserve fungi in the laboratory, how fungi are used as in food, pharmaceutical and agriculture industries.

MS-MB-224.5- learn about classification, structure and growth of protozoan parasites.

MS-MB-224.6- understand the basic and general concepts of causation of disease by the common protozoan parasites and the methods of diagnosis.

Unit 1: Virology

1.1 Discovery of viruses, nature and definition of viruses, general properties, concept of viroids, virusoids, satellite viruses and prions. Theories of viral origin.

1.2 Structure of viruses, Viral taxonomy- classification and nomenclature of different groups of viruses.

1.3 Diversity, classification of bacteriophages, lytic and lysogenic phages, concept of early and late proteins, regulation and transcription of lambda phage.

1.4 Modes of viral transmission, viral persistence and latency, host cell transformation by viruses and oncogenesis of DNA and RNA viruses, vertical and horizontal transfer.

1.5 Salient features of viral nucleic acid: Unusual bases (TMV, T4 phage), overlapping genes (Hepatitis B virus, ϕX174), alternate splicing (HIV), terminal redundancy (T4 phage), terminal cohesive ends (lambda phage), partial double stranded genomes (Hepatitis B virus), Long terminal repeats (retrovirus), segmented genome (Influenza virus), capping and tailing (TMV).

1.6 Viral multiplication and replication strategies. Interaction of viruses with cellular receptors and entry of viruses. Replication strategies as per Baltimore classification (phiX174, Retroviridae, Vaccinia virus, Picornavirus), viral assembly, maturation and release of virions.

Unit 2: Mycology

2.1 Classification, structure, reproduction and general features of fungi: Zygomycetes, Ascomycetes, Basidiomycetes and Deuteromycetes.

2.2 Cultivation: culture media for fungal growth, effects of the environment on growth, isolation, identification- and preservation of fungi.

2.3 Pathogenic and non-pathogenic fungi.

2.4 Application of fungi in food industry (Flavour& texture, fermentation, baking, organic acids, enzymes, myco-proteins).

2.5 Fungi in pharmaceutical industry, secondary metabolites.

2.6 Fungi in agriculture industry: Biofertilizers, Mycofungicides, Mycoherbicides, Mycoinsecticides.

Unit 3: Parasitology

3.1 Classification of parasites, classification of protozoan parasites, structure and growth.

3.2 *Entamoeba* and *Plasmodium*: Reproduction and other characteristics
3.3 *Leishmania* and *Cryptosporidium*: Reproduction and other characteristics
3.4 *Trichomonas* and *Taxoplasma*: Reproduction and other characteristics
3.5 *Trypanosoma* and *Giardia*: Reproduction and other characteristics

Text Books/Reference Books:

1. Sherris Medical Microbiology: Kenneth J. Ryan, C. George Ray,McGraw Hill publication
2. Principles of fermentation technology: P F Stanbury and A Whittaker, Pergamon press Publication
3. Basic Medical Microbiology E-Book: Patrik R. Murray,PhD
4. Prescott Microbiology:JoanneWilley,LindaSherwood,ChristopherJ.Woolverton,Publisher: McGraw Hill
5. Bailey & Scott's Diagnostic Microbiology:BettyA.Forbes,Daniel A Saham,Alice S Weisfeld,Publisher: Elsevier

Web links:

www.pravara.com/e-learning.html
https://www.kobo.com/us/en/ebook/basic-medical-microbiology-e-book
https://nptel.ac.in/courses/102103015/

Instruction for paper setting: Seven questions are to be set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Three questions will be set from each PART-A and PART-B (one from each Unit). Student needs to attempt two questions out of three from each part. Each question will be of 20 marks.

Assessment of outcomes through:

Everyday assessments
Class Tests
Sessional tests
Surprise questions during lectures/class performances
Term end examination

Term end examination

Course Articulation Matrix

CO Statement (MS-MB-224)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
MS-MB-224.1	3	2	1	1	1	1	3	3	1	3
MS-MB-224.2	3	3	1	2	1	3	3	3	2	3
MS-MB-224.3	3	1	1	2	2	1	3	2	1	3
MS-MB-224.4	3	3	2	2	2	2	3	3	3	3
MS-MB-224.5	3	2	1	2	1	1	3	2	1	2
MS-MB-224.6	3	3	2	2	2	2	3	3	3	3

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES, FARIDABAD

(Deemed to be University under section 3 of the UGC Act 1956)

MS-BT-224: BIOFERTILIZER AND BIOPESTICIDE

Periods/week	Credits	Max. Marks	: 200
L: 3 T: 0	3	Continuous Assessment	: 100
Duration of Examination: 3 Hrs		End Semester Examination	: 100

Course Outcome:
The students will be able to-

MS-BT-224.1 understand the fundamental concepts of bio-pesticides and bio-fertilizers and their role in sustainable agriculture.
MS-BT-224.2 Describe various mechanisms employed by plant growth promoting microorganisms (PGPM) and biocontrol agents in increasing crop productivity.
MS-BT-224.3 differentiate between various groups of PGPM and biocontrol strains.
MS-BT-224.4 analyze the different methods used for the mass production of bio-fertilizers and bio-pesticides.
MS-BT-224.5 modify the indigenous microorganisms to increase their survival and growth potential.
MS-BT-224.6 develop strategies for plant growth promotion using PGPM as bio-inoculants either alone or as a consortia different mechanisms of plant growth promotion by PGPR.

Unit 1: Nitrogen Fixing Microorganisms
1.1 Soil fertility; free living, symbiotic (rhizobial, actinorhizal), associative and endophytic nitrogen fixers including cyanobacteria,.
1.2 Taxonomic classification, nodule formation, competitiveness and quantification of Nitrogen fixed.
1.3 Nature, mode of action and mechanism of nitrogen fixation. The Nif genes: Genetics of Nif in *Klebsiella pneumoniae*.
1.4 Structure and regulation of nif genes in *Klebsiella pneumoniae.*
1.5 Modes of nitrogen fixation in BGA, isolation of BGA, agroclimatic variations, algalization
1.6 Mass cultivation Azolla, green manure, algae and soil reclamation, organic matter composting.
1.7 Phosphate solubilizing Microorganism and other PGPR, Biocontrol microbial inoculants

Unit 2: Production of Bio-fertilizers
2.1 Selection, establishment and competitiveness of different agriculturally important beneficial microorganisms.
2.2 Crop productivity, soil & plant health.
2.3 Mass scale production and quality.
2.4 Control of bio inoculants. Bio-fertilizer inoculation and microbial communities in the soil.

Unit 3: Biopesticide and their Application
3.1 Bacterial pesticides (Bt pesticides).
3.2 Viral biopesticides–Baculovirus, NPV insecticides, fungal (Trichoderma) bioinsecticide and weedicides.
3.3 Production of biopesticides for large scale application.
3.4 Application of pesticides and biocontrol agents: Seed dressing, soaking, root-dip treatment, dusting, spraying (low and high volume sprayers), Soil disinfestations, and soil fumigation.
3.5 Integrated Pest Management: tools of pest management, Ecological and socio-economic aspects.

Text Books/Reference Books:

1. Biological Nitrogen Fixation, Stacey, Burris and Evans; 1st Edition; (1992); CBA Publishers and Distributor, New Delhi, India.
2. Biofertilizer in agriculture and Forestry: Rao, N.S.S.; 4th Edition; (2017); Medtech Publication.
3. Principles of Insect Pest Management, Dhaliwal,G.S. and Arora,R.; 2nd Edition; (2006); Kalyani Publication, New Delhi.
4. Modern Soil Microbiology, Van Elsas JD, Trevors JT & Wellington EMH; 3rd Edition; (2019); CRC Press Publication.
5. Integrated Pest Management: Dent, D.; 1st Edition; (1995); Chapman and Hall Publication, London.

Web links:
http://nptel.ac.in/courses/126104003/
http://nptel.ac.in/courses/126104001/
http://www.amm-mcrc.org/publications/Biofertilizers.pdf

Instruction for paper setting: Seven questions are to be set in total. First question will be conceptual and will be compulsory to attempt. Rest of the six questions will cover entire syllabus and consist of two questions from each unit. Student needs to attempt four more questions, selecting at least one question from each unit. Each question will be of 20 marks.

Distribution of Continuous Assessment

Sessional I	**30%**
Sessional II	**30%**
Assignments	**20%**
Class Performance	**10%**
Class Attendance	**10%**

Assessment Tools:
Assignment/Tutorials
Class Performance
Sessional Examinations
End Semester Examination

Course Articulation Matrix

CO (MS-BT-224)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO 1	PSO 2	PSO 3
MS-BT-224.1	2	2	-	-	-	2	-	3	1	1
MS-BT-224.2	2	2	-	-	-	2	-	2	1	1
MS-BT-224.3	2	2	-	-	-	-	-	3	1	1
MS-BT-224.4	3	2	-	1	-	1	1	2	2	2
MS-BT-224.5	3	3	1	2	2	2	1	2	2	2
MS-BT-224.6	3	2	1	2	2	1	2	2	2	3

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES, FARIDABAD

(Deemed to be University under section 3 of the UGC Act 1956)

MS-MB-301: CLINICAL MICROBIOLOGY AND VACCINOLOGY

Periods/week	Credits	Max. Marks	: 200
L: 3 T: 0	3	Continuous Assessment	: 100
Duration of Examination: 3 Hrs		End Semester Examination	: 100

Course Outcomes:
The student will be able to

MS-MB-301.1 : recognize and diagnose common infectious diseases from the clinical presentation and associated microbiology.
MS-MB. 301.2 : assess treatment strategies including the appropriate use of antimicrobial agents and common mechanisms of antimicrobial action and resistance.
MS-MB-301.3 : explain interventions employed to prevent infectious diseases including infection control measure and vaccines

Unit 1: Introduction to clinical Microbiology
1.1 History and scope of clinical Microbiology
1.2 Importance of Normal bacterial and Fungal Microbiota
1.3 Classification and General Properties of Prokaryotic Microbiome
1.4 Prions and Toxins

Unit2:Antimicrobial agents and Clinical Diagnostics
2.1 Antibacterial agents, Antifungal agents and Antiviral agents: Types and their Mechanism of action
2.2 Antibiotic resistance, MDR, MRSA,
2.3 Collection, transport and culturing of clinical samples
2.4 Diagnosis of bacterial, fungal and viral infections
2.5 Diagnosis of anaerobic and obligate intracellular parasite

Unit 3:Vaccine Designing ant Types
1.1 Active and passive Immunity
1.2 Types of Vaccines
1.3 Hybrid Vaccine
1.4 Vaccine Safety
1.5 The creation of Vaccine

Text Books/ Reference Books:

1. Kuby, J. Punt, , S. Stranford , P. Jones , J.A.Owen,2018.Immunology ,8th Edition; WH Freeman Publication.
2. P.J Delves, S.J Martin, D.R Burton, IM Roitt,2017. Essential Immunology, 13th Edition; Willey-Blackwell Scientific Publications.
3. S. Gabriel,C. Panayi,S. David,1984,Immunogenetics, 1st Edition Eisiver Publication NY United State
4. J.Willey , L.Sherwood, C.J Woolverton,2013Prescott's Microbiology. 9th Edition,McGraw-HillEducation
5. E.A. Greenfield ,Antibodies A laboratory Manual, 2nd Edition; (2013); Cold spring harbor laboratory Publication.

Websites:
encyclopedia.com/science/encyclopedias-almanacs-transcripts-and-maps/immunogenetics

Instruction for paper setting: Seven questions are to be set in total. First question will be conceptual and will be compulsory to attempt. Rest of the six questions will cover entire syllabus and consist of two questions from each unit. Student needs to attempt four more questions, selecting at least one question from each unit. Each question will be of 20 marks.

Distribution of Continuous Assessment

Sessional I	**30%**
Sessional II	**30%**
Assignments	**20%**
Class Performance	**10%**
Class Attendance	**10%**

Assessment Tools:
Assignment/Tutorials
Class Performance
Sessional Examinations
End Semester Examination

Course Articulation Matrix

CO MS-MB-301	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO 1	PSO 2	PSO 3
MS-MB-301.1	3	2	1	2	-	1	2	3	-	2
MS-MB-301.2	2	3	2	1	3	1	2	3	2	-
MS-MB-301.3	3	2	1	3	1	-	2	1	-	1

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES

(Deemed to be University under section 3 of the UGC Act 1956)

MS-MB-302: MICROBIAL PATHOGENICITY

Periods/week	Credits	Max. Marks	:200
L: 3 T: 0	3	Continuous Evaluation	:100
Duration of Ext. Exam: 3 Hrs		End Semester Examination	:100

Course Outcomes:

The students will be able to-

MS-MB-302.1 Describe the mechanisms of pathogenesis of bacterial diseases, virulence factors, pathogencitiy islands and toxigenicity.

MS-MB-302.2 Understand the mechanisms of viral pathogenesis, viral replication, spread and virus shedding

MS-MB-302.3 Understand how pathogens evade our immune systems.

Unit 1 Pathogenesis of Bacterial Diseases

1.1Maintaining a reservoir of bacterial pathogen,
1.2 transport of the bacterial pathogen to the host;
1.3 Attachment and Colonization by the bacterial pathogen,
1.4 Invasion of the bacterial pathogen;
1.5 Growth and manipulation of the host by bacterial pathogen;
1. 6 The clonal nature of bacterial pathogens;
1.7 Regulation of bacterial virulence factors;
1.8 Pathogenicity Islands; Toxigenicity

Unit 2 Pathogenesis of Viral Diseases

2.1 Entry, Contact and Primary Replication;
2.2 Viral Spread and Cell Tropism; Cell Injury and Clinical Illness;
2.3 Host Immune Response;
2.4 Recovery from Infection;
2.5 Virus Shedding

Unit 3 Microbial Mechanisms for Escaping Host Defenses

3.1 Evasion of Host Defenses by Viruses;
3.2 Evasion of Host Defenses by Bacteria;
3.3 Basic principles of the innate and adaptive immune systems
3.4 Evasion of immune response by pathogens
3.5 pathogenic organisms of major public health importance, diseases caused, and their epidemiology.

Text Books/ Reference Books:

1. A.A.Salyers,D.D. Whitt **,Bacterial pathogenesis: Molecular approach,** Washington, D.C.: ASM
2. P.R. Murray, K.S. Rosenthal, and M.A.Pfaller, 2020, Medical microbiology E-book. Elsevier Health Sciences
3. M.Griffiths,2005. Understanding Pathogen Behaviour Virulence, Stress Response and Resistance (Vol. 111). CRC Press
4. T.J.Kindt,R.A.Goldsby, B.A.Osborne, and J. Kuby, 2007. Kuby immunology. Macmillan

Instruction for paper setting: Seven questions are to be set in total. First question will be conceptual and will be compulsory to attempt. Rest of the six questions will cover entire syllabus and consist of two questions from each unit. Student needs to attempt four more questions, selecting at least one question from each unit. Each question will be of 20 marks.

Distribution of Continuous Assessment

Sessional I	**30%**
Sessional II	**30%**
Assignments	**20%**
Class Performance	**10%**
Class Attendance	**10%**

Assessment Tools:
Assignment/Tutorials
Class Performance
Sessional Examinations
End Semester Examination

Course Articulation Matrix

CO (MS-BT-302)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO 1	PSO 2	PSO 3
MS-MB-302.1	3	3	2	2	2	-	-	3	3	2
MS-MB-302.2	3	3	3	3	3	2	2	2	2	1
MS-MB-302.3	3	1	-	2	2	-	-	-	1	1

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES, FARIDABAD

(Deemed to be Uniersity under section 3 of the UGC Act 1956)

MS-MB-303: SYNTHETIC BIOLOGY

Periods/week	Credits	Max. Marks	: 200
L: 3 T: 0	3	Continuous Assessment	: 100
Duration of Ext. Exam: 3 Hrs		End Semester Examination: 100	

Course Outcomes:

MS-MB-303.1: Understanding DNA information pathway and gene regulation, a basic gene regulatory mechanism

MS-MB-303.2: Analyze the function of various components of gene switches and circuits

MS-MB-303.3: Understanding the kinetics and equilibrium associated with metabolic pathways

MS-MB-303.4: Utilize and create the tools required for synthetic biology

Unit 1 Gene Regulation

1.1 Introduction, Structure of Biomolecules (DNA, RNA and protein)
1.2 Gene regulatory mechanisms
1.3 pattern formation via gene signalling
1.4 GMO and Human genome editing
1.5 Current research in synthetic biology, iGEM

Unit 2 Parts, logic and gene circuit logic

2.1 DNA parts, Cloning, piecing DNA together, vector, genome.
2.2 promoter, gene, terminator, enhancer etc. (Gene operon), Transcription factors,
2.3 cells signalling, Basic Logic gates (And, Or, not etc.),
2.4 Constructing logic and memory in gene

Unit 3 Complex circuit Design

3.1 Positive feedback, negative feedback loops,
3.2 Oscillators, toggle switches, Metabolic burden,
3.3 Efficiency in gene networking

Unit 4 Mathematical modelling

4.1 Kinetics, equilibrium,
4.2 Binding affinities,
4.3 Proteomics modelling studies
4.4 DNA database alignment

Unit 5 Tools in synthetic biology

5.1 Different oscillators unsynchronized v.s. quorum sensing synchronized version
5.2 pathways and efficiency
5.3 directed evolution, mutation studies, screening
5.4 pathway engineering and metabolic engineering

Reference Books:

1. P. S. Freemont and R. I. Kitney,2012, Synthetic Biology, A Primer, Imperial College Press, 2012. ISBN: 9781848168633.
2. J. Maynard Smith, Evolution and the Theory of Games, Cambridge University Press. ISBN: 0521288843.

3. P. Dayan and L. F. Abbott, Theoretical Neuroscience: Computational and Mathematical Modeling of Neural systems,The MIT Press. ISBN 0262041995
4. R. Durbin, S. Eddy,A. Krogh and G. Mitchison,1998, Biological Sequence Analysis: Probabilistic Models of Proteins and Nucleic Acids, Cambridge University Press, 1998. ISBN: 9780521629713
5. M. Ptashne A Genetic Switch: Phage Lambda Revisited, Cold Spring Harbor Laboratory Press. ISBN: 9780879697167
6. M. Ptashne, Genes and Signals, Cold Spring Harbor Laboratory Press. ISBN: 97808796963377
7. T. M. Mitchel ,Machine Learning, McGraw-Hill. ISBN: 9780070428072.

Instruction for paper setting: Seven questions are to be set in total. First question will be conceptual and will be compulsory to attempt. Rest of the six questions will cover entire syllabus and consist of two questions from each unit. Student needs to attempt four more questions, selecting at least one question from each unit. Each question will be of 20 marks.

Distribution of Continuous Assessment

Sessional I	**30%**
Sessional II	**30%**
Assignments	**20%**
Class Performance	**10%**
Class Attendance	**10%**

Assessment Tools:
Assignment/Tutorials
Class Performance
Sessional Examinations
End Semester Examination

Course Articulation Matrix

CO Statement (MS-MB-303)	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PS O1	PS O2	PS O3
MS-MB-303.1	3	2	2	1	1	1	2	2	2	2
MS-MB-303.2	2	3	2	1	1	1	2	2	2	2
MS-MB-303.3	3	2	2	1	-	-	2	2	2	2
MS-MB-303.4	3	3	2	-	-	-	2	2	2	2

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES, FARIDABAD

(Deemed to be University under section 3 of the UGC Act 1956)

MS-MB-351: IMMUNO TECHNIQUES LAB

Periods/week	Credits	Max. Marks	: 100
P: 3	1.5	Continuous Assessment	: 50
Duration of Examination: 3 Hrs		End Semester Examination	: 50

Course outcomes:

The students will be able to-

MS-MB-351.1 :Understand animal model anatomy and handling

MS-MB-351.2 : learn blood cell composition and counting of total leukocytes

MS-MB-351.3 : differentiate and identify different types of blood cells

MS-MB-351.4 : perform immuno techniques for the identification of antibody or antigen

List of Experiments:

1. To learn Handling and Anatomy of Mice
2. To study total leukocyte count
3. To Study Different immune cells
4. To Perform Double Diffusion Test
5. To Perform Sigle Radial Immuno Diffusion
6. To Perform DOT ELISA
7. To Performe Sandwich ELISA
8. To Perform Complement Fixation Test
9. To Perform Immunoelectrophoresis
10. To Perform Rocket Immunoelectrophoresis
11. To learn about Immunization Schedule and Adjuvants
12. Vist to Animal Facility to learn animal handling and Tagging.

Text Books/ Reference Books:

1. D.Bernard, B.Dulbecco, Eisen and Ginsberg. 1982.Microbiology including immunology and Molecular Genetics. 3rd Edition
2. I.Roitt ,2006. Essential Immunology. 10th Ed. Blackwell Science.
3. Kuby.2000, Immunology. 4th edition. W. H. Free man & company publication.
4. Ananthanarayan and T Paniker. 2013,ext book of microbiology. University press. 8th edition

Website:

https://www.urmc.rochester.edu/MediaLibraries/URMCMedia/labs/frelinger-lab/documents/Immunology-Lab-Manual.pdf

Distribution of Continuous Assessment

Viva I	**30%**
Viva II	**30%**
File/Record Keeping	**20%**
Class Performance	**10%**
Class Attendance	**10%**

Instructions for Exam: Every student needs to complete 10 experiments in a semester. One experiment out of 10 given randomly needs to be performed in exams.

Course Articulation Matrix

CO MS-MB-351	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO 1	PSO 2	PSO 3
MS-MB-351.1	3	2	1	3	2	1	3	3	1	-
MS-MB-351.2	3	1	2	-	3	2	1	2	-	2
MS-MB-351.3	2	1	3	-	1	3	2	3	1	-
MS-MB-351.4	3	1	2	3	1	2	3	3	2	1

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES, FARIDABAD

(Deemed to be University under section 3 of the UGC Act 1956)

MS-MB-352: SYSTEM BIOLOGY LAB

Periods/week Credits	Max. Marks : 100
L: 0P: 31.5	Continuous Assessment : 50
Duration of Ext. Exam: 3 Hrs	End Semester Examination: 50

Course Type: Core

Course Outcomes:

The students will be able to:
MS-MB-352.1 utilize the techniques involved in synthetic biology
MS-MB-352.2 demonstrate skills in creating biological gates and loops.
MS-MB-352.3 construct protein and gene interaction maps
MS-MB-352.4 construct basic bioparts for synthetic biology

List of Experiments:

1. To identify the components of gene circuit (example of Lac Operon)
2. To characterize and dissect the features of a promoter and gene body
3. To compare positive and negative feedback loops
4. To categorize gene regulatory circuits into gene logic gates
5. To construct a gene and protein-protein interaction network using STRING and CYTOSCAPE.
6. To classify a set of genes using Gene Ontology
7. To identify and characterize common motifs in a given set of sequences
8. To construct a cladogram for gene relatedness
9. To study the kinetics of gene regulation
10. To design a Biobrick

Text Books/ Reference Books:

1. U. Alon,2007, An Introduction to Systems Biology, Chapman and Hall/CRC, 2007. ISBN: 9781584886426.
2. Hamid Bolour ,Computational Modelling Of Gene Regulatory Networks - A Primer, Imperial College Press, 2008. ISBN: 9781848162211.
3. J. D. Murray, Mathematical Biology, by. Springer. ISBN: 0387952284.

Distribution of Continuous Assessment

Viva I	**30%**
Viva II	**30%**
File/Record Keeping	**20%**
Class Performance	**10%**
Class Attendance	**10%**

Instructions for Exam: Every student needs to complete 10 experiments in a semester. One experiment out of 10 given randomly needs to be performed in exams.

CO Statement (MS-MB-352)	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PS O1	PS O2	PS O3
MS-MB-352.1	3	3	2	1	1	2	2	2	2	2
MS-MB-352.2	2	2	3	1	1	2	2	2	2	2
MS-MB-352.3	2	3	2	1	1	2	2	2	2	2
MS-MB-352.4	3	2	2	1	1	2	2	2	2	2

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES, FARIDABAD

(Deemed to be University under section 3 of the UGC Act 1956)

MS-MB- 300: PROJECT PHASE-II

Periods/week Credits	Max. Marks : 300
P: 4 2	Continuous Assessment : 200
Duration of Ext. Exam: 3Hrs	End Semester Examination : 100

Course outcomes:

The students will be able to-

MS-MB- 300.1 identify various methodologies to conduct relevant experiments.

MS-MB- 300.2 customize and design the experiments for accomplishment of the research objectives.

MS-MB- 300.3 collect and assimilate the data through lab/ field experiments.

MS-MB- 300.4 assimilate and critically analyze the data .

MS-MB- 300.5 draw conclusions and inferences from the acquired data to address the research problem.

MS-MB- 300.6 compose a suitable research paper to communicate the research finding to the scientific community.

Every student will have to undertake a research project for minimum 8 hrs per weeks, in the field relevant to Biotechnology. The project will be an extension of Minor Project Phase I and the student will work towards the accomplishment of the objectives set previously and approve/ disapprove the hypothesis that was build at the end of Project Phase I after due literature survey. During this course of time he/she will be regularly monitored and evaluated by the Departmental Project Committee/ Project Supervisor. Continuous monitoring will include Mid Term Review Presentations and Feedback from supervisor. At the end of the Project Phase-II, each student will have to submit the report (hard bound), deliver a presentation pertaining to research work under taken and will have to appear for viva during Internal and End Semester Examination.

Continuous Assessment:

Continuous Performance Review-I	- 40 Marks
Continuous Performance Review-II	- 40 Marks
Presentation	- 50 Marks
Project Report	- 50 Marks
Attendance	- 20 Marks

Course Articulation Matrix

CO (MS-BT-300)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO 1	PSO 2	PSO 3
MS-BT-300.1	3	3	2	3	3	2	3	3	3	3
MS-BT-300.2	2	3	2	3	2	2	3	3	3	3
MS-BT-300.3	1	3	2	3	2	1	3	3	3	3
MS-BT-300.4	1	1	1	1	1	1	2	1	1	3
MS-BT-300.5	3	3	2	3	3	2	3	3	3	3
MS-BT-300.6	1	2	1	1	1	1	1	2	2	2

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES, FARIDABAD

(Deemed to be University under section 3 of the UGC Act 1956)

MS-MB-321: FOOD AND DAIRY MICROBIOLOGY

Periods/week	Credits		Max. Marks	: 200
L: 3 T: 0	3		Continuous Assessment	: 100
Duration of Examination: 3 Hrs			End Semester Examination	: 100

Course Outcomes:

The student will be able to

MS-MB-321.1 describe the role of microorganisms in the production of fermented foods

MS-MB-321.2 identify the role of microorganisms in the food spoilage and causation of the diseases

MS-MB-321.3 summarize and critically discuss current topics of importance in food microbiology including food sanitation, food preservation, detection methods, regulatory issues etc

Unit 1: Fermented food and dairy products.

1.1 Common microorganisms in food. Factors influencing microbial growth in food – intrinsic, extrinsic and implicit.
1.2 Food fermentations- Principles and classification.
1.3 Starter, non-starter cultures in food fermentation.
1.4 Fermentation of wine and beer. Fermented vegetables- sauerkraut, pickle, olives.
1.5 Fermented cereals- bread, idli, dosa, koji. Fermented meat– sausage.
1.6 Fermented fish products.
1.7Other fermented foods- Vinegar, soy sauce. Whey fermentation, SCP
1.8 Dairy microbiology: Physical and chemical properties of milk.
1.9 Microbiological analysis of milk- DMC, SPC, MBRT, Resazurin test, Alkaline phosphatase test.
1.10Fermented Dairy products- Yoghurt, kefir, Acidophilus milk, buttermilk and cheese.
1.11 Probiotics (Lactobacillus, Bifidobacterium) and prebiotics.

Unit 2: Food spoilage and preservation:

2.1 General principles underlying food spoilage.
2.2 Spoilage of meat, fish, egg, milk, vegetables, fruits and stored grains.
2.3 Spoilage at low temperature.
2.4 Spoilage of canned food. Principles of food preservation.
2.5 Food preservation by physical methods- high and low temperature, drying, freezing, irradiation and high pressure.
2.6 Food preservation by chemical methods- characteristics of food preservatives.
2.7 Class I and class II preservatives.
2.8 Modern food preservation techniques- high electronic field pulses, oscillating magnetic fields pulses, intense light pulses and ultra high hydrostatic pressure

Unit 3: Food poisoning Food hygiene, regulation and standards:

3.1 Food borne Bacterial infections- Salmonella, Staphylococcus, Listeria, Brucella, Bacillus, Clostridium, Escherichia.
3.2 Food borne Fungal infections– Aflatoxins and ergotism.
3.3 Food borne Viral infections- Hepatitis, Bovine Spongiform encephalopathy.
3.4 Detection of food pathogens
3.5 Food sanitation. Food control agencies and their regulations.

3.6 Codes for GMP.
3.7 HACCP and FSO Systems for food safety.

Text Books/Reference Books:

1. J.M.Jay,2005, Modern Food Microbiology: VNR Publication, New York.
2. M.R.Adams,2008, Food Microbiology: Royal Society of Chemistry, Publication.
3. N.M.Potter, 2007,Food Science: The AVI Publishing Co, Westport Connecticut, USA.

Instruction for paper setting: Seven questions are to be set in total. First question will be conceptual and will be compulsory to attempt. Rest of the six questions will cover entire syllabus and consist of two questions from each unit. Student needs to attempt four more questions, selecting at least one question from each unit. Each question will be of 20 marks.

Distribution of Continuous Assessment

Sessional I	**30%**
Sessional II	**30%**
Assignments	**20%**
Class Performance	**10%**
Class Attendance	**10%**

Assessment Tools:
Assignment/Tutorials
Class Performance
Sessional Examinations
End Semester Examination

Course Articulation Matrix

CO (MS-MB-321)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO 1	PSO 2	PSO 3
MS-MB-321.1	3	3	-	-	-	-	-	2	2	2
MS-MB-321.2	3	3	-	-	-	-	-	2	2	2
MS-MB-321.3	3	3	1	1	1	1	1	2	2	2

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES, FARIDABAD

(Deemed to be University under section 3 of the UGC Act 1956)

MS-BT-321: GENOMICS AND PROTEOMICS

Periods/week	Credits		Max. Marks	: 200
L: 3 T: 0	3		Continuous Assessment	: 100
Duration of Examination: 3 Hrs			End Semester Examination	: 100

Course Outcomes:

The student will be able to

MS-BT-321.1 describe the basic structures of proteins, its domains and mechanism of folding.

MS-BT-321.2 explain use of computer simulations and knowledge-based methods in the design process.

MS-BT-321.3 understand the genome organisation

MS-BT-321.4 study different sequencing platforms, human genome project and metagenomes.

MS-BT-321.5 familiar with the various techniques in Genomics & Proteomics.

MS-BT-321.6 apprise the validation of biological experiments through functional genomics/proteomic techniques

Unit 1: Proteomics

1.1 Protein structure, secondary structure and super-secondary structure.

1.2 Mechanisms of protein folding, tertiary folds.

1.3 Relationship between protein structure and function.

1.4 Prions.

1.5 Structure prediction and human proteomics.

1.6 Mutant proteins.

1.7 Use of computer simulations and knowledge-based methods in the design process.

1.8 De-novo design; making use of databases of sequence and structure.

1.9 2D analysis of cell protein.

1.10 Analysis and sequencing individual spots by Mass spectrometry (Malditoff) and protein microarrays.

Unit 2: Genomics

2.1 Organization of genomes: main features of prokaryotic and eukaryotic genome organization. C value paradox, organelle genomes.

2.2 Strategies for genome sequencing: Chain termination method, automated sequencing, pyro-sequencing, virtual terminator sequencing.

2.3 Sequence assembly and different approaches.

2.4 Human genome project and its applications.

2.5 Physical and genetic maps.

2.6 Locating the genes: ORF scanning, homology searches.

Unit 3: Techniques in Genomics & Proteomics

3.1 Determination of the functions of genes: gene inactivation (knock-out, anti-sense and RNA interference) and gene over expression.

3.2 Approaches to analyze global gene expression: Transcriptome, Serial Analysis of Gene Expression (SAGE), Expressed Sequence Tags (ESTs), Massively Parallel Signature Sequencing (MPSS), microarray and its applications, gene tagging, CRISPER-CAS.

3.3 Metagenomics: Prospecting for novel genes from metagenomes and their biotechnological applications.

Text Books/Reference Books:

1. Genomics and Proteomics: Functional and Computational Aspects, Sándor Suhai; 1st Edition; (2000); Springer Publication.
2. Bioinformatics, Genomics and Proteomics: Ann Finney Batiza Ph.D.; (2005); Chelsea House Publications.
3. From genomics to proteomics: Tyers M, Mann M; (2003); Nature Publications.
4. Evolutionary Genomics and Proteomics, Mark Pagel and Andrew Pomiankowski.; 1st Edition; (2007); Sinauer Associates Inc. Publications, U.S.A.
5. Genes and Genomes, M. Singer and P. Berg; 1st Edition; (1991); University Science Press Publication.
6. Genes IX, B. Lewin; 9th Edition; (2007); Pearson Prentice Hall Publications.

Instruction for paper setting: Seven questions are to be set in total. First question will be conceptual and will be compulsory to attempt. Rest of the six questions will cover entire syllabus and consist of two questions from each unit. Student needs to attempt four more questions, selecting at least one question from each unit. Each question will be of 20 marks.

Distribution of Continuous Assessment

Sessional I	**30%**
Sessional II	**30%**
Assignments	**20%**
Class Performance	**10%**
Class Attendance	**10%**

Assessment Tools:
Assignment/Tutorials
Class Performance
Sessional Examinations
End Semester Examination

Course Articulation Matrix

CO (MS-BT-321)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO 1	PSO 2	PSO 3
MS-BT-321.1	3	3	-	2	2	-	-	2	2	2
MS-BT-321.2	3	3	-	3	3	2	2	2	2	1
MS-BT-321.3	3	1	-	2	2	-	-	-	1	1
MS-BT-321.4	3	3	-	2	2	2	2	2	2	1
MS-BT-321.5	3	3	-	2	2	3	2	2	1	2
MS-BT-321.6	3	3	-	2	2	3	2	2	1	1

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES, FARIDABAD

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MS-BT-324: STEM CELL & REGENERATIVE MEDICINE

Periods/week Credits	Max. Marks : 200
L: 3 T:0 3	Continuous Assessment : 100
Duration of Examination: 3 Hrs	End Semester Examination : 100

Course Outcome:

The students will be able to-

MS-BT-324.1 remember the basics of stem cells.
MS-BT-324.2 describe the different aspects of developmental biology with stem cells.
MS-BT-324.3 differentiate between various types of stem cells and mapping techniques.
MS-BT-324.4 analyze the different molecular mechanisms of stem cells.
MS-BT-324.5 Evaluate the various signaling pathways in stem cells.
MS-BT-324.6 Propose novel strategies and solutions in regenerative medicine and the IPR issues.

Unit 1: Basics of Stem cells

1.1 Stem cells: Introduction and properties.
1.2 Types of stem cells: ES cells, HSC cells.
1.3 Mesenchymal stem cells, Adult stem cells.
1.4 Stem cell niches.
1.5 Fate Mapping.

Unit 2: Molecular Mechanisms of Stem Cells

2.1 Molecular basis of Pluripotency and Self-Renewal.
2.2 Epigenetics Modification.
2.3 Notch Signalling.
2.4 Hedgehog signalling.
2.5 Signalling in cancer stem cells.

Unit 3: Regenerative Medicine

3.1 Stem cells in Nervous system repairing: Parkinson's Disease.
3.2 Stem cells in Cardiac repair.
3.3 Strategies to treat Diabetes.
3.4 IPR issues in stem cell and regenerative medicine.

Text Books/Reference Books:

1. Molecular Biology of the Cell, Bruce Alberts, Dennis Bray, Julian Lewis, Martin Raff, Keith Roberts, James D. Watson; 3rd Edition; (1994); Garland Publication.
2. Essential of stem cell biology: Editors - Robert Lanza et al, 3rd Edition; (2013); Elsevier Science & Technology Books Publication.
3. Hematology: William J. Williams, Ernest Beutler, Allan JU. Erslev, Marshall A. Lichtman; 5th Edition; (1995); McGraw Hill Professional Publication.
4. Stem Cell Biology: Marshak; (2001); Cold Spring Harbar Symposium Publication.
5. Stem Cell Handbook (2003): S. Sell Ed.; 2nd Edition; (2013); Springer-Verlag Berlin Heidelberg.
6. Stem Cell and Future Regenerative Medicines; 1st Edition; (2002); National Academy Press Publication, Washington D.C.

Instruction for paper setting: Seven questions are to be set in total. First question will be conceptual and will be compulsory to attempt. Rest of the six questions will cover entire syllabus and consist of two questions from each unit. Student needs to attempt four more questions, selecting at least one question from each unit. Each question will be of 20 marks.

Distribution of Continuous Assessment

Sessional I	**30%**
Sessional II	**30%**
Assignments	**20%**
Class Performance	**10%**
Class Attendance	**10%**

Assessment Tools:
Assignment/Tutorials
Class Performance
Sessional Examinations
End Semester Examination

Course Articulation Matrix

CO (MS-BT-324)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO 1	PSO 2	PSO 3
MS-BT-324.1	3	3	-	-	-	-	-	2	1	2
MS-BT-324.2	3	3	-	-	-	-	-	1	1	2
MS-BT-324.3	3	3	-	2	-	-	-	1	1	2
MS-BT-324.4	3	3	-	1	-	-	1	2	2	2
MS-BT-324.5	3	3	-	-	-	-	1	1	1	1
MS-BT-324.6	3	3	-	-	2	-	2	1	2	2

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES, FARIDABAD

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MS-PROJ-400: DISSERTATION

Periods/week	Credits	Max. Mark	: 500
Duration: 24 weeks	16	Continuous Assessment	: 300
Duration of Examination: 3 Hrs		End Semester Examination	: 200

Course outcomes:

The students will be able to-

MS-PROJ-400.1 survey and review relevant previous work literature to identify the research gaps.

MS-PROJ-400.2 formulate a meaningful and worthwhile research problem that is necessary to bridge the research gap as identified through literature survey.

MS-PROJ-400.3 identify and apply appropriate methodologies to address the research objectives.

MS-PROJ-400.4 work collaboratively with other researchers, demonstrating effective communication and problem-solving skills.

MS-PROJ-400.5 demonstrate the responsible conduct of research with high degree of ethics and standards.

MS-PROJ-400.6 present the research effectively in a conference setting and a written publication.

The dissertation is aimed to train a postgraduate student in research. This subject is divided into two parts, as follows:

I) Submission and approval of dissertation proposal:

The student shall submit dissertation proposal under the guidance of supervisor nominated by Head of the respective Department to the Program Co-coordinator and shall make a presentation before a committee, called Departmental Dissertation Committee (DDC), recommended by concerned Head of Department and approved by Dean Faculty of Engineering and Technology. The student may also have co-supervisor (Internal or External) with the permission of concerned Head of Department. The student shall carry out the dissertation in the fourth semester if the topic is approved by the DDC. The DDC may also reject the proposal if not found feasible and in such case, he /she shall submit the revised proposal.

II) Dissertation Work:

The student shall carry out his/her dissertation work on the approved topic under the faculty supervisor. The DDC would sequentially conduct two mid-term progress review meetings during the semester. Each student pursuing dissertation work shall be expected to make a power-point presentation, documenting the progress/ developments made pertaining to the work, having valid references with approval from authorized supervisor. Submission of Dissertation shall include hard bound copies (3) of the thesis and soft copy of thesis and final presentation.

The overall evaluation scheme for the Dissertation will be as follows-

Internal Evaluation-

1.	Mid Term Review- I	:	100 marks
2.	Mid Term Review- II	:	100 marks
3.	Feedback from Supervisor	:	100 marks
	TOTAL	**:**	**300 marks**

External Evaluation-

1.	Dissertation Report	:	100 marks

2. Presentation : 50 marks
3. Viva : 50 marks
TOTAL : 200 marks

Course Articulation Matrix

CO (MS-BT-400)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO 1	PSO 2	PSO 3
MS-BT-400.1	3	3	-	2	-	1	1	2	2	2
MS-BT-400.2	3	3	-	-	-	1	1	2	2	2
MS-BT-400.3	2	2	-	3	-	-	1	2	2	2
MS-BT-400.4	2	2	3	-	-	-	2	1	3	3
MS-BT-400.5	1	1	2	-	3	1	3	2	1	3
MS-BT-400.6	2	1	-	1	1	-	3	1	1	1