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

BIOTECHNOLOGY

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 Biotechnology being offered at 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 33.03 of 33rd AC held on 21st April, 2020, and changes, if any deemed appropriate, shall be duly incorporated after the necessary approval by the Academic Council.

This Curriculum and Scheme of Examination of M.Sc Biotechnology shall be implemented w.e.f. AY 2023-24.

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

Preamble

The program M.Sc in Biotechnology is adapted to an outcome based education system which would enable the students to acquire the capabilities to meet the demands of society and industry at regional, national and global level. The Program Education Objectives (PEOs) of M.Sc in Biotechnology are consistent with the Vision and Mission of the Department as well as the University, and aim to produce globally successful biotechnologists who are empowered to contribute to nation building through sound knowledge, technical skills and research aptitude. The POs and PSOs address the PEOs and aim to produce innovators, scientists, entrepreneurs and technocrats with high professional and social ethics and who are aware about the socio-ethical implications of Biotechnology so that the products and processes related to the field can be utilized for the benefit of mankind.

The design of curriculum is done in accordance with the predetermined Program Education Objectives. The syllabus content of each course is meticulously created to develop thorough understanding and gain in-depth knowledge in the subject. A number of theory courses are accompanied with laboratory courses to inculcate the practical skills. In order to ensure the effectiveness of teaching-learning process and true implementation of the curriculum, the course outcomes of each course are developed to meet the program outcomes and program specific outcomes, which are also reflected in the Course Articulation Matrix. Course outcome and program outcome attainment is measured through direct and indirect tools including continuous evaluation, assignments, end semester examinations, dissertations and projects etc. The curriculum incorporates Choice based credit system (CBCS) in which the students are free to opt elective courses from the proposed baskets of subjects.

Although the curriculum had been designed after thorough deliberations involving experts from academia and industry, and considering the feedbacks obtained from various stakeholders, there is always a scope of regular revision and updation of the syllabus keeping in view the changing needs of the industry and society. Thus a well- articulated process is followed to revise the curriculum from time to time. The process begins with obtaining feedbacks from various stakeholders i.e. students, faculty, alumni, parents and industry experts. The feedbacks are analyzed and relevant suggestions are incorporated in the curriculum through a Curriculum revision workshop under the supervision of Departmental Academic Committee (DAC). The revised curriculum is scrutinized by the Board of Studies (BOS) and suggestions of the BOS are also incorporated. The revised curriculum is then placed before the Board of Faculty for consideration which is further reviewed and approved by the Academic Council.

The curriculum exhibits the requisite balance among the fundamental, core and elective subjects. This is to create a Biotechnology student talent pool that can serve the need of the Indian as well as global industry. The curriculum includes courses focusing on employability, entrepreneurship and skill development and courses that are meant to create awareness about the environment and sustainability and inculcate professional ethics so that all round development of students is ensured and they are transformed into entrepreneurs and professionals with high values and ethics.

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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 Biotechnology

PROGRAM EDUCATIONAL OBJECTIVES (PEO)

1. To develop the capability to work as biotechnology 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)

1. Critical Thinking: Take informed actions after identifying the assumptions that frame our thinking and actions, checking out the degree to which these assumptions are accurate and valid, and looking at our ideas and decisions (intellectual, organizational, and personal) from different perspectives.

2. Effective Communication: Speak, read, write and listen clearly in person and through electronic media in English and in one Indian language, and make meaning of the world by connecting people, ideas, books, media and technology.

3. Social Interaction: Elicit views of others, mediate disagreements and help reach conclusions in group settings.

4. Effective Citizenship: Demonstrate empathetic social concern and equity centered national development, and the ability to act with an informed awareness of issues and participate in civic life through volunteering.

5. Ethics: Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them.

6. Environment and Sustainability: Understand the issues of environmental contexts and sustainable development.

7. Self-directed and Life-long Learning: Acquire the ability to engage in independent and life-long learning in the broadest context socio-technological changes.

PROGRAMME SPECIFIC OUTCOMES (PSOs)

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

2. Enable the students to develop innovative technologies for betterment of our nation and our earth.

3. Recognize the importance of bioethics, IPR, entrepreneurship, communication and management skills so as to usher next generation of Indian industrialists.

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	2	3	3	3	3	2	3	3
2	3	3	3	3	3	3	3	3	3	3
3	3	3	3	3	3	3	3	3	3	2

M. Sc in Biotechnology

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- Biotechnology, 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.

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SCHEME OF STUDIES

M.Sc IN BIOTECHNOLOGY 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-BT-103	Biomolecules	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-BT-201	Genetic Engineering & Applicatior	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	3	0	0	3	100	100	200	3 hrs.	3
Core	MS-BT-251	Genetic Engineering Lab	0	0	3	3	50	50	100	3 hrs.	1.5
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-BT-200	Project Phase-I	0	0	4	4	50	50	100		2
TOTAL	**TOTAL**		**9**	**0**	**12**	**21**	**500**	**500**	**1000**	**0**	**15**
Elective Courses*											
Elective	MS-BT-221	Bioethics, Biosafety & IPR	3	0	0	3	100	100	200	3 hrs.	3
Elective	MS-BT-222	Immunology	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-BT-224	Biofertilizer and Biopesticide	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-BT-301	Plant Biotechnology	3	0	0	3	100	100	200	3 hrs.	3
Core	MS-BT-302	Environment Biotechnology	3	0	0	3	100	100	200	3 hrs.	3
Core	MS-BT-303	Food & Enzyme Biotechnology	3	0	0	3	100	100	200	3 hrs.	3
Core	MS-BT-351	Cell & Tissue Culture Lab	0	0	3	3	50	50	100	3 hrs.	1.5
Core	MS-BT-352	Environment Biotechnology Lab	0	0	2	2	50	50	100	3 hrs.	1
Core	MS-BT-353	ood & Enzyme Biotechnology Lab	0	0	3	3	50	50	100	3 hrs.	1.5
Project	MS-BT-300	Project Phase-II	0	0	4	4	200	100	300		2
TOTAL	**TOTAL**		**9**	**0**	**12**	**21**	**650**	**550**	**1200**		**15**
Elective Courses*											
Elective	MS-BT-321	Genomics and Proteomics	3	0	0	3	100	100	200	3 hrs.	3
Elective	MS-BT-322	Animal Biotechnology	3	0	0	3	100	100	200	3 hrs.	3
Elective	MS-BT-323	Nanobiotechnology	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-BT-400	Dissertation	Minimum 20 weeks				300	200	500		16
TOTAL	**TOTAL**								**500**		**16**
Elective Courses*											
Elective	MS-BT-421	Metabolic Engineering	3	0	0	3	100	100	200	3 hrs.	3
Elective	MS-BT-422	Clinical Research & Database Management	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.											

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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: Richard R Sinden, 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.

Web links:
http://nptel.ac.in/courses/102106025/

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	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-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.

Web links:

http://nptel.ac.in/courses/102103015/

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-BT-103: BIOMOLECULES

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-103.1 describe the molecular structures of basic biomolecules.
MS-BT-103.2 paraphrase the hierarchical organization of complex biomolecules.
MS-BT-103.3 illustrate the anabolic and catabolic pathways of various biomolecules.
MS-BT-103.4 appraise the significance of enzymes in metabolism of all the biomolecules.
MS-BT-103.5 derive various enzyme kinetic parameters based on equations and graphs.
MS-BT-103.6 evaluate the energy use and yield from the anabolism or catabolism of a biomolecule under different physiological circumstances.

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: Nutrition, Vitamins and Hormones

2.1 Hormones – chemistry, mechanism of action and physiological effects.
2.2 Nutrition and food assimilation.
2.3 Macronutrients and micronutrients.
2.4 Vitamins and trace elements.

Unit 3: Metabolism

3.1 Enzymes, coenzymes, metabolism of carbohydrate.
3.2 amino acids and lipids, in born errors of metabolism.
3.3 Bio-energetics and oxidative phosphorylation.
3.4 Blood clotting – biochemistry, body fluids – pH and acid base balance and their importance in clinical biochemistry.

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.

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

Course Articulation Matrix

CO (MS-BT-103)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO 1	PSO 2	PSO 3
MS-BT-103.1	2	2	-	-	-	-	-	2	2	1
MS-BT-103.2	3	3	2	1	1	2	1	2	2	1
MS-BT-103.3	3	3	2	2	2	2	1	2	2	2
MS-BT-103.4	3	3	3	3	2	3	2	2	2	2
MS-BT-103.5	3	3	3	3	2	3	2	3	3	3
MS-BT-103.6	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	-	-	-	-	-	2	2	1
MS-BT-104.2	3	3	2	1	1	2	1	2	2	1
MS-BT-104.3	3	3	2	2	2	2	1	2	2	2
MS-BT-104.4	3	3	3	3	2	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	3	2	3	2	3	3	3

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES, FARIDABAD

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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

Weblinks:
http://nptel.ac.in/courses/111101004/
http://nptel.ac.in/courses/111105090/

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	2	1
MS-BT-105.2	3	3	2	1	1	2	1	2	2	1
MS-BT-105.3	3	3	2	2	2	2	1	2	2	2
MS-BT-105.4	3	3	3	3	2	3	2	2	2	2
MS-BT-105.5	3	3	3	3	2	3	2	3	3	3
MS-BT-105.6	3	3	3	3	2	3	2	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	**60%**
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	3	2	-	3	3	1	2	-
MS-BT-151.2	3	3	1	-	-	3	3	-	-	-
MS-BT-151.3	3	3	1	2	-	3	3	-	-	1
MS-BT-151.4	3	3	-	-	-	3	3	2	-	-
MS-BT-151.5	3	3	1	-	-	3	3	-	3	-
MS-BT-151.6	3	3	1	-	-	3	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	**60%**
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	-	-	3	3	2
MS-BT-152.2	3	3	3	3	3	2	2	2	2	1
MS-BT-152.3	3	1	-	2	2	-	-	-	1	1
MS-BT-152.4	3	3	2	2	2	2	2	2	2	1
MS-BT-152.5	3	3	2	2	2	3	2	2	1	-
MS-BT-152.6	3	3	2	2	2	3	2	2	1	-

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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	**60%**
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	3	2	-	3	3	1	-	2
MS-BT-153.2	3	3	1	-	-	3	3	-	-	-
MS-BT-153.3	3	3	1	2	-	3	3	2	1	-
MS-BT-153.4	3	3	-	-	-	3	3	-	1	-
MS-BT-153.5	3	3	1	-	-	3	3	2	-	1
MS-BT-153.6	3	3	-	2	-	3	3	1	-	-

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	3	2	-	3	3	1	2	-
MS-BT-154.2	3	3	1	-	-	3	3	-	1	-
MS-BT-154.3	3	3	1	2	-	3	3	1	-	2
MS-BT-154.4	3	3	-	-	-	3	3	2	1	-
MS-BT-154.5	3	3	1	-	-	3	3	-	2	-
MS-BT-154.6	3	3	-	2	-	3	3	1	-	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

Course Outcomes: The students would be able to-
MS-BT-100.1 assimilate the relevant information from various sources
MS-BT-100.2 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 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	2	3	3	2	3	3	3	3
MS-BT-100.2	2	3	2	3	2	2	3	3	3	3
MS-BT-100.3	1	3	2	3	2	1	3	3	3	3
MS-BT-100.4	1	1	1	1	1	1	2	1	1	3
MS-BT-100.5	3	3	2	3	3	2	3	3	3	3
MS-BT-100.6	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-201: GENETIC ENGINEERING & APPLICATIONS

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-201.1 understand the various tools and techniques in recombinant DNA technology.

MS-BT-201.2 explain and classify the various tools and techniques in Recombinant DNA Technology

MS-BT-201.3 identify and select the techniques for genetic engineering.

MS-BT-201.4 compare and contrast the characteristics related to different types of tools and techniques employed in creating a recombinant molecule.

MS-BT-201.5 apply knowledge of genetic engineering tools and technologies in current applications of biotechnology.

MS-BT-201.6 employ their creative potential in investigating and developing new ideas in genetic engineering based projects.

Unit 1: Molecular Tools for Genetic Engineering

1.1 Nucleases.
1.2 Methylases.
1.3 Polymerases.
1.4 Ligases.
1.5 Topoisomerases.
1.6 End Modifying Enzymes.
1.7 Vectors and Gene Cloning.

Unit 2: Advanced Techniques in Molecular Cloning

2.1 AGE, Blotting.
2.2 PCR.
2.3 Gene Transfer Technologies.
2.4 Construction of DNA Libraries.
2.5 DNA Sequencing.
2.6 Protein Engineering.
2.7 DNA Protein Interactions, Protein-Protein Interactions.
2.8 Reporter Gene Assays, DNA Foot-printing.

Unit 3: Recent Trends in Genetic Engineering

3.1 Targeted Genome Editing.
3.2 Gene Targeting- Knock Ins and Knock outs.
3.3 DNA Fingerprinting.

3.4 Genetic Engineering to Bioengineering.
3.5 Genetic Engineering as Commercial venture.
3.6 Genetic Engineering and Public Concern: Transgenic Technologies and Ethics.

Text Books/ Reference Books:

1. Principles of Gene manipulation, An introduction to Genetic engineering: Old RW, Primrose SB, 7th Edition; (2014); Blackwell Scientific Publications.
2. Gene Cloning: T.A. Brown; 7th Edition; (2016); Wiley Blackwell Publication.
3. Recombinant DNA: J.D.Watson et al; 3rd Edition; (2008); W.H. Freeman and Company Publication.
4. Current protocols in Molecular Biology: Ansubel FM., Brent A, Kingston AE, Moore DO; 1st Edition; (1987); Greene Publishing Associates, NY.
5. Molecular Cell Biology: Gerald Carp, 5th Edition; (2007); John Wiley & Sons Inc.
6. Molecular Biotechnology: Principles Application of Recombinant DNA - Bernard R Glick and Jack J. Pasternak; 3rd Edition; (1905); ASM Press Publication, Washington DC.

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-201)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO 1	PSO 2	PSO 3
MS-BT-201.1	3	3	2	2	2	-	-	3	3	2
MS-BT-201.2	3	3	3	3	3	2	2	2	2	1
MS-BT-201.3	3	1	-	2	2	-	-	-	1	1
MS-BT-201.4	3	3	2	2	2	2	2	2	2	1
MS-BT-201.5	3	3	2	2	2	3	2	2	1	-
MS-BT-201.6	3	3	2	2	2	3	2	2	1	-

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	Max. Marks : 200
Duration of Examination: 3 Hrs			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

3.1 Cell separation.
3.2 Cell Disruption.
3.3 Concentration methods.
3.4 Chromatographic methods.
3.5 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	2	2	2	-	1	2	2	3	3	2
MS-BT-202.2	1	1	-	2	2	-	-	2	1	1
MS-BT-202.3	2	1	2	2	2	2	2	2	2	1
MS-BT-202.4	1	2	2	2	2	1	2	2	1	2
MS-BT-202.5	1	1	2	2	2	2	2	2	1	1
MS-BT-202.6	2	1	2	2	2	2	2	2	1	1

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	Max. Marks : 200
Duration of Examination: 3 Hrs			Continuous Assessment : 100
			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	-	-	3	2	2
MS-BT-203.2	3	2	1	1	2	-	-	3	2	1
MS-BT-203.3	2	3	1	2	2	1	-	3	2	1
MS-BT-203.4	3	3	1	2	2	1	1	3	2	1
MS-BT-203.5	3	3	1	2	2	-	1	3	2	-
MS-BT-203.6	3	3	1	2	2	-	1	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-251: GENETIC ENGINEERING 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-251.1 know different techniques in genetic engineering.

MS-BT-251.2 apply their subject knowledge for practical solution to the given problem.

MS-BT-251.3 acquire skills in analysis, quantification and manipulation of biomolecules for different applications.

MS-BT-251.4 acquire skills for planning experiments.

MS-BT-251.5 analyse data and present results.

MS-BT-251.6 know about quality, safety and ethical considerations about working in a laboratory.

List of Experiments:

1. Isolation of genomic DNA from the target organism
2. Plasmid isolation from the host.
3. Preparation of the vector for cloning
4. To observe the ligation of target gene in vector
5. To perform the Competent cell preparation
6. To perform the transformation of ligated construct.
7. Induction of the target gene expression in the clone using IPTG
8. To screen the cloned colonies using Blue/White screening method
9. To learn the technique of conjugation
10. To study and perform the technique of Northern blotting.
11. To study and perform the technique of Southern blotting.
12. To learn Restriction Mapping.

Distribution of Continuous Assessment

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

Reference Books:

1. Molecular Cloning- A Laboratory Manual: J. Sambrook and D.W. Russell; 4th Edition; (2013); Cold Spring Harbor Laboratory Press Publication, New York

Course Articulation Matrix

CO (MS-BT-251)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO 1	PSO 2	PSO 3
MS-BT-251.1	1	1	-	1	-	1	-	2	2	1
MS-BT-251.2	1	1	1	1	-	1	-	3	2	2
MS-BT-251.3	1	1	-	2	-	-	-	2	1	1
MS-BT-251.4	1	1	2	2	2	2	1	2	2	1
MS-BT-251.5	1	1	2	2	2	2	1	2	2	1
MS-BT-251.6	1	1	2	2	2	3	2	2	1	2

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES, FARIDABAD

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

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	1	-	-	2	2	2
MS-BT-252.2	2	2	2	2	1	-	1	3	3	3
MS-BT-252.3	2	2	2	2	1	-	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	1	-	1	2	2	1

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES, FARIDABAD

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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	3	3	3	2	2
MS-BT-253.2	3	3	1	-	1	3	3	1	-	2
MS-BT-253.3	3	3	1	2	2	3	3	1	1	2
MS-BT-253.4	3	3	-	-	1	3	3	1	1	2
MS-BT-253.5	3	3	1	-	3	3	3	1	1	2
MS-BT-253.6	2	2	-	-	1	3	3	1	1	2

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES, FARIDABAD

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

MS-BT- 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-BT- 200.1 survey relevant research literature.
MS-BT- 200.2 learn to communicate effectively.
MS-BT- 200.3 assimilate the purpose of research through literature survey.
MS-BT- 200.4 acquire ability to identify the gaps in research.
MS-BT- 200.5 appraise the importance of ethics in research.
MS-BT- 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-BT-200.1	3	3	2	3	3	2	3	3	3	3
MS-BT-200.2	2	3	2	3	2	2	3	3	3	3
MS-BT-200.3	1	3	2	3	2	1	3	3	3	3
MS-BT-200.4	1	1	1	1	1	1	2	1	1	3
MS-BT-200.5	3	3	2	3	3	2	3	3	3	3
MS-BT-200.6	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-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	--	--	--	--	--	--	2	--
MS-BT-221.2	--	--	--	--	--	--	1	1	--	--
MS-BT-221.3	--	--	1	--	1	1	--	--	--	1
MS-BT-221.4	--	--	--	--	--	--	--	1	2	--
MS-BT-221.5	--	--	--	--	1	--	--	--	1	--
MS-BT-221.6	--	--	--	--	--	--	--	--	1	--

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES, FARIDABAD

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

MS-BT-222: IMMUNOLOGY

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-222.1 recall the general concepts of the immune system.

MS-BT-222.2 differentiate different types of immune cells, immunities and chemical aspects of immunology.

MS-BT-222.3 compare and contrast different immune mechanisms the knowledge of immune response.

MS-BT-222.4 infer the role of different immune-modulatory agents.

MS-BT-222.5 summarize the links between different infections and the immunity.

MS-BT-222.6 apply the concepts of immunology in different techniques.

Unit 1: Overview of Immune System

1.1 Introduction, Cells and Organs of the Immune System: B & T-Iymphocytes, Macrophages, Dendritic cells, Natural killer. Eosinophils, Neutrophils and Mast Cells.

1.2 Innate and acquired immunity.

1.3 Antigens and immunogens.

1.4 Polyclonal vs monoclonal antibodies.

1.5 Antibody structure and function.

Unit 2: Immune response Mechanisms

2.1 Major histocompatibility complex.

2.2 Complement system.

2.3 Antigen processing and presentation.

2.4 Generation of humoral and cell mediated immune responses.

2.5 Antibody diversity.

2.6 Cytokines and their receptors: T-cell regulation.

2.7 Immunological tolerance, Cell - mediated cytotoxicity.

2.8 Mechanism of T cell and NK cell mediated lysis.

Unit 3: Immune Diseases

3.1 Hypersensitivity.

3.2 Autoimmunity.

3.3 Transplantation.

3.4 Immunity to infectious agents (interacellular parasites, heleminthes& viruses).

3.5 Tumor Immunology.
3.6 AIDS and other Immunodeficiency diseases.
3.7 Antigen - antibody interactions: Principles and Applications.

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. Immunology A Short Course Coico R, Sunshine G; 7th Edition; (2015); WILLEY Balckwell Publication
4. Fundamentals of Immunology Paul W.E. (Eds); 7th Edition; (2012), LWW Publisher, New York.
5. Antibodies A laboratory Manual Greenfield EA; 2nd Edition; (2013); Cold spring harbor laboratory Publication.
6. Prescott's Microbiology Willey J, Sherwood L, Woolverton CJ; 9th Edition; (2013); McGraw-Hill Education

Websites:
https://www.immunopaedia.org.za/immunology/basics/

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-222)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO 1	PSO 2	PSO 3
MS-BT-222.1	2	3	2	2	3	-	-	3	2	2
MS-BT-222.2	3	2	1	1	2	-	-	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	-
MS-BT-222.6	3	3	1	2	2	-	1	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-223: HUMAN GENOME

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-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	2	2	2	-	3	3	1
MS-BT-223.2	2	2	2	2	2	2	-	3	3	1
MS-BT-223.3	3	2	2	2	2	1	1	2	2	2
MS-BT-223.4	3	2	2	2	2	1	1	2	2	2
MS-BT-223.5	1	2	2	2	2	2	-	2	2	2
MS-BT-223.6	2	2	2	2	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-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	2	2	2	-	3	3	1
MS-BT-224.2	2	2	2	2	2	2	-	3	3	1
MS-BT-224.3	3	2	2	2	2	1	1	2	2	2
MS-BT-224.4	3	2	2	2	-	1	1	2	2	2
MS-BT-224.5	3	3	1	2	2	-	-	2	2	2
MS-BT-224.6	3	2	2	2	2	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-301: PLANT BIOTECHNOLOGY

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-301.1 develop the understanding of general techniques and applications of plant tissue culture.

MS-BT-301.2 get familiarized with the techniques that will be used for haploid production and hybridization of various plants.

MS-BT-301.3 explain what a transgenic plants is, how they are created, and their uses.

MS-BT-301.4 illustrate different techniques for growth promotion of cultured tissues/plant.

MS-BT-301.5 apply the knowledge of tools of molecular biology and biotechnology for the improved production and protection of plants, plant products.

MS-BT-301.6 develop the understanding of different types of stresses and how transgenic technology can be used to overcome them.

Unit 1: Plant Tissue Culture

1.1 Introduction to Cell and Tissue Culture.

1.2 Embryo culture and embryo rescue.

1.3 Protoplast isolation.

1.4 Culture and fusion.

1.5 Selection of hybrid cells and regeneration of hybrid plants.

1.6 Symmetric and asymmetric hybrids, cybrids.

1.7 Anther, pollen and ovary culture for production of haploid plants and homozygous lines.

1.8 Cryopreservation and DNA banking for germ plasm conservation.

Unit 2: Plant Transformation Technology

2.1 Basis of tumor formation.

2.2 Hairy root features of Ti and Ri plasmids.

2.3 Mechanisms of DNA transfer

2.4 Role of virulence genes, use of Ti and Ri as vectors,

2.5 Binary vectors, viral vectors,

2.6 Vectors-less or direct DNA transfer- particle bombardment, electroporation, microinjection.

Unit 3: Plant Transformation

3.1 Application of Plant Transformation for productivity and performance: Herbicide resistance.
3.2 Insect resistance, virus resistance, disease resistance, abiotic stress, post-harvest losses.
3.3 Long shelf life of fruits and flowers.
3.4 RFLP, RAPD markers, microsatellites.

Text Books/Reference Books:

1. Plant Tissue culture: Theory and Practice: S.S. Bhojwani and M.K. Razdan; 5th Edition; (2003); Elsevier Science Publication, Netherlands.
2. Introduction to Plant Biotechnology: H.S Chawla, 3rd Edition; (2020); Oxford and IBH Publishing Co. Pvt Ltd. New Delhi
3. Molecular Biotechnology: Principles and Applications of recombinant DNA: Bernard R Glick, Jack.J. Pasternak; 3rd Edition; (1905); ASM press Publication, Washington DC.
4. Plant Genetic Engineering vol 7, Metabolic engineering and Molecular farming-I: P.K.Jaiwal, R.P. Singh; 7th Edition; (2006); Studium Press LLC Publication, U.S.A.
5. Plant Genetic Engineering vol 8, Metabolic engineering and Molecular farming-II: P.K.Jaiwal, R.P. Singh; 7th Edition; (2006); Studium Press LLC Publication, U.S.A.
6. Genetic transformation in plants: R.Walden, 1st Edition; (1988); Prentice Hall Publication.
7. Plants, genes and crop biotechnology: M.J. Chrispeels and D.E. Sadava , 2nd Edition; (2002); Jones Barlett Publications.
8. Plant Biotechnology and transgenic plants: K.M.O. Caldentey, W.H.Barz and H.L.Willis, 1st Edition; (2002); Marcel Dekker 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-301)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO 1	PSO 2	PSO 3
MS-BT-301.1	2	-	2	2	2	-	-	3	3	2
MS-BT-301.2	2	2	2	3	2	2	2	2	2	1
MS-BT-301.3	2	1	-	2	2	-	-	-	1	1
MS-BT-301.4	2	-	2	2	2	2	2	2	2	1
MS-BT-301.5	2	1	2	2	2	1	2	2	1	-
MS-BT-301.6	2	1	2	2	2	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-302: ENVIRONMENT BIOTECHNOLOGY

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-302.1 assimilate significant knowledge of environmental resources and global environmental issues.

MS-BT-302.2 understand different types of bioreactors for waste water treatment.

MS-BT-302.3 classify hazardous wastes.

MS-BT-302.4 understand the use of microorganisms and their processes to improve environmental quality.

MS-BT-302.5 establish and differentiate in situ and ex situ technologies of bioremediation.

MS-BT-302.6 design ecofriendly technologies for human society.

Unit 1: Waste water treatment

1.1 Waste water – physical parameters.

1.2 Chemical parameters.

1.3 Biological parameters.

1.4 treatment – primary, secondary and tertiary, aerobic and anaerobic processes.

1.5 Bioreactors.

Unit 2: Bioremediation,

2.1 Bioremediation strategies- Ex situ and in situ technologies.

2.2 Predictive models for testing efficacy of bioremediation.

2.3 Genetically-engineered microbes.

2.4 Heavy metal bioremediation.

2.5 Sources of heavy metal pollution.

2.6 Microbial ecology of contaminated site.

2.7 Microbial interaction with pollutants.

2.8 Microbial metal resistance.

2.9 Accumulation and concentration of metals.

2.10 Mechanisms & techniques of Phytoremediation.

Unit 3: Sustainable development, Bioprospecting and Bio-piracy

3.1 Sustainable Development: Scope and definitions.
3.2 Industrialization patterns, global and regional challenges.
3.3 Green business and Green design.
3.4 Urban development and sustainable cities.
3.5 Biodiversity conservation.
3.6 Biogeographical classification of India.
3.7 Hot spot of Biodiversity.
3.8 Legislation and the Convention for Biological Diversity.
3.9 Bioprospecting and Biopiracy: Famous cases, Legal and political aspects.

Text Books/Reference Books:

1. Introduction to Environmental Biotechnology: Chatterji; 3rd Edition; (2011); Prentice Hall of India Publication.
2. Wastewater Engineering Treatment, disposal and reuse: Metcalfe and Eddy Inc.; 4th Edition; (2017); McGraw-Hill Publication.
3. Biodegradation & Bioremediation: Martin Alexander, 2nd Edition; (2014); Academic Press Publication.
4. Environmental Biotechnology: Alan Scragg; 2nd Edition; (2007); Oxford University press.
5. Environmental Biotechnology-Principles and Applications: Bruce Rittman, Perry L. McCarty; (2017); McGraw-Hill Publication.
6. Bioremediation: Applied Microbial Solutions for Real World Environmental Cleanup: edited by Ronald M. Atlas, Terry Hazen, James Philp; (2005); ASM Press.

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-BT-302.1	3	3	2	2	-	2	3	1	3	2
MS-BT-302.2	3	3	1	-	-	2	3	1	2	2
MS-BT-302.3	3	3	1	2	-	2	3	1	3	2
MS-BT-302.4	3	3	-	-	-	2	3	-	2	2
MS-BT-302.5	3	3	1	-	-	2	3	-	-	1
MS-BT-302.6	3	3	-	-	-	2	3	-	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-303: FOOD & ENZYME BIOTECHNOLOGY

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 would be able to-

MS-BT-303.1 explain the significance of various microbes associated with food and enzymes.

MS-BT-303.2 know analytical techniques for food and enzymes.

MS-BT-303.3 compare methods for analysis, preservation and preparation methods for food and enzymes.

MS-BT-303.4 apply principles from the various facets of biotechnology to solve practical, real-world problems.

MS-BT-303.5 utilize of food waste for production of valuables.

MS-BT-303.6 summarize and critically discuss current topics of importance in food and enzyme biotechnology.

Unit 1: Introduction

1.1 Biotechnology in relation to the food industry.

1.2 Types of microorganisms associated with food, its sources, types and behavior in foods.

1.3 Enumeration and Detection of Food-borne Organisms.

1.4 Food Spoilage and Preservation: General principle and types of spoilage, microbial toxins, factors affecting spoilage.

1.5 Preservation: Different methods of food preservation.

1.6 Fermented Food Products: origin, scope and development, Dairy products, non-beverage plant products, beverages and related products of baking.

1.7 Protein foods and nutraceuticals: SCP, mushroom, food yeasts, algal proteins and nutraceuticals.

1.8 Process Wastes: Utilization of food waste for production of valuables.

Unit 2: Enzymes

2.1 Introduction to enzymes: Enzyme classification.

2.2 Mechanism of enzyme action.

2.3 Enzyme Activity, factors affecting enzyme activity.

2.4 Extraction and Purification of enzyme, Test of purity.

2.5 Kinetics of Enzyme action and regulation: Concept of ES complex, active site, specificity,

2.6 Derivation of Michaelis's Menten equation, Lineweaver Burk Plots,

2.7 Competitive, non-competitive, uncompetitive, linear-mixed type inhibitions and their kinetics, Feedback inhibition.

2.8 Recent advances and future prospects in Enzyme Technology:, Reactions and stabilization of enzymes in biphasic aqueous-organic systems , Enzyme engineering-synzymes and artificial enzymes.

Unit 3: Enzymes in food

3.1 Application of enzymes in industries.
3.2 Proteases, glucose oxidase and catalase in the food industry.
3.3 Production of glucose syrup and syrups containing maltose.
3.4 Use of enzymes in cellulose and starch hydrolysis.
3.5 Use of lactases in the dairy industry.
3.6 Starch and sugar conversion process.
3.7 Baking by amylases.

Text Books/Reference Books:

1. Enzymes: Palmer; 1st Edition; (2001); Horwood Publishing Series.
2. Modern Food Micro-biology by J.M. Jay; 4th Edition; (2005); Van Nostrand Reinhold Company New York.
3. Enzymes in Industry: Production and Applications: W. Gerhartz (1990), VCH Publishers, New York.
4. Fundamentals of Enzymology: Nicholes C. Price and Lewis Stevens; 3rd Edition; (2009); Oxford Univ. Press.
5. Enzyme Structure and mechanism: Alan Fersht; 2nd Edition; (1984); Reading, USA.
6. The chemical kinetics of enzyme action: K. J. Laider and P. S. Bunting; 2nd Edition; (1973); Oxford University Press, London.

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-BT-303)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO 1	PSO 2	PSO 3
MS-BT-303.1	3	3	2	2	-	2	3	1	3	2
MS-BT-303.2	3	3	1	-	-	2	3	1	2	2
MS-BT-303.3	3	3	1	2	-	2	3	1	3	2
MS-BT-303.4	3	3	-	-	-	2	3	-	2	2
MS-BT-303.5	3	3	1	-	-	2	3	-	-	1
MS-BT-303.6	3	3	-	-	-	2	3	-	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-351: PLANT BIOTECHNOLOGY LAB

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

Course Outcome-

The students will be able to-

MS-BT-351.1 learn the sterilization techniques to maintain aseptic conditions.
MS-BT-351.2 prepare different nutrient media for tissue culture.
MS-BT-351.3 develop plant tissue cultures from various explants.
MS-BT-351.4 isolate the plant protoplast by enzymatic method.
MS-BT-351.5 demonstrate and apply the basic techniques of animal tissue culture.
MS-BT-351.6 apply the cytotoxicity assay method.

List of Experiments:

1. To study different sterilization techniques.
2. To prepare Hoagland medium for tissue culture.
3. To prepare Murashig & Skoog's (MS) medium for tissue culture.
4. To study different growth parameters in plants.
5. To study embryo culture from *Triticumaestivum*.
6. To culture the anther to get whole plant.
7. To isolate the plant protoplast by enzymatic method.
8. To isolate the DNA from cultured cell/plantlet or plant tissue.
9. To study *Agrobacterium* mediated gene transfer method in plants.
10. To carry out cryopreservation of cells.
11. To perform cell quantification.
12. To carry out cytotoxicity assay.

Distribution of Continuous Assessment

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

Text Books/Reference Books:

1. Experiments in plant tissue culture (1998) - J.H. Dodde and L.W. Roberts, Cambridge University Press Publication.
2. Practical application of Plant Molecular biology - R.J.Henry., Chapman and Hall Publication.
3. Experiments in plant tissue culture, J.H. Dodde and L.W. Roberts; (1998); Cambridge University Press Publication.
4. Practical application of Plant Molecular biology: R.J.Henry.; 1st Edition; (1997); Chapman and Hall Publication.

Course Articulation Matrix

CO (MS-BT-351)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO 1	PSO 2	PSO 3
MS-BT-351.1	3	3	2	2	-	2	3	1	3	2
MS-BT-351.2	3	3	1	-	-	2	3	1	2	2
MS-BT-351.3	3	3	1	2	-	2	3	1	3	2
MS-BT-351.4	3	3	-	-	-	2	3	-	2	2
MS-BT-351.5	3	3	1	-	-	2	3	-	-	1
MS-BT-351.6	3	3	1	-	-	2	3	-	-	1

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES, FARIDABAD

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

MS-BT-352: ENVIRONMENT BIOTECHNOLOGY LAB

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

Course Outcome-

The students will be able to-

MS-BT-352.1 estimate of physical, chemical and biological parameters of water.
MS-BT-352.2 determine the different solid contents in wastewater.
MS-BT-352.3 determine the alkalinity of water.
MS-BT-352.4 determine the hardness of water.
MS-BT-352.5 determine electrical conductivity of water samples.
MS-BT-352.6 determine the chemical oxygen demand of water.

List of Experiments:

1. To determine the physical parameters of water.
2. Estimation of pH, EC and TDS in given water samples.
3. Estimation of Hardness, Alkalinity, Chloride and Salinity in given water samples.
4. Estimation of Nitrate, Phosphate and Sulphate in given water samples.
5. Estimation of Heavy metals in soil/ water samples.
6. Determination of COD and BOD of given water sample.
7. To test potability of water samples from different localities.
8. To estimate suspended particulate matter and gases in ambient air.
9. To study the Microflora of air,water and soil
10. Isolation of Xenobiotic degrading bacteria from given samples.
11. Identification and screening of Hyperaccumulator plant species for Heavy Metals.
12. To study the production of Vermicompost.

Distribution of Continuous Assessment

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

Text Books/Reference Books:

1. Microbiology lab. Manual - Cappuccino J. & Sheeman N.,2004, 4th Edition & Addison Wesley Publication, California.
2. Standard method for Environment, Air & Water - Ealon, Andrewd, APHA.
3. Environment Microbiology - P D. Sharma, Panima Pub. Corpn.

Course Articulation Matrix

CO Statement (MS-BT-352)	PO1	PO2	PO3	PO 4	PO 5	PO 6	PO 7	PO 10	PO 11	PO 12	PSO 1	PS O 2	PS O 3
MS-BT-352.1	3	3	2	2	-	2	3	2	1	1	1	3	2
MS-BT-352.2	3	3	1	-	-	2	3	2	1	1	1	2	2
MS-BT-3523	3	3	1	2	-	2	3	2	1	1	1	3	2
MS-BT-352.4	3	3	-	-	-	2	3	2	1	1	-	2	2
MS-BT-352.5	3	3	1	-	-	2	3	1	1	1	-	-	1
MS-BT-352.6	3	3	1	-	-	2	3	1	1	1	-	-	1

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES, FARIDABAD

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

MS-BT-353: FOOD & ENZYME BIOTECHNOLOGY LAB

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

Course Outcome:

The students will be able to-

MS-BT-353.1 demonstrate knowledge of methods for assay of enzymes
MS-BT-353.2 develop competencies in working with enzymes
MS-BT-353.3 able to analyze, identify and characterize the given enzyme.
MS-BT-353.4 acquire skills for quality testing of various food products.
MS-BT-353.5 know about industrial production of fermented products such as dahi, wine and yeasts .
MS-BT-353.6 analyse data and present results.

List of Experiments:

1. To perform the assay of given enzymes.
2. Determination of optimum pH, temperature & Time for the given enzyme.
3. Determination of Km value of the given enzyme.
4. Enzyme purification: Ammonium sulphate precipitation, ion exchange chromatography, molecular sieve chromatography.
5. Molecular weight determination of enzyme by Gel filtration chromatography.
6. Water quality testing including presumptive and confirmatory tests for coli form bacteria in water.
7. Microbiological quality of processed milk.
8. Production of alcohol by fermentation.
9. Production of Dahi and examination of its microbiological study.
10. To study the process of production of Brewer/Baker/Folder yeast.
11. To study the various physical methods such as heat, cold, dehydration, high osmotic pressure etc for preservation of food.
12. Industrial Visit

Distribution of Continuous Assessment

Viva I	**30%**
Viva II	**60%**
File/Record Keeping	**20%**

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

Reference books:

1. Laboratory Techniques in Biochemistry and Molecular Biology Series, P C Vandervliet and S. Pillai; 1st edition; (2008); Elsevier Publications.
2. Modern Food Micro-biology by J.M. Jay; 4th Edition; (2005); Van Nostrand Reinhold Company New York.
3. Enzymes in Industry: Production and Applications: W. Gerhartz (1990), VCH Publishers, New York.

Course Articulation Matrix

CO (MS-BT-353)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO 1	PSO 2	PSO 3
MS-BT-353.1	3	3	2	2	-	2	3	1	3	2
MS-BT-353.2	3	3	1	-	-	2	3	1	2	2
MS-BT-353.3	3	3	1	2	-	2	3	1	3	2
MS-BT-353.4	3	3	-	-	-	2	3	-	2	2
MS-BT-353.5	3	3	1	-	-	2	3	-	-	1
MS-BT-353.6	3	3	1	-	-	2	3	-	-	1

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES, FARIDABAD

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

MS-BT- 300: PROJECT PHASE-II

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

Course outcomes:

The students will be able to-

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

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

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

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

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

MS-BT- 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 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-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	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	2	1
MS-BT-321.5	3	3	2	2	2	3	2	2	1	-
MS-BT-321.6	3	3	2	2	2	3	2	2	1	1

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES, FARIDABAD

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

MS-BT-322: ANIMAL BIOTECHNOLOGY

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-322.1 demonstrate the knowledge of animal cell culture technology.
MS-BT-322.2 explain the advanced methods in animal cell culture.
MS-BT-322.3 apply his knowledge in practice in academia or industry.
MS-BT-322.4 analyze the requirements in application field of animal cell culture technology.
MS-BT-322.5 evaluate methods for different applications of animal cell culture technology.
MS-BT-322.6 design approaches for application of animal cell culture technology in research.

Unit 1: Animal Cell Culture technology basics

1.1 Scope of Animal cell culture technology.
1.2 Biology of the cultured cell.
1.3 Essential facilities required for cell culture.
1.4 Animal cell culture medium.
1.5 Development of serum-free medium.
1.6 Primary culture of animal cells.
1.7 Subculture.
1.8 Cryopreservation.
1.9 Measurement of growth parameters.

Unit 2: Advanced Techniques in Animal Cell Culture

2.1 Cell Separation.
2.2 Characterization of cell lines.
2.3 Transformation and immortalization.
2.4 Three dimensional culture.
2.5 Organ and Histotypic cultures.
2.6 Animal Cell Bioreactors.
2.7 Stem Cell Culture.

Unit 3: Applications of Animal Cell and Tissue Culture

3.1 Production and applications of transgenic animals.
3.2 Applications in animal reproductive biotechnology.
3.3 Production of conventional and recombinant vaccines.
3.4 Cytotoxicity testing.
3.5 Tissue Engineering.
3.6 Production of Biopharmaceuticals.
3.7 Ethical considerations in animal handling and cell culture.

Text Books/Reference Books:

1. Culture of Animal Cells: A manual of Basic Techniques and Specialized Applications, R. Ian Freshney. 7th Edition; (2016); Wiley and Sons Publication.
2. Animal Cell Culture – Practical Approach, Ed. John R.W. Masters, 3rd Edition; (2000); Oxford Publication.
3. Animal Cell Culture and Technology, Michael Butler; 2nd Edition; (2004); Garland Sciences.
4. Stem Cell Biology - Marshak, 2001, Cold Spring Harbar Symposium 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-322)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO 1	PSO 2	PSO 3
MS-BT-322.1	-	1	1	2	-	3	3	2	2	2
MS-BT-322.2	-	1	1	2	-	3	3	2	2	2
MS-BT-322.3	1	1	1	2	1	3	3	2	2	2
MS-BT-322.4	1	1	1	2	1	3	3	3	3	3
MS-BT-322.5	1	1	1	1	-	2	2	2	2	3
MS-BT-322.6	1	1	1	1	1	2	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-323: NANOBIOTECHNOLOGY

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-323.1 understand the basic concepts of nanotechnology.

MS-BT-323.2 explain the structure of nanoparticles commonly used in biology.

MS-BT-323.3 apply the knowledge of microscopy and other instruments employed to analyze nanoparticles.

MS-BT-323.4 analyze different types of nanoparticles used for application in biotechnology.

MS-BT-323.5 evaluate nanoparticles as tools for use in different fields of food, medicine and health science.

MS-BT-323.6 propose novel nanoparticles for various applications.

Unit 1: Structural & functional principles of bio-nanotechnology

1.1 Surface and Bulk Properties of Nano-biomaterials: Nano-ceramics, Nano-polymers, Carbon Based nanomaterials, inorganic nanomaterials.

1.2 Textured and Porous Materials.

1.3 Surface immobilized biomolecules.

1.4 Nano-circuitry-S-layer proteins: structure, chemistry and assembly.

1.5 Lipid chips–S-Layers as Templates.

1.6 Engineered nano-pores: DNA–Protein Nanostructures.

1.7 DNA scaffolds.

1.8 DNA-templated Electronics.

1.9 DNA-based Metallic Nanowires and Networks.

1.10 DNA–Gold-Nanoparticle Conjugates.

Unit 2: Nano-bioanalytics

2.1 Analysis of biomolecular Structure by Atomic Force Microscopy, TEM, SEM.

2.2 Bio-functionalized Nanoparticles for Surface-Enhanced Raman Scattering.

2.3 Surface Plasmon Resonance-Bio conjugated Silica Nanoparticles for Bioanalytical Applications.

Unit 3: Nanotechnology in food, medicine and health science

3.1 Nanoparticle based drug delivery systems.

3.2 Nano-immuno conjugates.

3.3 Optical Biosensors based on Nano-plasmonics.

3.4 Nano-Biosensors.
3.5 Cyclodextrin in Nano-medicinal Foods and Cosmetics.
3.6 Bioavailability and delivery of nutraceuticals and functional foods using nanotechnology.
3.7 Nanocomposites for food packaging.
3.8 Toxicity and environmental risks of nanomaterials.

Text books/Reference Books:

1. Nanobiotechnology: Concepts, Applications and Perspectives, Niemeyer C. M, (2006); Wiley–VCH.
2. Bionanotechnology, David S Goodsell; (2004); John Wiley & Sons.
3. Bio-Nanotechnology: A Revolution in Food, Biomedical and Health Sciences, Debasis Bagchi, Manashi Bagchi, Hiroyoshi Moriyama, Fereidoon Shahidi; (2013); Wiley-Blackwell.
4. Biomaterials Science: An Introduction to Materials in Medicine, Buddy D. Ratner, Allan S. Hoffman, Frederick J. Schoen, Jack E. Lemons; (2012); Academic Press.
5. Nanobiomaterials Handbook, Balaji Sitharaman; (2011); Taylor & Francis Group.

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-323)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO 1	PSO 2	PSO 3
MS-BT-323.1	3	3	2	2	-	2	3	1	3	2
MS-BT-323.2	3	3	1	-	-	2	3	1	2	2
MS-BT-323.3	3	3	1	2	-	2	3	1	3	2
MS-BT-323.4	3	3	-	-	-	2	3	-	2	2
MS-BT-323.5	3	3	1	-	-	2	3	-	-	1
MS-BT-323.6	3	3	-	-	-	2	3	-	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-324: STEM CELL & REGENERATIVE MEDICINE

Periods/week	Credits		
L: 3	T:0	3	Max. Marks : 200
			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	2	-	2	3	1	3	2
MS-BT-324.2	3	3	1	-	-	2	3	1	2	2
MS-BT-324.3	3	3	1	2	-	2	3	1	3	2
MS-BT-324.4	3	3	-	-	-	2	3	-	2	2
MS-BT-324.5	3	3	1	-	-	2	3	-	-	1
MS-BT-324.6	3	3	-	-	-	2	3	-	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-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-BT-400.1 identify various methodologies to conduct relevant experiments.
MS-BT-400.2 customize and design the experiments for accomplishment of the research objectives.
MS-BT-400.3 collect and assimilate the data through lab/ field experiments.
MS-BT-400.4 assimilate and critically analyze the data .
MS-BT-400.5 draw conclusions and inferences from the acquired data to address the research problem.
MS-BT-400.6 compose a suitable research paper to communicate the research finding to the scientific community.

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	1	2	3	3	2	3	3	3
MS-BT-400.2	3	3	1	3	3	1	1	3	3	3
MS-BT-400.3	2	2	1	3	3	1	1	3	3	3
MS-BT-400.4	2	2	3	1	1	3	3	1	1	1
MS-BT-400.5	1	1	2	1	1	3	3	3	3	3
MS-BT-400.6	2	2	3	1	1	3	3	1	1	1

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES, FARIDABAD

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

MS-BT-421: METABOLIC ENGINEERING

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 would be able to-

MS-BT-421.1 explain the fundamentals of metabolic engineering.

MS-BT-421.2 interpret how the fluxes through the different pathways are regulated.

MS-BT-421.3 select concepts of engineering principles in optimizing cellular processes.

MS-BT-421.4 integrate the knowledge of biotechnology fundamentals for potential applications in improvising industrial processes.

MS-BT-421.5 design pathways leading to industrially relevant products like primary metabolites, antibiotics, industrial enzymes, and pharmaceutical proteins.

MS-BT-421.6 apply their knowledge for therapy for diseases.

Unit 1: Basic Concepts and Principles of Metabolic Engineering

1.1 Overview of cellular metabolism.

1.2 Different models for cellular reactions.

1.3 Metabolic regulation network at enzyme level and whole cell level.

1.4 Synthesis of Primary Metabolites, its regulation at enzyme level and whole cell level, Limiting accumulation of end products.

1.5 Biosynthesis of Secondary Metabolites.

1.6 Regulation of secondary metabolite pathways, precursor effects.

1.7 Catabolite regulation by passing control of secondary metabolism.

Unit 2: Bioconversions

2.1 Bioconversions and their Applications.

2.2 Factors affecting bioconversions, Product inhibition, mixed or sequential bioconversions.

2.3 Regulation of Enzyme Production.

2.4 Strain selection, Genetic improvement of strains, Gene dosage

2.5 Metabolic pathway manipulations to improve fermentation, modification of existing – or the introduction of entirely new metabolic pathways.

Unit 3: Applications of Metabolic Engineering

3.1 Metabolic flux.

3.2 Integration of anabolism and catabolism.

3.3 Material balance.

3.4 Metabolic engineering with Bioinformatics, Metabolic pathway modeling.

3.5 Applications of Metabolic Engineering: pharmaceuticals, chemical bioprocess, food technology, agriculture, environmental bioremediation and biomass conversion.

Text Books/Reference Books:

1. Metabolic Engineering: Principles and Methodologies: Gregory N. Stephanopoulos, Aristos A. Aristidou, Jens Nielsen; 1st Edition; (1998); Academic Press Publications.
2. Metabolic Engineering: Gregory N. Stephanopoulos; 3rd Edition; (2005); Elsevier India Publication.
3. Fermentation and Enzyme Technology: Wang.D.I.C Cooney C.L., Demain A.L., Dunnil. P. Humphrey A.E. Lilly M.D; (1980); John Wiley and sons Publications.
4. Plant Genetic Engineering Metabolic engineering and Molecular farming-I: P.K.Jaiwal, R.P.Singh 7th Edition; (2006); Studium Press LLC, U.S.A.
5. Principles of Fermentation Technology, Stanbury P.F., and Whitaker A.; 3rd Edition; (2016); Pergamon Press.

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-421)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO 1	PSO 2	PSO 3
MS-BT-421.1	2	-	2	2	2	-	-	3	3	2
MS-BT-421.2	2	2	2	3	2	2	2	2	2	1
MS-BT-421.3	2	1	-	2	2	-	-	-	1	1
MS-BT-421.4	2	-	2	2	2	2	2	2	2	1
MS-BT-421.5	2	1	2	2	2	1	2	2	1	-
MS-BT-421.6	2	1	2	2	2	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-422: CLINICAL RESEARCH & DATABASE MANAGEMENT

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-422.1	describe the basic concept of clinical research and data management process.
MS-BT-422.2	evaluate the essential documents for regulatory submission and clinical monitoring.
MS-BT-422.3	distinguish different clinical databases and query management.
MS-BT-422.4	illustrate various software toolsand programming languages for clinical research.
MS-BT-422.5	identify the issues associated with the regulatory affairs and ethics.
MS-BT-422.6	design the clinical research based on the regulatory guidelines and bioethics.

Unit 1: Basic Concepts

1.1 Introduction to Clinical Research and Drug Discovery and Development.
1.2 Bioinformatics and Drug development. Roles and Responsibilities of study team.
1.3 ICH-GCP.21 CFR 11. Introduction to CDISC. Clinical Trial Process.
1.4 Clinical Data Management Process. Essential documentation in Clinical Research.
1.5 Regulatory Submissions. Essentials for Clinical Monitoring.

Unit 2: Database Management

2.1 Introduction to Databases. Data definition, clinical databases and types.
2.2 Data capture methods, Data Entry, External Data Loading, Data Validation, Query Management, Data Storage & archival.
2.3 Data management Plan. EDC (Electronic Data Capture.) CRF Design. MedDRA Adverse Drug Reactions (ADR).
2.4 OpenClinica. Oracle Clinical, Rave (overview). Software tools, SAS programming program.
2.5 Documentation, program validation, and development of data entry platforms.

Unit 3: Regulatory Affairs and Ethics

3.1 Good Clinical Practice & other regulatory guidelines, Regulations & guidelines for CDM, Regulatory Aspects in Pharmacovigilance.
3.2 Medical coding and medical dictionaries, application of permission, approval of clinical trials responsibility of sponsor, informed consent.
3.3 Principles of ICH-GCP, Institutional Review Board/Independent Ethics Committee (IRB/IEC).
3.4 Bioethics, Ethics, Drug approvals, Drug Registry and safety.

Text Books/Reference Books:

1. Fundamentals of clinical research: Antonella Bacchieri, Giovanni Della Cioppa; 1st Edition; (2017); Springer Publication.
2. Textbook of Clinical Trials: David Machin, Simon Day and Sylwan Green; 2nd Edition; (2010); Wiley India Pvt Ltd.
3. The Oxford Textbook of Clinical Research Ethics: Ezekiel J. Emanuel, Christine Grady, Robert A. Crouch, Reidar Lie, Franklin Miller and David Wendler; 2nd Edition; (2011); OUP USA.
4. Designing Clinical Research: Stephen B Hulley, Steven R Cummings, Warren S Browner, Deborah G Grady, Thomas B Newman; 4th Edition; (2013); Lippincott Williams & Wilkins Publication.
5. Principles and Practice of Clinical Research: John L Gallin and Fredrick P. Ognibene; 4th Edition; (2017); Academic Press 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-422)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO 1	PSO 2	PSO 3
MS-BT-422.1	2	2	2	2	2	2	-	3	3	1
MS-BT-422.2	2	2	2	2	2	2	-	3	3	1
MS-BT-422.3	3	2	2	2	2	1	1	2	2	2
MS-BT-422.4	3	2	2	2	-	1	1	2	2	2
MS-BT-422.5	3	3	1	2	2	-	-	2	2	2
MS-BT-422.6	3	2	2	2	2	1	1	2	2	2

Appendix A

Course having focus on Regional, National or Global requirements.

M.Sc in Biotechnology				
Course Code	**Course Title**	**Regional**	**National**	**Global**
MS-BT-101	Cell & Molecular Biology		√	
MS-BT-102	Microbial Physiology & Genetics		√	
MS-BT-103	Biomolecules		√	
MS-BT-104	Bioanalytical Techniques			√
MS-BT-105	Biostatistics			√
MS-BT-151	Cell Biology Lab		√	
MS-BT-152	Molecular Biology Lab		√	
MS-BT-153	Microbiology Lab		√	
MS-BT-154	Bioanalytical Techniques Lab			√
MS-BT-100	Independent Study Seminar			√
MS-BT-201	Genetic Engineering & Applications			√
MS-BT-202	Bioprocess Technology		√	
MS-BT-203	Bioinformatics & Computational Biology			√
MS-BT-251	Genetic Engineering Lab			√
MS-BT-252	Fermentation Technology Lab		√	
MS-BT-253	Bioinformatics Lab			√
MS-BT-200	Project Phase-I			√
MS-BT-301	Plant Biotechnology	√		
MS-BT-302	Environment Biotechnology	√		
MS-BT-303	Food & Enzyme Biotechnology	√		
MS-BT-351	Cell & Tissue Culture Lab	√		
MS-BT-352	Environment Biotechnology Lab	√		
MS-BT-353	Food & Enzyme Biotechnology Lab	√		
MS-BT-300	Project Phase-II			√
MS-BT-400	Dissertation			√

Appendix B

Courses catering to the need of Employability, Entrepreneurship or Skill development requirements

Name of the Course	Course Code	Employability	Entrepreneurship	Skill development
Molecular Biology Lab	MS-BT-152			√
Microbiology Lab	MS-BT-153			√
Bioanalytical Techniques Lab	MS-BT-154			√
Bioinformatics & Computational Biology	MS-BT-203			√
Bioinformatics Lab	MS-BT-253			√
Plant Biotechnology	MS-BT-301	√		
Environment Biotechnology	MS-BT-302		√	
Food & Enzyme Biotechnology	MS-BT-303		√	
Cell & Tissue Culture Lab	MS-BT-351	√		
Environment Biotechnology Lab	MS-BT-352		√	
Food & Enzyme Biotechnology Lab	MS-BT-353		√	
Dissertation	MS-BT-400	√		

Appendix C

Courses catering to the need of Environment and Sustainability, Professional Ethics, Human Values or Gender equality requirements

Name of the Course	Course Code	Environment & Sustainability	Professional Ethics	Human Values
Plant Biotechnology	MS-BT-301	√		
Environment Biotechnology	MS-BT-302	√		
Food & Enzyme Biotechnology	MS-BT-303			√
Cell & Tissue Culture Lab	MS-BT-351	√		
Environment Biotechnology Lab	MS-BT-352	√		
Food & Enzyme Biotechnology Lab	MS-BT-353			√
Dissertation	MS-BT-400		√	