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.TECH

BIOTECHNOLOGY

2021-23

Faculty 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. Tech 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 30.3 of 30th AC held on 11th October, 2019, 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. Tech Biotechnology shall be implemented w.e.f. AY 2021-22.

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

Preamble

The program M.Tech 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.Tech 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 internal Evaluation s, 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 and also meet the local and regional needs. The curriculum includes courses focusing on employability, entrepreneurship and skill development which map strongly with the PO defining demonstration of technical knowledge and engagement in independent and life-long learning. Certain courses 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
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- 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 recently 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. The programme 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. These organizations are-

1. Translational Health Science and Technology Institute (THSTI), Faridabad
2. ICAR-National Bureau of Plant Genetic Resources (NBPGR), New Delhi
3. National Institute of Immunology (NII), New Delhi
4. Indian Institute of Petroleum (IIP) Dehradun
5. Indian Oil Company Ltd. (IOCL), Faridabad
6. AdvanCells- Stem Cell Therapy, Noida

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.TECH 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 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. Empower the students to apply their knowledge for development of innovative technologies for betterment of our nation and our earth.

MAPPING OF PEO WITH PO AND PSO

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

M.TECH 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. A few courses/activities are without credit (s) and are referred to as Audit Pass Courses (APC) but are mandatory to pass as a partial fulfillment of award of degree.

(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 B.Tech in, he/she has to earn minimum **68 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 50 credits** required to be earned under "Compulsory Courses Basket" and **18 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 three types of courses:

- Semester-wise courses offered by the department itself
- Open/Inter-disciplinary courses offered at the Institute/University level notified from the office of Dean-Academics.
- 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.

SCHEME - M. Tech Biotechnology (2019-2021 Onwards)

Semester I

Sr. No.	Course Code	Course Title	L	T	P	Total Hrs	Marks			Duration of Exam	Credits
							Continuous Evaluation	End Semester	Total		
1	M-BT-101	Genetic Engineering	3	0	0	3	100	100	200	3 hrs	3
2	M-BT-102	Applied Bioinformatics	3	0	0	3	100	100	200	3 hrs	3
3	-	Program Elective-I	3	0	0	3	100	100	200	3 hrs	3
4	-	Program Elective-II	3	0	0	3	100	100	200	3 hrs	3
5	M-BT-151	Genetic Engineering Lab	0	0	4	4	50	50	100	3 hrs	2
6	M-BT-152	Applied Bioinformatics Lab	0	0	4	4	50	50	100	3 hrs	2
7	M-MC-100	Research Methodology and IPR	2	0	0	2	50	50	100	3 hrs	2
8	-	Audit Course I	2	0	0	2	50	50	100	3 hrs	AP
		TOTAL				**24**					**18**

Semester II

Sr. No.	Course Code	Course Title	L	T	P	Total Hrs	Marks			Duration of Exam	Credits
							Continuous Evaluation	End Semester	Total		
1	M-BT-201	Advanced Plant Biotechnology	3	0	0	3	100	100	200	3 hrs	3
2	M-BT-202	Advanced Environmental Biotechnology	3	0	0	3	100	100	200	3 hrs	3
3	-	Program Elective-III	3	0	0	3	100	100	200	3 hrs	3
4	-	Program Elective-IV	3	0	0	3	100	100	200	3 hrs	3
5	M-BT-251	Advanced Plant Biotechnology Lab	0	0	4	4	50	50	100	3 hrs	2
6	M-BT-252	Advanced Environmental Biotechnology Lab	0	0	4	4	50	50	100	3 hrs	2
7	M-BT-200	Mini Project	0	0	4	4	100	100	200	3hrs	2
8	-	Audit Course II	2	0	0	2	50	50	100	2hrs	AP
		TOTAL				**26**					**18**

Semester III

Sr. No.	Course Code	Course Title	L	T	P	Total Hrs	Marks			Duration of Exam	Credits
							Continuous Evaluation	End Semester	Total		
1	M-BT-321	Program Elective-V	3	0	0	3	100	100	200	3 hrs	3
2	-	Open Elective	3	0	0	3	100	100	200	3 hrs	3
3	M-BT-300	Dissertation Phase - I	0	0	20	20	200	100	300	3 hrs	10
		TOTAL				**26**					**16**

Semester IV

Sr. No.	Course Code	Course Title	L	T	P	Total Hrs	Marks			Duration of Exam	Credits
							Continuous Evaluation	End Semester	Total		
1	M-BT-400	Dissertation Phase - II	Min 16 Weeks				400	200	600	3 hrs	**16**

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES		
FACULTY OF ENGINEERING & TECHNOLOGY		
SCHEME - M. Tech Biotechnology (2019-2021 Onwards)		
List of Elective Courses		
Program Elective-I		
1	M-BT-121	Food Microbiology
2	M-BT-122	Soil Microbiology
3	M-BT-123	Bioreactor Analysis and Design
4	M-BT-124	Stem Cell Biology
5	M-BT-125	Nanoscale Materials
Program Elective-II		
1	M-BT-126	Food Process Technology
2	M-BT-127	Plant Protection
3	M-BT-128	Upstream Bioprocessing
4	M-BT-129	Stem Cells based Tissue Engineering
5	M-BT-130	Biomedical Nanotechnology
Program Elective-III		
1	M-BT-221	Food Packaging Technology
2	M-BT-222	Seed Technology
3	M-BT-223	Downstream Processing
4	M-BT-224	Stem Cells based Tissue Development
5	M-BT-225	Technology of Nanostructured Fabrications
Program Elective-IV		
1	M-BT-226	Nutraceuticals & Functional Foods
2	M-BT-227	Crop Improvement
3	M-BT-228	Biopharmaceutical Manufacturing
4	M-BT-229	Stem Cells Therapy
5	M-BT-230	Nanomaterials and Applications
Program Elective-V		
1	M-BT-321	Entrepreneurship Opportunities in Food Industry
2	M-BT-322	Molecular Breeding and Transgenic Plants
3	M-BT-323	Advances in Fermentation Technology
4	M-BT-324	Bioethics in Stem Cell Technology
5	M-BT-325	Nanoscale Devices
Open Elective		
1	M-ID-001	Business Analytics
2	M-ID-002	Industrial Safety
3	M-ID-003	Operations Research
4	M-ID-004	Cost Management of Engineering Projects
5	M-ID-005	Composite Materials
6	M-ID-006	Waste to Energy
7	M-HM-ID-001	Human Resource Management
8	M-HM-ID-002	Strategic Human Resource Management
Audit Courses		
1	M-MC-001	Stress Management by Yoga
2	M-MC-002	English for Research Paper Writing
3	M-MC-003	Disaster Management
4	M-MC-004	Sanskrit for Technical Knowledge
5	M-MC-005	Value Education
6	M-MC-006	Constitution of India
7	M-MC-007	Pedagogy Studies
8	M-MC-008	Personality Development through Life Enlightenment Skills

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M-BT-101: GENETIC ENGINEERING

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

Pre-requisites: Knowledge of Undergraduate level Biotechnology
Course Type: Core

Course Outcomes:
The students will be able to-

M-BT-101.1	identify the complexity and organization of prokaryotic and eukaryotic genome.
M-BT-101.2	interpret the comparative, functional and evolutionary aspects of genes and genomes.
M-BT-101.3	apply the tools and techniques used in genetic engineering to understand the complexity of living systems.
M-BT-101.4	assess the genetic regulation mechanisms.
M-BT-101.5	evaluate the tools and techniques of gene manipulation for practical applications.
M-BT-101.6	design genetic engineering experiments for deriving solutions to complex problems.

Unit 1: Basic Concepts of genome and its regulation
Concept of gene, organization of genetic material in prokaryotes, organization of genetic material in Eukaryotes: Ultrastructure of Eukaryotic chromosomes, molecular structure of nucleic acids – structure & forms of DNA & RNA, Replication: structure & function of DNA polymerases, replication in prokaryotes and eukaryotes, replication of chromatin. Transcription - components of transcription machinery, RNA polymerases, processing of RNA. Transcription in prokaryotes & eukaryotes, genetic code. Translation – mechanism, post-translational modification. Operon concept, Gene regulation in eukaryotes: mechanism of gene regulation in eukaryotes

Unit 2: Tools of Gene manipulation
Vectors in recombinant DNA technology, biology and salient features of vectors, types of vectors, Molecular basis of lytic and lysogenic life cycle, expression vectors in prokaryotes and eukaryotes, restriction endonucleases, classification and modifying enzymes: Polynucleotide phosphorylase, Kinases, phosphatases, Ligases. Gene transfer techniques, electroporation, micro projectile system, liposome mediated transfer, Ti plasmid mediated gene transfer and other methods,

Unit 3: Basic Techniques in Gene Manipulation
Isolation and purification of Nucleic Acids, Electrophoresis ,Detection of clones and its expression**:** Blotting techniques, Immunological techniques. PCR, construction and screening of c-DNA
Genomic and cDNA library construction and application. DNA sequencing Molecular markers: RFLP, RAPD, AFLP, 16s r-RNA typing, Developments in microbial biotechnology and Genetic manipulation, engineering microbes for the production of antibiotics, enzymes, Insulin, growth hormones, monoclonal antibodies

Text Books/Reference Books:

1. R.W. Old, S.B. Primrose, 1995, Principles of Gene manipulation, An introduction to Genetic engineering, Blackwell Scientific Publications.
2. T.A. Brown, 2001, Gene Cloning, Wiley Blackwell Publication.
3. Bruce Alberts, J.D. Watson, 2009, Molecular Cell Biology: Garland Publication.
4. Cooper, 2008, The cell – a molecular approach, A.S.M. Press Publication.

Web links:
http://nptel.ac.in/courses/102103013/
http://nptel.ac.in/courses/102103041/
http://nptel.ac.in/courses/102103013/
http://nptel.ac.in/courses/102103013/10

Instruction for paper setting: Seven questions are to be set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Six questions will be set from all the three units (two from each unit). Student needs to attempt four more questions out of six, with at least one question from each unit. Each question will be of 20 marks.

Continuous Evaluation :
Sessional I - 30 Marks
Sessional II - 30 Marks
Assignments - 20 Marks
Class Work/Performance - 10 Marks
Attendance - 10 Marks

Course Articulation Matrix

CO (M-BT-101)	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PSO 1**	**PSO 2**
M-BT-101.1	-	-	-	1	-	-	2	3	3
M-BT-101.2	2	2	-	2	1	3	3	2	2
M-BT-101.3	-	-	-	2	1	2	1	-	1
M-BT-101.4	2	2	-	2	1	3	2	2	2
M-BT-101.5	3	2	2	1	1	1	2	2	1
M-BT-101.6	3	2	2	1	1	1	2	2	1

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M-BT-102: APPLIED BIOINFORMATICS

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

Pre-requisites: Knowledge of Undergraduate level Biotechnology
Course Type: Core

Course outcomes:
The students will be able to-

M-BT-102.1 define the basic concepts of computational Biology and its role in Bioinformatics.
M-BT-102.2 describe the functionality of various Algorithm.
M-BT-102.3 apply commonly used sequence alignment tools and its significance
M-BT-102.4 connect the protein structure determination tools to prediction methods.
M-BT-102.5 appraise the use of machine learning techniques in biological systems.
M-BT-102.6 generalize the concepts of systems biology and synthetic biology.

Unit 1: Elementary Data Structures
Arrays, stacks, queues, dequeues, order lists, generalized list, linear list, linked lists, circular linked lists, doubly-linked lists, infinite lists, hash tables, hash functions, recursive functions.

Unit 2: BioPerl and modular programming
Basic operators and control flow, basic Perl data types, references, matrices, complex/nested data structures, scope (my, local, our), functions/subroutines, system and user function, the local operator, Perl modules, Name spaces, packages, defining modules, storing modules, using modules, CPAN modules.
Sequences similarity searches **–** Sequence homology as product of molecular evolution; Basics and Algorithm of BLAST and FASTA, Significance of sequence alignment; sequence alignment – global (Needleman & Wunsch Algorithm), local (The Smith & Waterman Algorithm); Dynamic Programming, alignment scores and gap penalties.

Unit 3: Sequence alignment
Concept, programmes, dot matrix, dot plot, sequences repeats and inversion, database searching (BLAST and FASTA); multiple Sequence alignment (MSA), significance, softwares (PIMA, Clustal, Pileup). Phylogenetic analysis: Phylogenetics, cladistics and ontology; phylogenetic representations, graphs, trees and cladograms; Classification and ontologies; Steps in phylogenetic analysis; methods of phylogenetic analysis, similarity and distance tables, distance matrix method, method of calculation of distance matrix (UPGMA, WPGMA)

Text Books / Reference Books:

1. D. W. Mount, 2014, Bioinformatics: Sequence and Genome Analysis, Cold spring Harbour Laboratory Press Publication.
2. C.W. Sensen, 2008, Essential of Genomics and Bioinformatics: John Wiley and Sons Publication.
3. S. C. Rastogi, N. Mendiratta, P. Rastogi , 2004, Bioinformatics : Methods and Applications Genomics, Proteomics and Drug discovery, Prentice Hall of India Pvt. Ltd Publication.

4. A.D. Baxevanis and B.F.F.Ouellette, 2012, Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins: A.D. Baxevanis and B.F.F.Ouellette, Wiley interscience Publication.

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

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

Instruction for paper setting: Seven questions are to be set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Six questions will be set from all the three units (two from each unit). Student needs to attempt four more questions out of six, with at least one question from each unit. Each question will be of 20 marks.

Continuous Evaluation :
Sessional I - 30 Marks
Sessional II - 30 Marks
Assignments - 20 Marks
Class Work/Performance - 10 Marks
Attendance - 10 Marks

Course Articulation Matrix

CO (M-BT-102)	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2
M-BT-102.1	-	-	-	1	-	-	2	2	2
M-BT-102.2	2	2	-	2	1	3	3	2	2
M-BT-102.3	-	-	-	2	1	2	1	-	1
M-BT-102.4	2	2	-	2	1	3	2	2	2
M-BT-102.5	3	2	2	1	1	1	2	2	1
M-BT-102.6	3	2	2	1	2	1	2	2	1

Program Elective-I

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M-BT-121: FOOD MICROBIOLOGY

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

Pre-requisites: Knowledge of Undergraduate level Biotechnology
Course Type: Elective

Course outcomes:

The students will be able to-

M-BT-121.1 identify and explain the presence and detection of various microbes associated with food nutrients in foods and the specific functions in maintaining health.
M-BT-121.2 describe techniques that can be used to monitor quality of raw ingredients and final products.
M-BT-121.3 demonstrate the effects of common food preservation and production methods, and food storage conditions, on survival and growth of microbial contaminants.
M-BT-121.4 apply principles from the various facets of food biotechnology to solve practical, real-world problems.
M-BT-121.5 assess the utilization of food waste for production of valuables.
M-BT-121.6 summarize and critically discuss current topics of importance in food biotechnology.

Unit 1: Introduction:
Introduction: definition, Historical developments and significance of food-microbiology. Types of microorganism normally associated with food-mold, yeast, and bacteria. Sources of microorganism found in foods. Rapid identification methods of food pathogens.

Unit 2: Food spoilage:
Definition of spoilage, causes of spoilage. Microbiological and food enzymes, insects, parasites, rodents, temperature, moisture, oxygen, light and time. Biochemical changes caused by microorganisms, Microbiology of vegetable and fruit products (sauerkraut, pickles, jam, jellies, marmalades, juices, syrups, ketchups); Cereal products (bread, biscuits, cakes etc.); meat, egg and fish products. Microbiology of milk and milk products (milk powder, cheese, butter, ice cream)

Unit 3: Food Poisoning and Food Additives
Food poisoning and microbial toxins, mycotoxins. Major food borne infections. Food Additives: Nutrients, antimicrobial agents, antioxidants, flavoring agents, sweeteners, coloring agents, emulsifiers, enzymes, polysaccharides and other miscellaneous food additives.

Text Books/Reference Books:

1. J.M. Jay, 1986, Modern Food Micro-biology, Van Nostrand Reinhold company, New York.
2. M.R. Adams, 2008, Food Microbiology, Royal Society of Chemistry.
3. N.M. Potter, 2007, Food Science, The AVI Publishing Co, Westport Connecticut, USA.

Web links:
http://nptel.ac.in/courses/103103029/34
http://nptel.ac.in/courses/103103029/35
http://nptel.ac.in/courses/103107088/module1/lecture1/lecture1.pdf

Instruction for paper setting: Seven questions are to be set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Six questions will be set from all the three units (two from each unit). Student needs to attempt four more questions out of six, with at least one question from each unit. Each question will be of 20 marks.

Continuous Evaluation :

Sessional I - 30 Marks
Sessional II - 30 Marks
Assignments - 20 Marks
Class Work/Performance - 10 Marks
Attendance - 10 Marks

Course Articulation Matrix

CO Statement (M-BT-121)	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2
M-BT-121.1	2	-	-	1	1	2	2	3	2
M-BT-121.2	2	-	-	1	1	2	3	3	3
M-BT-121.3	2	-	-	2	1	2	1	2	2
M-BT-121.4	1	1	-	2	1	3	2	2	2
M-BT-121.5	2	1	2	1	1	1	2	3	2
M-BT-121.6	2	1	2	1	1	1	2	3	2

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES, FARIDABAD

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

M-BT-122: SOIL MICROBIOLOGY

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

Pre-requisites: Knowledge of Undergraduate level Biotechnology
Course Type: Elective

Course Outcomes:

The students will be able to-

M-BT-122.1 identify the diversity of microbes and recognize their role in soil ecosystems.
M-BT-122.2 explain the theoretical basis of the tools, technologies and methods common to soil microbiology.
M-BT-122.3 relate the processes used by soil microorganisms for their growth, replication, survival, and interaction with the environment.
M-BT-122.4 analyze the different types of physiological processes carried out by bacteria.
M-BT-122.5 summarize basic metabolic and genetic principles of bacterial and analyze their impact on soil ecosystem.
M-BT-122.6 formulate strategies to enhance beneficial microorganisms in soil for its improvement.

Unit 1: Microbial Ecology

Soil environment, Soil microbial ecology, Microbial communities in soil-Bacteria, Actinomycetes, Fungi, Algae, Protozoa, Viruses. Different interfaces of interaction-Soil microbe, soil-plant- microbe leading to symbiotic (mycorrhizal and rhizobial), associative, endosymbiotic and pathogenic interactions, unculturable soil biota, plant growth promoting rhizobacteria, Soil enzyme activities and their importance, Different methods to assess soil microbial biodiversity:-nucleic acid re-association and hybridization, low molecular weight RNA fingerfrinting, PCR based techniques like denaturing gradient gel electrophoresis, single stranded conformation polymorphism, amplified ribosomal DNA restriction analysis etc.

Unit 2: Biogeochemical Cycles

The carbon cycle: Organic matter decomposition, Microbiology of cellulose, hemicellulose, Lignin decomposition

The nitrogen cycle: Mineralization and immobilization of nitrogen, Nitrification, Denitrification, Nitrogen fixation: Symbiotic and non symbiotic

Unit 3: Mineral Transformations

Microbial transformations of phosphorous, sulphur, iron and manganese in soil. Siderophores and antimicrobials, Biodegradation of pesticides, Organic wastes and their use in the production of biogas and manures

Text Books/ Reference Books:

1. M. Alexander, 2005, Soil Microbiology: John Wiley Publication.
2. M. T. Madigan, J. M. Martinko and J. Parker, 2010, Biology of Microorganisms, Prentice Hall Int Inc Publication.
3. Pelczar, 2012, Microbiology: Concepts and Application, Tata Mc Graw Hill Publication, New Delhi
4. S.R. Maloy, J.E.Jr Cronan and Friefelder, 2013, Microbial Genetics, D.Jones and Bartlett Publishers
5. G.A. Weistreich, M.D Lechtman, 2014, Microbiology, McMillan Publishing Co. Publication.

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 covering entire syllabus and will be compulsory to attempt. Six questions will be set from all the three units (two from each unit). Student needs to attempt four more questions out of six, with at least one question from each unit. Each question will be of 20 marks.

Continuous Evaluation :
Sessional I - 30 Marks
Sessional II - 30 Marks
Assignments - 20 Marks
Class Work/Performance - 10 Marks
Attendance - 10 Marks

Course Articulation Matrix

CO (M-BT-122)	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2
M-BT-122.1	1	-	-	1	-	-	2	2	2
M-BT-122.2	1	-	-	2	1	-	2	3	2
M-BT-122.3	-	-	-	2	1	2	1	2	1
M-BT-122.4	2	1	1	1	1	1	2	2	2
M-BT-122.5	2	1	-	2	1	1	2	2	2
M-BT-122.5	2	2	2	1	1	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)

M-BT-123: BIOREACTOR ANALYSIS AND DESIGN

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

Pre-requisites: Knowledge of Undergraduate level Biotechnology
Course Type: Elective

Course Outcomes:
The students will be able to-

M-BT-123.1 describe basics details of bioreactor design and operation.
M-BT-123.2 explain the relevance and functioning of different components of a bioreactor.
M-BT-123.3 distinguish between ideal and non-ideal bioreactors.
M-BT-123.4 analyze biochemical and reactor data using the various mathematical models
M-BT-123.5 assess the enzymatic and microbial kinetics in a bioreactor.
M-BT-123.6 generalize the mass-transfer phenomena in the bioreactors.

Unit 1: Ideal Reactors
Analysis of ideal bioreactors: The ideal batch reactor, Continuous Stirred Tank Reactor (CSTR), series of CSTRs, turbidostat, chemostat, fetd batch, plug flow reactors, reasons for non ideality

Unit 2: Bioreactor Design
Mechanical design of bioreactor, Accessories for Bioreactor, monitoring and control of bioreactors, containment and sterilization

Unit 3: Bioreactor types
Types of Bioreactors, Bubble column, Air lift bioreactor, Reactors for Solid state fermentation, trickle bed reactor, Hollow fiber reactors, non conventional reactors

Text Books/ Reference Books:

1. P. F. Stanbury and A. Whitaker, 2014, Principles of fermentation technology, Pergamon Press Publication.
2. M. L. Shuller, F. Kargi, 1994, Bioprocess Engineering, Prentice Hall PTR Publications, New Jersy.
3. P. M. Doran, 2001, Bioprocess Engineering Principles, Academic Press Publications

Web links:
https://www.boundless.com/microbiology/textbooks/boundless-microbiology-textbook/
http://nptel.ac.in/courses/103105054/
https://www.nap.edu/read/2052

Instruction for paper setting: Seven questions are to be set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Six questions will be set from all the three units (two from each unit). Student needs to attempt four more questions out of six, with at least one question from each unit. Each question will be of 20 marks.

Continuous Evaluation :
Sessional I - 30 Marks
Sessional II - 30 Marks

Assignments - 20 Marks
Class Work/Performance - 10 Marks
Attendance - 10 Marks

Course Articulation Matrix

CO Statement (M-BT-123)	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PSO 1**	**PSO 2**
M-BT-123.1	2	2	1	1	1	-	2	3	3
M-BT-123.2	-	-	-	2	1	2	1	2	1
M-BT-123.3	2	2	-	2	1	-	2	2	2
M-BT-123.4	1	2	2	1	1	1	2	2	1
M-BT-123.5	2	2	2	1	1	1	2	2	1
M-BT-123.6	2	2	2	1	1	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)

M-BT-124: STEM CELL BIOLOGY

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

Pre-requisites: Knowledge of Undergraduate level Biotechnology
Course Type: Elective

Course Outcomes:

The students will be able to
M-BT-124.1 discover the potential of stem cells in animal systems.
M-BT-124.2 explain the functioning of stem cells.
M-BT-124.3 categorize the stem cells used for different therapeutic purposes
M-BT-124.4 analyze the categories of stem cells for applications in healthcare
M-BT-124.5 assess the strategies used in stem cell technology.
M-BT-124.6 propose new stem cell based therapy to overcome the shortcomings of existing approaches

Unit 1: Basics of developmental biology
Gametogenesis, fertilization, early development: zygote stage, morula stage and blastocyst stage. Cell differentiation: ectoderm, mesoderm, endoderm, committed cells, organogenesis.

Unit 2: Characteristics of stem cells
Molecular bases of pluripotency, stem cell niches, mechanism of stem cell renewal, signalling through the ion channel in stem cells, signalling pathways for maintaining pluripotency and cell differentiation. Cancer stem cell pathways: Bmi 1, Wnt, Sonic Hedgehog and Notch.

Unit 3: Types and mechanisms of stem cells
Embryonic, haematopoetic, neural, mesenchymal, adipose derived, endothelial and muscle stem cells., Epigenetics, cell fusion and differential state, phenotypic changes in cell, nuclear cloning and epigenetic reprogramming, stem cell markers.

Text Books/ Reference Books:

1. Robert Lanza, 2013, Essential of stem cell biology, Elsevier Science & Technology Books Publication.
2. Marshak, 2001, Stem Cell Biology, Cold Spring Harbar Symposium Publication.
3. S. Sell, 2003, Stem Cell Handbook, Humana Press Publication.

Web links:
https://online.stanford.edu/courses/xgen204-stem-cell-therapeutics
http://www.biolim.org/programmes/online-courses/open/certificate-course-on-stem-cells/
https://stemcells.nih.gov/info/2001report/chapter11.htm
http://nptel.ac.in/courses/105104102/4
https://www.nature.com/articles/ni0402-318?proof=t
https://www.broadinstitute.org/what-broad/areas-focus/project-spotlight/questions-and-answers-about-crispr

Instruction for paper setting: Seven questions are to be set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Six questions will be set from all the three units (two from each unit). Student needs to attempt four more questions out of six, with at least one question from each unit. Each question will be of 20 marks.

Continuous Evaluation :

Sessional I - 30 Marks
Sessional II - 30 Marks
Assignments - 20 Marks
Class Work/Performance - 10 Marks
Attendance - 10 Marks

Course Articulation Matrix

CO Statement (M-BT-124)	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PSO 1**	**PSO 2**
M-BT-124.1	2	-	-	1	1	1	2	3	3
M-BT-124.2	2	2	2	1	2	2	3	3	3
M-BT-124.3	1	1	-	2	1	2	1	2	2
M-BT-124.4	2	2	1	2	2	3	2	3	2
M-BT-124.5	1	1	2	1	1	1	2	3	2
M-BT-124.6	1	1	2	1	1	1	2	3	2

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES, FARIDABAD

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

M-BT-125: NANOSCALE MATERIALS

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

Pre-requisites: Knowledge of Undergraduate level Biotechnology
Course Type: Elective

Course Outcomes:
The students will be able to-

M-BT-125.1 define the use of nanomaterials owing to its versatility and usefulness.
M-BT-125.2 classify different types of nanoscale materials along with their methods of synthesis and characterization.
M-BT-125.3 differentiate nanoparticles by their salient characteristics- morphological and physicochemical.
M-BT-125.4 apply suitable method of synthesis for target nanomaterial.
M-BT-125.5 evaluate nanoparticles as tools for use in different fields of food, medicine and health science.
M-BT-125.6 provide novel solutions in designing nanoparticles for applications in biotechnology.

Unit 1: Introduction to Nanomaterials

Classification and Nomenclature of Nanomaterials: Nanosized metals and alloys, Semiconductors, ceramics, organic semiconductors, carbon nanotube, quantum dots.

Unit 2: Synthesis of Nanomaterials

Physical Methods: Nucleation and growth of Nanosystems, self-assembly; mechanical milling, laser ablation, sputtering and microwave plasma.

Chemical Methods: Chemical reduction and oxidation, hydrothermal, micelles, sol-gel processes, photolysis, radiolysis, and metallo-organic chemical vapor deposition.
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Unit 3: Characterization of Nanomaterials

Structural Characterization - XRD, SAXS, SEM, TEM, SPM/AFM
Chemical Characterization – Optical spectroscopy, Electron spectroscopy, Ionic spectrometry
Physical properties – Melting point, Lattice constant, Electrical and magnetic characterization; Mechanical properties – nanoindentaion, nanotribology.

Text Books/Reference Books:

1. Eisberg, Robert, Resnick, Robert, 2014, Quantum Physics of Atoms, Molecules, Solids, Nuclei, and Particles,John Wiley Publication.
2. Harold P. Klug, Leroy E. Alexander, 2002, X-Ray Diffraction Procedures: For Polycrystalline and Amorphous Materials, Wiley Publication.
3. CNR Rao, 2010, Chemistry of nanomaterials: Synthesis, properties and applications, Wiley Publication.

Instruction for paper setting: Seven questions are to be set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Six questions will be set from all the three units (two from each unit). Student needs to attempt four more questions out of six, with at least one question from each unit. Each question will be of 20 marks.

Continuous Evaluation :

Sessional I - 30 Marks
Sessional II - 30 Marks
Assignments - 20 Marks
Class Work/Performance - 10 Marks
Attendance - 10 Marks

Course articulation Matrix

CO Statement (M-BT-125)	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2
M-BT-125.1	-	-	-	-	-	-	-	3	-
M-BT-125.2	-	-	-	-	-	-	-	2	-
M-BT-125.3	1	-	-	-	1	2	-	-	-
M-BT-125.4	-	-	-	-	2	2	-	1	-
M-BT-125.5	1	1	-	1	2	2	1	3	2
M-BT-125.6	1	2	-	1	2	1	1	3	2

Program Elective-II

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES, FARIDABAD

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

M-BT-126: FOOD PROCESS TECHNOLOGY

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

Pre-requisites: Knowledge of Undergraduate level Biotechnology
Course Type: Elective

Course Outcomes:
The students will be able to-

M-BT-126.1	describe of the principles underlying the food preservation methods and technologies used.
M-BT-126.2	appreciate the food processing technology used for improvement of foods.
M-BT-126.3	apply scientific principles in processing and storage of food and improving product quality.
M-BT-126.4	distinguish the methods of preservation and processing used for different types of food.
M-BT-126.5	assess the mechanism of processing and preservation of food.
M-BT-126.6	design appropriate method of processing and preservation of food using emerging technologies.

Unit 1: Introduction
Definition, history and scope of food processing. General principles of food preservation. Different methods of food preservation: high temperature, low temperature, radiations, preservatives, canning, fermentation etc. Concept of TDT, F, Z &D values.

Unit 2: Processing and storage of cereals
Infestation control, drying & milling of grains including, wheat, corn, barley, oat etc. Processing and storage of rice and rice products.
Preservation of fruit and vegetables : Production and preservation of fruit and vegetable products (juices, jams, jelly, pickles, marmalades etc).

Unit 3: Processing and preservation of milk and milk products
Cheeses, fermented milk, cultured buttermilk, yogurt, kefir, koumiss, Bulgarian milk, acidophilus milk, curd, Processing and preservation of poultry: Egg, egg products, chicken Handling, storage and transport of raw fish : Composition of fish, quality analysis of fish. Processing and preservation of fish and fish products (fish meal, fish concentrate, fish liver oil, sauce etc.).

Text/ Reference Books:

1. Palmer, 2001, Enzymes, Horwood Publishing Series.
2. J.M. Jay, 1986, Modern Food Micro-biology, Van Nostrand Reinhold company, New York.
3. W. Gerhartz, 1990, Enzymes in Industry: Production and Applications, VCH Publishers, New York.
4. N.C. Price and Lewis Stevens, 2012, Fundamentals of Enzymology, Oxford Univ. Press.

Web links:
http://nptel.ac.in/courses/103103029/34
http://nptel.ac.in/courses/103103029/35
http://nptel.ac.in/courses/103107088/module1/lecture1/lecture1.pdf

Instruction for paper setting: Seven questions are to be set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Six questions will be set from all the three units (two from each unit). Student needs to attempt four more questions out of six, with at least one question from each unit. Each question will be of 20 marks.

Continuous Evaluation :

Sessional I - 30 Marks
Sessional II - 30 Marks
Assignments - 20 Marks
Class Work/Performance - 10 Marks
Attendance - 10 Marks

Course Articulation Matrix

CO Statement (M-BT-126)	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2
M-BT-126.1	2	-	-	1	1	2	2	3	2
M-BT-126.2	2	-	-	1	1	2	3	3	3
M-BT-126.3	2	-	-	2	1	2	1	2	2
M-BT-126.4	1	1	-	2	1	3	2	2	2
M-BT-126.5	2	1	2	1	1	1	2	3	2
M-BT-126.6	2	1	2	1	1	1	2	3	2

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES, FARIDABAD

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

M-BT-127: PLANT PROTECTION

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

Pre-requisites: Knowledge of Undergraduate level Biotechnology
Course Type: Elective

Course Outcomes:
The students will be able to-

M-BT-127.1	identify various diseases of plants on the basis of symptoms.
M-BT-127.2	explain the physiological basis of plant diseases.
M-BT-127.3	relate the host parasite interactions with occurrence of diseases.
M-BT-127.4	interpret the defense mechanisms in diseased plants.
M-BT-127.5	apply various methods for disease control in plants.
M-BT-127.6	design a broad strategy for plant disease management.

Unit 1: Introduction
Definitions and terminology of Plant Diseases, air, water and soil–borne plant diseases, mineral deficiencies and toxicities, non-parasitic plant pathogens, allelopathy in plant pathology.
Secondary metabolism of the host in response to disease: Mycotoxin, phenyl propanoid pathway. Enzymes in plant disease: Cell wall degrading enzymes, pectinases, cellulases, hemicellulases, lignases

Unit 2: Host parasite interaction
Host Plant Resistance: Types and Inheritance of resistance in plants, local and systemic acquired resistance and signal transduction. phytoalexins,. Defense mechanisms, recognition and compatibility phenomenon, hypersensitivity, detoxifying toxins, alien genes for resistance. Genetics of resistance. Genetic engineering for novel and stable plant disease control, cloning of resistant genes, RNA silencing of endogenous genes. GM plants for parasite resistance.

Unit 3: Chemical & Biological Control
Chemicals in plant disease control- fungicides, bactericides, nematicides, antiviral chemicals and botanical pesticides. Mechanism of biocontrol: Hyperparasitism, antibiosis, competition, siderophores, mycorrhizae. Biocontrol agents.
Plant Disease Management : History & efficacy of Plant quarantine, Molecular detection techniques for disease diagnosis, molecular mapping. Integrated Pest Management

Text/ Reference Books:

1. Stacey, Burris and Evans, 2012, Biological Nitrogen Fixation, CBA Publishers and Distributor, New Delhi, India.
2. Rao, N.S.S., 1996, Biofertilizer in agriculture and Forestry, Oxford & IBM Pvt Ltd. Publication.
3. Dhaliwal, G.S. and Arora,R., 1998, Principles of Insect Pest Management, Kalyani Publication, New Delhi

Web links:
https://www.ncbi.nlm.nih.gov › NCBI › Literature › PubMed Central (PMC)
https://www.ncbi.nlm.nih.gov/pubmed/965014

vle.du.ac.in/mod/book/view.php?id=13141&chapterid=28369

Instruction for paper setting: Seven questions are to be set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Six questions will be set from all the three units (two from each unit). Student needs to attempt four more questions out of six, with at least one question from each unit. Each question will be of 20 marks.

Continuous Evaluation :
Sessional I - 30 Marks
Sessional II - 30 Marks
Assignments - 20 Marks
Class Work/Performance - 10 Marks
Attendance - 10 Marks

Course Articulation Matrix

CO Statement (M-BT-127)	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PSO 1**	**PSO 2**
M-BT-127.1	-	-	1	-	-	2	2	3	2
M-BT-127.2	-	-	-	-	-	2	3	3	2
M-BT-127.3	1	-	-	2	1	2	1	3	2
M-BT-127.4	1	1	-	2	1	3	2	3	2
M-BT-127.4	-	1	2	1	1	1	2	3	2
M-BT-127.6	-	1	2	1	1	1	2	3	2

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES, FARIDABAD

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

M-BT-128: UPSTREAM BIOPROCESSING

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

Pre-requisites: Knowledge of Undergraduate level Biotechnology
Course Type: Elective

Course Outcomes:

The students will be able to:

M-BT-128.1	describe the industrial aspects of microbiological processes.
M-BT-128.2	select and evaluate bioreactors and bioprocess operations for particular applications.
M-BT-128.3	assess the processes of microbial strain development.
M-BT-128.4	Optimize fermentation media for different types of microbial cultures.
M-BT-128.5	analyze and integrate different aspects of upstream and downstream processing.
M-BT-128.6	design bioprocess strategies for different applications.

Unit 1: Strain Development
Role of Bioprocess Engineer in Biotechnology, Selection and screening of industrially important microorganisms, Chemical Mutagenesis, Genetic engineering applied for strain improvement, case studies

Unit 2: Design of fermentation media
Requirements of fermentation media, Media optimization, Animal and plant tissue culture media, sterilization of media, Considerations for the production of primary and secondary metabolites, case studies.

Unit 3: Basics of Bioprocess Plant Design
General design of Bioprocess Plant; Material and energy balance calculations; Process Flowsheeting. Scale up and scale down issues, Selection of equipment for bioprocessing, facility design aspects

Text Books/ Reference Books:

1. P. F. Stanbury and A. Whitaker, 2014, Principles of fermentation technology, Pergamon Press Publication.
2. M. L. Shuller, F. Kargi, 1994, Bioprocess Engineering, Prentice Hall PTR Publications, New Jersy.
3. P. M. Doran, 2001, Bioprocess Engineering Principles, Academic Press Publications

Web links:
https://www.boundless.com/microbiology/textbooks/boundless-microbiology-textbook/
http://nptel.ac.in/courses/103105054/
https://www.nap.edu/read/2052

Instruction for paper setting: Seven questions are to be set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Six questions will be set from all the three units (two from each unit). Student needs to attempt four more questions out of six, with at least one question from each unit. Each question will be of 20 marks.

Continuous Evaluation :

Sessional I - 30 Marks
Sessional II - 30 Marks
Assignments - 20 Marks
Class Work/Performance - 10 Marks
Attendance - 10 Marks

Course Articulation Matrix

CO Statement (M-BT-128)	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PSO 1**	**PSO 2**
M-BT-128.1	2	2	1	1	1	-	2	3	3
M-BT-128.2	-	-	-	2	1	2	1	2	1
M-BT-128.3	2	2	-	2	1	-	2	2	2
M-BT-128.4	1	2	2	1	1	1	2	2	1
M-BT-128.5	2	2	2	1	1	1	2	2	1
M-BT-128.6	2	2	2	1	1	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)

M-BT-129: STEM CELLS BASED TISSUE ENGINEERING

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

Pre-requisites: Knowledge of Undergraduate level Biotechnology
Course Type: Elective

Course Outcomes:

The students will be able to
M-BT-129.1 identify the potential sources of stem cells for tissue engineering.
M-BT-129.2 discover the potential of biomaterials for their use as scaffolds.
M-BT-129.3 categorize the processes involved in formation of engineered tissues.
M-BT-129.4 analyze the categories of stem cells for applications in healthcare
M-BT-129.5 assess the strategies used in tissue engineering.
M-BT-129.6 propose new stem cell based therapy to overcome the shortcomings of existing approaches

Unit 1: Cells as building blocks
Biomaterials scaffolds: novel biomaterials, designed for the organization, growth, and differentiation of cells, proliferation and differentiation of cells, acquiring the appropriate source of cells such as autologous cells, allogeneic cells, xenogeneic cells, stem cells, genetically engineered cells, and immunological manipulation.

Unit 2: Synthesis, Characterization and Cell-Material Interactions
Biomolecules, angiogenic factors, growth factors, differentiation factors and bone morphogenic proteins, Engineering Design Aspects: 2-d cell expansion, 3-d tissue growth, bioreactors, Processes involved in formation of engineered tissues, Regulation of cell adhesion and function via changes in surface and bulk characteristics of material, vascularization, cell and tissue storage and shipping (biological packaging).

Unit 3: Engineered Tissues
Biomechanical Aspects of Design: properties of native tissues, identification of minimum properties required of engineered tissues, mechanical signals regulating engineered tissues, and efficacy and safety of engineered tissues.

Text Books/ Reference Books:

1. Robert Lanza, 2013, Essential of stem cell biology, Elsevier Science & Technology Books Publication.
2. Marshak, 2001, Stem Cell Biology, Cold Spring Harbar Symposium Publication.
3. S. Sell, 2003, Stem Cell Handbook, Humana Press Publication.

Web links:
https://online.stanford.edu/courses/xgen204-stem-cell-therapeutics
http://www.biolim.org/programmes/online-courses/open/certificate-course-on-stem-cells/
https://stemcells.nih.gov/info/2001report/chapter11.htm
http://nptel.ac.in/courses/105104102/4
https://www.nature.com/articles/ni0402-318?proof=t
https://www.broadinstitute.org/what-broad/areas-focus/project-spotlight/questions-and-answers-about-crispr

Instruction for paper setting: Seven questions are to be set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Six questions will be set from all the three units (two from each unit). Student needs to attempt four more questions out of six, with at least one question from each unit. Each question will be of 20 marks.

Continuous Evaluation :

Sessional I - 30 Marks
Sessional II - 30 Marks
Assignments - 20 Marks
Class Work/Performance - 10 Marks
Attendance - 10 Marks

Course Articulation Matrix

CO Statement (M-BT-129)	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PS O 1**	**PS O 2**
M-BT-129.1	2	-	-	1	1	1	2	3	3
M-BT-129.2	2	2	2	1	2	2	3	3	3
M-BT-129.3	1	1	-	2	1	2	1	2	2
M-BT-129.4	2	2	1	2	2	3	2	3	2
M-BT-129.5	1	1	2	1	1	1	2	3	2
M-BT-129.6	1	1	2	1	1	1	2	3	2

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES, FARIDABAD

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

M-BT-130: BIOMEDICAL NANOTECHNOLOGY

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

Pre-requisites: Knowledge of Undergraduate level Biotechnology
Course Type: Elective

Course Outcomes:
The students will be able to-

M-BT-130.1	define the biomedical use of nanoparticles owing to its versatility and usefulness.
M-BT-130.2	classify different types of biologically useful nanoparticles.
M-BT-130.3	discover the methods of nanoparticle synthesis.
M-BT-130.4	apply suitable method of synthesis for target nanomaterial.
M-BT-130.5	appreciate the use of nanoparticles for biomedical applications.
M-BT-130.6	develop biomedically useful nanoparticles and assess their toxicity and other properties.

Unit 1: Synthesis of Nanoparticles

Synthesis of nanoparticles by physical, chemical and biological methods; Cell organization and subcellular structure; Cell–nanostructure Interactions; Molecular Biomimetics; Nanostructures for medicinal applications

Unit 2: Biomedical Applications of Nanoparticles

Virus-based nanoparticles for gene therapy; Nanotechnology in nonviral gene delivery. Nanotechnology in tissue Engineering; Nanostructured extracellular matrix; Nanomaterials for cell engineering; Nanostructured biomaterials; Nanostructured surface modifications for biomedical implants; Artificial cells; Nanotechnology for regenerative medicine.

Unit 3: Nanopharmaceuticals

Nanopharmaceuticals; Biodegradable targeted nano drug delivery system; Diagnostic and therapeutic applications of nanoparticles; Theranostic nanoparticles; Pharmacokinetics of nanocarrier-mediated drug and gene delivery; Cytotoxicity and genotoxicity; Cell toxicity mechanisms and method of analysis; Toxicity of nanoparticles in vivo.

Text/ Reference Books:

1. Eisberg, Robert; Resnick, Robert, 2014, Quantum Physics of Atoms, Molecules, Solids, Nuclei, and Particles,John Wiley Publication.
2. Harold P. Klug, Leroy E. Alexander, 2002, X-Ray Diffraction Procedures: For Polycrystalline and Amorphous Materials, Wiley Publication.
3. CNR Rao, 2010, Chemistry of nanomaterials: Synthesis, properties and applications, Wiley Publication.

Web Links:
http://www.wtec.org/loyola/nano/IWGN.Research.Directions/chapter07.pdf
http://www.nanotech-now.com/current-uses.htm
https://www.nano.gov/you/nanotechnology-benefits

Instruction for paper setting: Seven questions are to be set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Six questions will be set from all the three units (two from each unit). Student needs to attempt four more questions out of six, with at least one question from each unit. Each question will be of 20 marks.

Continuous Evaluation :
Sessional I - 30 Marks
Sessional II - 30 Marks
Assignments - 20 Marks
Class Work/Performance - 10 Marks
Attendance - 10 Marks

Course Articulation Matrix

CO Statement (M-BT-130)	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PSO 1**	**PSO 2**
M-BT-130.1	-	-	1	-	-	2	2	3	2
M-BT-130.2	-	-	-	-	-	2	3	3	2
M-BT-130.3	1	-	-	2	1	2	1	3	2
M-BT-130.4	1	1	-	2	1	3	2	3	2
M-BT-130.5	-	1	2	1	1	1	2	3	2
M-BT-130.6	-	1	2	1	1	1	2	3	2

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES, FARIDABAD

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

M-BT-151 : GENETIC ENGINEERING LAB

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

Pre-requisites: None

Course Outcomes:

The students will be able to:

M-BT-151.1	describe the techniques involved in molecular biology
M-BT-151.2	demonstrate skills in isolation, quantification and purification of RNA and DNA.
M-BT-151.3	compare the variants of PCR and their applications
M-BT-151.4	apply the molecular biology techniques for genetic testing
M-BT-151.5	analyze DNA sequencing data.
M-BT-151.6	design molecular biology techniques for novel applications.

List of Experiments:

1. Isolation of genomic DNA.
2. Isolation of DNA from eukaryotes
3. Isolation of plasmid DNA.
4. To observe the ligation of target gene in vector.
5. To study the competent cell preparation, transformation and screening of transformed host.
6. To study PCR based site directed mutagenesis.
7. To study single nucleotide polymorphism.
8. To study amplified fragment length polymorphism (AFLP).
9. To study mRNA purification based on Oligo $(dT)_{30}$ magnetic beads.
10. To perform RT-PCR with given m-RNA sample.
11. Isolation of DNA from hair for forensic use.
12. To learn the technique of DNA extraction from gel.

Reference Books:

1. C. Frank, Hay Ollwyn, N. Paul, Nelson L. Hudson, 2007, Practical Immunology, Blackwell Science Publication.
2. J. Sambrook and D.W. Russell, 2013, Molecular Cloning- a laboratory manual, Cold Spring Harbor Laboratory Press Publication, New York

Instructions for Exam: Every student needs to complete 8 experiments in a semester.

Continuous Evaluation :

Viva	- 30 Marks
File/Records	- 10 Marks
Class Work/ Performance	- 05 Marks
Attendance	- 05 Marks

Course Articulation Matrix

CO (M-BT-151)	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2
M-BT-151.1	-	-	-	1	-	-	2	3	3
M-BT-151.2	2	2	-	2	1	3	3	2	2
M-BT-151.3	-	-	-	2	1	2	1	-	1
M-BT-151.4	2	2	-	2	1	3	2	2	2
M-BT-151.5	3	2	2	1	1	1	2	2	1
M-BT-151.6	3	2	2	1	1	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)

M-BT-152: APPLIED BIOINFORMATICS LAB

Periods/week	Credits	Max. Marks	: 100
P: 4	2	Continuous Evaluation	: 50
Duration of Ext. Exam: 3 Hrs		End Semester Examination	: 50

Pre-requisites: None

Course outcomes:

The students will be able to:

M-BT-152.1	develop a working knowledge of using various tools of bioinformatics and use of databases
M-BT-152.2	demonstrate the local and global alignment search tools for DNA sequence analysis
M-BT-152.3	determine molecular weight and secondary structure of proteins.
M-BT-152.4	infer Biological sequences using Basic Blast and Clutal W.
M-BT-152.5	predict gene behaviour using appropriate tools.
M-BT-152.6	compute and verify restriction map for a DNA sequence.

List of Experiments:

1. To study Literature searches method by using Pubmed, OMIM.
2. To study Nucleic acid databases, Protein sequence databases and Protein structure Databases.
3. To study File format conversion.
4. Analysis of Biological sequences using Basic Blast.
5. Analysis of Biological sequences by using Clustal W
6. To study Protein motifs and profile in sequences.
7. To study Sequence Submission Tools by using Webin & Sequin.
8. Exploring KEGG (Kyoto Encyclopedia of Genes and Genomes) tool.
9. To study visualization tool by using Rasmol.
10. To study Phylogenetic analysis.

Reference Books:

1. S. C. Rastogi, N. Mendiratta, P. Rastogi , 2004, Bioinformatics : Methods and Applications Genomics, Proteomics and Drug discovery, Prentice Hall of India Pvt. Ltd Publication.
2. A.D. Baxevanis and B.F.F.Ouellette, 2012, Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins: A.D. Baxevanis and B.F.F.Ouellette, Wiley interscience Publication.
3. Alfred Brown, Heidi Smith, 2014, Microbiological Applications (Laboratory manual in general microbiology), Mc Graw Hill, New York.

Instructions for Exam: Every student needs to complete 10 experiments in a semester.

Continuous Evaluation :

Viva	- 30 Marks
File/Records	- 10 Marks
Class Work/ Performance	- 05 Marks

Attendance - 05 Marks

Course Articulation Matrix

CO (M-BT-152)	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2
M-BT-152.1	3	3	1	1	1	1	1	3	2
M-BT-152.2	3	3	-	1	1	-	2	1	-
M-BT-152.3	3	3	2	1	1	2	-	1	1
M-BT-152.4	3	3	1	1	1	3	1	1	1
M-BT-152.5	3	3	3	1	1	-	3	1	1
M-BT-152.6	3	3	1	1	1	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)

M-MC-100: RESEARCH METHODOLOGY AND IPR

Periods/week	Credits	Max. Marks	: 100
L: 2 T:	2	Continuous Evaluation	
: 50			
Duration of Ext. Exam: 3 Hrs		End Semester Examination	: 50

Pre-requisites: None

Course Outcomes:

The students will be able to-

M-MC-100.1 describe the process of undertaking research to solve a relevant problem.

M-MC-100.2 interpret research related information by assimilating the available literature.

M-MC-100.3 demonstrate high degree of conduct and ethics while carrying out the research work.

M-MC-100.4 appreciate the concept of Intellectual Property Rights for the growth of individuals & nation.

M-MC-100.5 assess the incentives to inventors provided through IPR protection.

Unit 1: Meaning of research problem, Sources of research problem, Criteria, Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations

Unit 2: Effective literature studies approaches, analysis, Plagiarism, Research ethics

Unit 3: Effective technical writing, how to write report, Paper, Developing a Research Proposal, Format of research proposal, a presentation and Evaluation by a review committee

Unit 4: Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

Unit 5: Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

Unit 6: New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

References:

1. Stuart Melville and Wayne Goddard, 2010, "Research methodology: an introduction for science & engineering students'"
2. Ranjit Kumar, 2014, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners"
3. Halbert, 2007, Resisting Intellectual Property, Taylor & Francis Ltd.
4. Mayall, 1992, Industrial Design, McGraw Hill.

Course Articulation Matrix

CO (M-MC-100)	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2
M-MC-100.1	3	3	1	1	1	1	1	3	2
M-MC-100.2	3	3	2	3	1	1	2	1	-
M-MC-100.3	3	3	2	1	1	2	-	1	1
M-MC-100.4	3	3	1	3	1	3	1	1	1
M-MC-100.5	3	3	3	1	1	-	3	1	1

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES, FARIDABAD

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

M-MC-001: STRESS MANAGEMENT BY YOGA

Periods/week Credits
L: 2 T: 0

Pre-requisites: None

Course Outcomes:
The students will be able to-
M-MC-001.1 achieve overall health of body and mind
M-MC-001.2 overcome stress

Syllabus

Unit	Content	Hours
1	Definitions of Eight parts of yog. (Ashtanga)	**8**
2	• Yam and Niyam. Do`s and Don't's in life. i) Ahinsa, satya, astheya, bramhacharya and aparigraha ii) Shaucha, santosh, tapa, swadhyay, ishwarpranidhan	**8**
3	Asan and Pranayam i) Various yog poses and their benefits for mind & body. ii) Regularization of breathing techniques and its effects-Types of pranayam.	**8**

Suggested reading
1. 'Yogic Asanas for Group Tarining-Part-I" :Janardan Swami Yogabhyasi Mandal, Nagpur
2. "Rajayoga or conquering the Internal Nature" by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata

Course Articulation Matrix

CO (M-MC-001)	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2
M-MC-001.1	1	-	3	3	2	-	3	2	2
M-MC-001.2	1	1	3	3	2	1	3	2	2

2nd Semester

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES, FARIDABAD

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

M-BT-201: ADVANCED PLANT BIOTECHNOLOGY

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

Pre-requisites: Knowledge of Undergraduate level Biotechnology
Course Type: Core

Course Outcomes:
The students will be able to

M-BT-201.1	describe and select various plant tissue culture techniques for appropriate use.
M-BT-201.2	paraphrase the concepts of in-vitro growth and development of plants.
M-BT-201.3	illustrate the molecular mechanisms inherent in plant biotechnology.
M-BT-201.4	apply different techniques for growth promotion of cultured tissues/plant.
M-BT-201.5	evaluate the pros and cons of biotechnological strategies used in plant breeding.
M-BT-201.6	hypothesize the strategy for improvement of plants through biotechnological approaches.

Unit 1: Developmental Biology of Plants
Embryogenesis of plants, Cell Culture, Cellular totipotency, Somatic Embryogenesis, Triploid Production, In- vitro Pollination and Fertilization, Zygotic Embryo Culture, Somaclonal and Gametoclonal Variant Selection.

Unit 2: Industrial Applications
Secondary metabolite production, Mass culture of plant cells, Techniques for selection of high yielding cell Lines, Elicitor-induced accumulation of secondary products, Biotransformation using Plant Cell Cultures, Genetic transformation, Secondary metabolite Production using Genetically-Engineered Plant Cell Cultures.

Unit 3: Germplasm conservation
Types of germplasms, Modes and methods of germplasm conservation, Plant breeding for germplasm conservation, Plant quarantine, Laws and regulations related to Plant Genetic Resources.

Text Books/ Reference Books

1. S.S. Bhojwani and M.K. Razdan, 2010, Plant Tissue culture: Theory and Practice, Elsevier Science Publication, Netherlands.
2. B.R. Glick, J.J. Pasternak, 2010, Molecular Biotechnology: Principles and Applications of recombinant DNA, ASM press Publication, Washington DC.
3. P.K. Jaiwal, R.P. Singh, 2009, Plant Genetic Engineering, Metabolic engineering and Molecular farming, Studium Press LLC Publication, U.S.A.

Web links:
https://www.ncbi.nlm.nih.gov › NCBI › Literature › PubMed Central (PMC)
https://www.ncbi.nlm.nih.gov/pubmed/965014
vle.du.ac.in/mod/book/view.php?id=13141&chapterid=28369

Instruction for paper setting: Seven questions are to be set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Six questions will be set from all the three units (two from each unit). Student needs to attempt four more questions out of six, with at least one question from each unit. Each question will be of 20 marks.

Continuous Evaluation :

Sessional I - 30 Marks
Sessional II - 30 Marks
Assignments - 20 Marks
Class Work/Performance - 10 Marks
Attendance - 10 Marks

Course Articulation Matrix

CO Statement (M-BT-201)	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2
M-BT-201.1	2	-	2	2	2	-	-	3	3
M-BT-201.2	2	2	2	3	2	2	2	2	2
M-BT-201.3	2	1	-	2	2	-	-	-	1
M-BT-201.4	2	-	2	2	2	2	2	2	2
M-BT-201.5	2	1	2	2	2	1	2	2	1
M-BT-201.6	2	1	2	2	2	1	2	2	1

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES, FARIDABAD

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M-BT-202: ADVANCED ENVIRONMENTAL BIOTECHNOLOGY

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

Pre-requisites: Knowledge of Undergraduate level Biotechnology
Course Type: Core

Course Outcomes:
The students will be able to-

M-BT-202.1 assimilate significant knowledge of environmental resources and global environmental issues.
M-BT-202.2 explain different types of bioreactors for waste water treatment.
M-BT-202.3 classify hazardous wastes.
M-BT-202.4 differentiate in situ and ex situ technologies of bioremediation.
M-BT-202.5 evaluate the use of microorganisms and their processes to improve environmental quality.
M-BT-202.6 design ecofriendly technologies for human society.

Unit 1: Waste water treatment
Definition, types and collection of waste water, treatment: physical, chemical and biological processes, aerobic and anaerobic processes, Bioreactors.
Cleaner Technologies: Bioprocess and cleaner technologies for removal of specific pollutants: paper and pulp industry, dairy industry, dye industry, textile industry, sugar industry, tanning industry, antibiotic industry, etc.

Unit 2: Bioremediation
Introduction, Environmental site Evaluation s, microbial ecology of contaminated sites, *in situ* and *ex situ* technologies, Predictive models for efficacy of bioremediation, Heavy metal bioremediation**:** Sources of heavy metal pollution; Microbial interactions with inorganic pollutants - Microbial metal resistance; Microbial transformation; Accumulation and concentration of metals. Phytoremediation,Genetic Engineering to improve phytoremediation, Limitations & utilization of Phytoremediation by-product, Future of Phytoremediation

Unit 3: Biotechnology and sustainable development
Sustainable Development : Introduction & development, industrialization patterns, issues: global and regional and challenges, biodiversity conservation legislation and the Convention for Biological Diversity, the importance of local and indigenous knowledge, particularly in relation to management of biodiversity and sustainable livelihoods, genetic engineering and genetically modified organisms (GMOs), bioprospecting and biopiracy and the needs, challenges and alternatives for the future.

Text Books/ Reference Books:

1. Alan Scragg, 1995, Environmental Biotechnology, Oxford University Press.
2. Bruce Rittman, Perry L. McCarty, 2012, Environmental Biotechnology-Principles and Applications, McGraw-Hill Publication.
3. Raina M. Maier, Ian L. Pepper, Charles P. Gerba, 2002, Environmental Microbiology, Academic Press Publication.

Web links:
http://nptel.ac.in/courses/105105048/
http://nptel.ac.in/courses/122106030/Pdfs/1_4.pdf
http://nptel.ac.in/courses/105104102/4
http://nptel.ac.in/courses/102103013/module7/lec4/5.html
http://nptel.ac.in/courses/105108075/module9/Lecture40.pdf

Instruction for paper setting: Seven questions are to be set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Six questions will be set from all the three units (two from each unit). Student needs to attempt four more questions out of six, with at least one question from each unit. Each question will be of 20 marks.

Continuous Evaluation :
Sessional I - 30 Marks
Sessional II - 30 Marks
Assignments - 20 Marks
Class Work/Performance - 10 Marks
Attendance - 10 Marks

Course Articulation Matrix

CO Statement (M-BT-202)	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2
M-BT-202.1	2	3	2	2	3	-	-	1	-
M-BT-202.2	3	2	1	1	2	-	-	-	-
M-BT-202.3	2	3	1	2	2	1	-	-	2
M-BT-202.4	3	3	1	2	2	1	1	-	2
M-BT-202.5	3	3	1	2	2	-	1	2	1
M-BT-202.6	3	3	1	2	2	-	1	2	1

Program Elective-II

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES, FARIDABAD

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

M-BT-221 : FOOD PACKAGING TECHNOLOGY

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

Pre-requisites: Knowledge of Undergraduate level Biotechnology
Course Type: Elective

Course Outcomes:
The students will be able to-

M-BT-221.1	describe of the principles underlying the food packaging methods and technologies used.
M-BT-221.2	appreciate the food packaging technology used by industries.
M-BT-221.3	apply scientific principles in storage and packaging of food to maintain product quality.
M-BT-221.4	distinguish the methods of packaging used for different types of food.
M-BT-221.5	assess the mechanism of sterilization and processing for food packaging.
M-BT-221.6	design appropriate method of packaging of food using emerging technologies.

Unit 1: Introduction to packaging
Concept of packaging, Historical developments in packaging techniques, Principles of protective packaging and green packaging. Functions of packaging, Types of food packaging, Trends in food Packaging, Food Safety and Standards (Packaging and Labeling) Regulations Act 2011: Definitions- Best before, Date of manufacture, Date of packaging, Lot number or code number or batch number, Multi-piece package, Non- Vegetarian Food, Prepackaged or Pre-packed food, Packaging of cereals, pulses, water, milk and confectionaries, Use – by date or Recommended last consumption date or Expiry date, Wholesale package and other important terms, general requirements of packaging and labeling.

Unit 2: Types of packages
Different types of packaging materials and their properties, Deterioration of food and its prevention by packaging and other methods, shelf life and influencing factors, Interaction between foodstuff and printed packaging material. Classification of food stuffs according to BIS code and their packaging.

Unit 3: Manufacture of Packaging Materials
Manufacturing of packaging materials, Laminating and Coating process, Aseptic packaging system, Packaging machineries and equipments, Packaging testing, Disposal and recycling of packaging Materials.

Text / Reference Books:

1. Palmer, 2001, Enzymes, Horwood Publishing Series.
2. J.M. Jay, 1986, Modern Food Micro-biology, Van Nostrand Reinhold company, New York.
3. W. Gerhartz, 1990, Enzymes in Industry: Production and Applications, VCH Publishers, New York.
4. N.C. Price and Lewis Stevens, 2012, Fundamentals of Enzymology, Oxford Univ. Press.

Web links:
https://nptel.ac.in/courses/103107088/module37/lecture1/lecture1.pdf
https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/food_technology/food_packaging_technology/11.processing_and_converting_of__thermoplastic_materials/et/2651_et_m11.pdf
https://www.fssai.gov.in/dam/jcr:2d48f646.../Packaging_Labelling_Regulations.pdf

Web links:
http://www.roitt.com/

Instruction for paper setting: Seven questions are to be set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Six questions will be set from all the three units (two from each unit). Student needs to attempt four more questions out of six, with at least one question from each unit. Each question will be of 20 marks.

Continuous Evaluation :
Sessional I - 30 Marks
Sessional II - 30 Marks
Assignments - 20 Marks
Class Work/Performance - 10 Marks
Attendance - 10 Marks

Course Articulation Matrix

CO Statement (M-BT-221)	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PSO 1**	**PSO 2**
M-BT-221.1	2	3	2	2	3	2	2	3	2
M-BT-221.2	3	2	1	1	2	2	3	3	2
M-BT-221.3	2	3	1	2	2	2	1	3	2
M-BT-221.4	3	3	1	2	2	3	2	3	2
M-BT-221.5	3	3	1	2	2	1	2	3	2
M-BT-221.6	3	3	1	2	2	1	2	3	2

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES, FARIDABAD

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M-BT-222 : SEED TECHNOLOGY

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

Pre-requisites: Knowledge of Undergraduate level Biotechnology
Course Type: Elective

Course Outcomes:
The students will be able to-
M-BT-222.1 recognize conventional methods of crop breeding and seed production.
M-BT-222.2 appreciate the seed enhancement techniques.
M-BT-222.3 apply scientific principles for seed testing and quality control.
M-BT-222.4 distinguish various modes and mechanisms of transmission of microorganisms.
M-BT-222.5 assess the phytosanitary and quarantine rules.
M-BT-222.6 design appropriate method of seed storage using emerging technologies.

Unit 1: Seed Production
Introduction to crop breeding methods, variety testing, release and notification, hybrid seed production. Seed crop management, time of harvesting and threshing/extraction methods. Disease free clonal propagation of annual and perennial crops. Seed enhancement techniques, Artificial seeds and embryo rescue, Seed Processing

Unit 2: Seed Quality Control
Seed legislation, Seed Law Enforcement, Seed Certification Schemes, Seed sampling, seed moisture testing, purity analysis, germination testing, tolerance tables.

Significance of seed health. Mode and mechanism of transmission of microorganisms. Procedures for seed health test and rules. Externally and internally seed - borne pathogens, mode of infection, development and spread, methods of detection of seed borne diseases. Use of pesticides, botanicals, mycotoxins for seed treatments. Phytosanitary and Quarantine rules.

Unit 3: Seed Storage and Seed Industry Development
Requirements and types of seed storage. Factors affecting seed storage and role of moisture, temperature, RH and moisture equilibrium. Viability nomographs. Seed deterioration, Physiological, biochemical and molecular changes during seed ageing. Seed priming and seed coating, Seed drying and Packaging needs. Germplasm storage. Cryo preservation.

Trends in national and international seed industry development. International Seed Trade Federation (ISF) and Indian seed associations. Economics of seed production. Seed import and export.

Text / Reference Books:

1. J.D. Bewley, and L. Black, 2005, Physiology and Biochemistry of seeds in relation to germination, Springer-Verlag Publication, BerlinHeiderbe, New York.
2. JaimaKigel, and Galili, 2012, Seed development and germination, Marcel Dekker, New York.
3. A. Kha, 1998, The Physiology and Biochemistry of seed dormancy and germination, North Holland Publishing Co., Amsterdam, New York.
4. T.T. Kozlowski, 1995., Seed Biology, Academic Press Publication, London.

Web links:

1. http://agriinfo.in/default.aspx?page=topiclist&superid=3&catid=18
2. http://www.agrimoon.com/principles-of-seed-technology-pdf-book/
3. http://www.unipune.ac.in/Syllabi_PDF/revised_2014/science/vocational/7%20S.Y.B.Sc.%20Seed%20Technology.pdf

Instruction for paper setting: Seven questions are to be set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Six questions will be set from all the three units (two from each unit). Student needs to attempt four more questions out of six, with at least one question from each unit. Each question will be of 20 marks.

Continuous Evaluation :

Sessional I - 30 Marks
Sessional II - 30 Marks
Assignments - 20 Marks
Class Work/Performance - 10 Marks
Attendance - 10 Marks

Course Articulation Matrix

CO Statement (M-BT-222)	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PSO 1**	**PSO 2**
M-BT-222.1	2	3	2	2	3	2	2	3	2
M-BT-222.2	3	2	1	1	2	2	3	3	2
M-BT-222.3	2	3	1	2	2	2	1	3	2
M-BT-222.4	3	3	1	2	2	3	2	3	2
M-BT-222.5	3	3	1	2	2	1	2	3	2
M-BT-222.6	3	3	1	2	2	1	2	3	2

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES, FARIDABAD

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

M-BT-223: DOWNSTREAM PROCESSING

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

Pre-requisites: Knowledge of Undergraduate level Biotechnology
Course Type: Elective

Course Outcomes:

The students will be able to:

M-BT-223.1 describe the industrial aspects of microbiological processes.
M-BT-223.2 select and evaluate various bioseparation techniques.
M-BT-223.3 quantitatively assess the methods of cell disintegration.
M-BT-223.4 classify bioproducts of different categories.
M-BT-223.5 analyze and integrate different aspects of downstream processing for bioproduct development.
M-BT-223.6 design downstream process strategies for different applications.

Unit 1: Introduction to Downstream Process

Upstream and downstream aspects of bioprocess. Applications of downstream processing in bioprocesses, Problems associated with downstream processing of bioproducts

Physico-chemical basis of bioseparation: size, charge, shape, affinity, hydrophobic and hydrophilic interactions. Properties of bioproducts, classification of bioproducts: pharmaceutical, food, chemical, beverages and agricultural products.

Unit 2: Separation of particulate matter

Cell disintegration: mechanical, physical and chemical methods; filtration: filter aid, plate and frame filter, rotary vacuum filters, crossflow filtration, filtration at constant pressure, centrifugation: batch, semi-continuous, continuous, foam based separation, flocculation and broth conditioning, settling, sedimentation, decantation.

Unit 3: Enrichment and Purification Techniques

Extraction Techniques: Aqueous two phase extraction, adsorption, protein precipitation, super critical fluid extraction. Electrophoresis, chromatographic techniques: gel permeation, ion exchange, chromatography, affinity chromatography, HPLC. Process integration

Text Books/ Reference Books:

1. P. F. Stanbury and A. Whitaker, 2014, Principles of fermentation technology, Pergamon Press Publication.
2. M. L. Shuller, F. Kargi, 1994, Bioprocess Engineering, Prentice Hall PTR Publications, New Jersy.
3. P. M. Doran, 2001, Bioprocess Engineering Principles, Academic Press Publications
4. P.A. Belter, E.L Cussler and W.S. Hu, 2013, Bioseparation: Downstream Processing for Biotechnology, John Wiley & Sons Publication.

Web links:
https://www.boundless.com/microbiology/textbooks/boundless-microbiology-textbook/
http://nptel.ac.in/courses/103105054/
https://www.nap.edu/read/2052

Instruction for paper setting: Seven questions are to be set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Six questions will be set from all the three units (two from each unit). Student needs to attempt four more questions out of six, with at least one question from each unit. Each question will be of 20 marks.

Continuous Evaluation :
Sessional I - 30 Marks
Sessional II - 30 Marks
Assignments - 20 Marks
Class Work/Performance - 10 Marks
Attendance - 10 Marks

Course Articulation Matrix

CO Statement (M-BT-223)	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PSO 1**	**PSO 2**
M-BT-223.1	2	2	1	1	1	-	2	3	3
M-BT-223.2	-	-	-	2	1	2	1	2	1
M-BT-223.3	2	2	-	2	1	-	2	2	2
M-BT-223.4	1	2	2	1	1	1	2	2	1
M-BT-223.5	2	2	2	1	1	1	2	2	1
M-BT-223.6	2	2	2	1	1	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)

M-BT-224: STEM CELLS BASED TISSUE DEVELOPMENT

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

Pre-requisites: Knowledge of Undergraduate level Biotechnology
Course Type: Elective

Course Outcomes:

The students will be able to
M-BT-224.1 identify the potential sources of stem cells for tissue development.
M-BT-224.2 discover the potential of stem cells for development of tissue.
M-BT-224.3 categorize the processes involved in development of tissues.
M-BT-224.4 analyze the categories of stem cells for applications in healthcare.
M-BT-224.5 assess the strategies used in tissue development.
M-BT-224.6 propose new stem cell based therapy to overcome the shortcomings of existing approaches

Unit 1: Stem Cells & Tissue Development
Cell culture, cell extracellular matrix, native tissue architecture: maintenance, remodeling, and types of stem cells: Embryonic stem cells, MSC and adult stem cells; Wound healing and tissue regeneration- skin, liver, bone and lung. Cell migration- proliferation and motility, growth factors, actin cycle and migration. Artificial liver and artificial bone

Unit 2: Principles and applications of cell adhesion in Tissue engineering
Cell adhesion: cell-extracellular matrix interactions, cell-cell Adhesion, cell adhesion molecules, biomechanics of cell adhesion; focus on vascular and blood cells. Biomedical applications of tissue engineering.

Unit 3: Regulatory and Clinical Issues in Tissue Engineering
Directives on Tissue Engineering, preclinical evaluation of tissue engineered constructs, handling of animal models. FDA regulation, other considerations relevant to engineered tissue. Case studies.

Text Books/ Reference Books:

1. Robert Lanza, 2013, Essential of stem cell biology, Elsevier Science & Technology Books Publication.
2. Marshak, 2001, Stem Cell Biology, Cold Spring Harbar Symposium Publication.
3. S. Sell, 2003, Stem Cell Handbook, Humana Press Publication.

Web links:
https://online.stanford.edu/courses/xgen204-stem-cell-therapeutics
http://www.biolim.org/programmes/online-courses/open/certificate-course-on-stem-cells/
https://stemcells.nih.gov/info/2001report/chapter11.htm
http://nptel.ac.in/courses/105104102/4
https://www.nature.com/articles/ni0402-318?proof=t
https://www.broadinstitute.org/what-broad/areas-focus/project-spotlight/questions-and-answers-about-crispr

Instruction for paper setting: Seven questions are to be set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Six questions will be set from all the three units (two from each unit). Student needs to attempt four more questions out of six, with at least one question from each unit. Each question will be of 20 marks.

Continuous Evaluation :
Sessional I - 30 Marks
Sessional II - 30 Marks
Assignments - 20 Marks
Class Work/Performance - 10 Marks
Attendance - 10 Marks

Course Articulation Matrix

CO Statement (M-BT-224)	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PS O 1**	**PS O 2**
M-BT-224.1	2	-	-	1	1	1	2	3	3
M-BT-224.2	2	2	2	1	2	2	3	3	3
M-BT-224.3	1	1	-	2	1	2	1	2	2
M-BT-224.4	2	2	1	2	2	3	2	3	2
M-BT-224.5	1	1	2	1	1	1	2	3	2
M-BT-224.6	1	1	2	1	1	1	2	3	2

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES, FARIDABAD

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

M-BT-225: TECHNOLOGY OF NANOSTRUCTURED FABRICATIONS

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

Pre-requisites: Knowledge of Undergraduate level Biotechnology
Course Type: Elective

Course Outcomes:
The students will be able to-
M-BT-225.1 define the use of nanomaterials owing to its versatility and usefulness.
M-BT-225.2 classify different types of nanometerials.
M-BT-225.3 discover the analytical methods for material characterization.
M-BT-225.4 apply suitable method of synthesis for target nanomaterial.
M-BT-225.5 summarize various methods of nanomaterial synthesis.
M-BT-225.6 characterize the nanomaterial on the basis of different properties.

Unit 1: Introduction to Material Science
Chemical Bonding: Types of bonds, hybridization, Molecular orbital theory for simple molecules such as diatomic molecule. Types of Imperfections in solids. Properties of individual nanostructures. Bulk nanostructured materials. Foundations of Quantum and Statistical Mechanics for nanomaterials. Analytical Techniques for Material characterization: X- ray Diffraction (XRD), Fourier Transform Infra Red (FTIR) Spectroscopy, Raman Spectroscopy, Ellipsometry, Nuclear Magnetic Resonance (NMR), Electron Microscopes: Scanning electron Microscopy and Transmission electron microscopy, Scanning Probe Microscopes – Scanning tunneling microscopy (STM), Atomic Force Microscope (AFM).

Unit 2: Properties of Nanomaterials
Types of materials- Metal, semiconductors, composite materials- ceramics, alloys and polymers, Properties of materials &nanomaterials, role of size in nanomaterials.
Synthesis of Nanomaterials Physical Methods, Chemical Methods and Biological Methods, Quantum Dots, Lithographic Techniques, NEMS and MEMS.
Carbon Nanotube and its Functionalization: Preparation of Carbon Nano-Tubes- CVD and other methods of preparation of CNT. Properties of Carbon Nanotubes- Applications of Carbon Nanotubes, Functionalization of Carbon Nanotubes.

Unit 3: Chemical Routes for Synthesis of Nanomaterials
Chemical precipitation and co-precipitation; Sol-gel synthesis; Microemulsions or reverse micelles; Solvothermal synthesis; Thermolysis routes, Microwave heating synthesis; Sonochemical synthesis; Photochemical synthesis; Synthesis in supercritical fluids. Metal Nanoparticles: Size and shape control of metal Nanoparticles and their characterization; Semiconductor Nanoparticles: Size and shape control of semiconductor Nanoparticles and their characterization. Organic nanoparticles: Size and shape control of nanoparticles and their characterization. Inorganic-organic hybrid nanoparticles; Nanopolymers: Preparation and characterization of diblock Copolymer based nanocomposites

Text Books:

1. Eisberg, Robert; Resnick, Robert, 2014, Quantum Physics of Atoms, Molecules, Solids, Nuclei, and Particles,John Wiley Publication.
2. Harold P. Klug, Leroy E. Alexander, 2002, X-Ray Diffraction Procedures: For Polycrystalline and Amorphous Materials, Wiley Publication.
3. CNR Rao, 2010, Chemistry of nanomaterials: Synthesis, properties and applications, Wiley Publication.

Web links:

http://old.kpfu.ru/f6/b_files/nanophys3!307.pdf
https://www.ttu.ee/public/m/Mehaanikateaduskond/Instituudid/Materjalitehnika_instituut/MTX9100/Lecture11_Synthesis.pdf
https://is.muni.cz/el/1431/podzim2006/C7780/um/Read/2712941/nanopartcl_chemsynth_ApplOMC01_331.pdf

Instruction for paper setting: Seven questions are to be set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Six questions will be set from all the three units (two from each unit). Student needs to attempt four more questions out of six, with at least one question from each unit. Each question will be of 20 marks.

Continuous Evaluation :

Sessional I - 30 Marks
Sessional II - 30 Marks
Assignments - 20 Marks
Class Work/Performance - 10 Marks
Attendance - 10 Marks

Course Articulation Matrix

CO Statement (M-BT-225)	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PSO 1**	**PSO 2**
M-BT-225.1	2	3	2	2	-	2	2	3	2
M-BT-225.2	3	2	1	1	-	2	3	3	2
M-BT-225.3	2	3	1	2	1	2	1	3	2
M-BT-225.4	3	3	1	2	1	3	2	3	2
M-BT-225.5	3	3	1	2	1	1	2	3	2
M-BT-225.6	3	3	1	2	1	1	2	3	2

Program Elective-IV

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES, FARIDABAD

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

M-BT-226: NUTRACEUTICALS AND FUNCTIONAL FOODS

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

Pre-requisites: Knowledge of Undergraduate level Biotechnology
Course Type: Elective

Course Outcomes:
The students will be able to-

M-BT-226.1 recognize the nutraceutical importance of food and its components.
M-BT-226.2 classify nutraceuticals and functional foods.
M-BT-226.3 appreciate nature of phytonutrients and their therapeutic applications.
M-BT-226.4 categorize different types of functional elements of food that are of nutraceutical importance
M-BT-226.5 assess the role of Nutrition and functional foods in diseases
M-BT-226.6 recommend appropriate composition of functional foods for dietary benefits.

Unit 1: Introduction to Nutraceuticals and functional Foods

Definition, concept, and history, Classification of nutraceuticals and functional foods, Management of diseases and disorders, Antioxidants and flavonoids: omega – 3 fatty acids, Dietary fiber, Phytoestrogens, Glucosinates, organosulphur compounds.

Unit 2: Isolation of phytochemicals from plant materials

Isoprenoids, Isoflavones, and Flavonoids, Terpenoids, carotenoids, Polyunsaturated fatty acids, Sphingolipids, lecithin, & choline, Probiotics and their health benefits, Prebiotics: Prebiotic ingredients in foods; Types of prebiotics and their effects on gut microbes

Unit 3 Nutrition and functional foods in diseases

Obesity, Diabetes, Cardiovascular health, Arthritis, Nephrological disorders, Liver disorders, Nutraceutical rich supplements, Immunomodulators /vaccines through functional foods , Nutrigenomics

Text Books

1. Wildman, 2007, Handbook of Nutraceuticals and Functional Foods, second edition. CRC Press.
2. Palmer, 2001, Enzymes, Horwood Publishing Series.
3. J.M. Jay, 1986, Modern Food Micro-biology, Van Nostrand Reinhold company, New York.
4. W. Gerhartz, 1990, Enzymes in Industry: Production and Applications, VCH Publishers, New York.
5. N.C. Price and Lewis Stevens, 2012, Fundamentals of Enzymology, Oxford Univ. Press.

Reference books

1. Brigelius-Flohé, J &Joost HG. Nutritional Genomics: Impact on Health and Disease. Wiley VCH. 2006.
2. Cupp J & Tracy TS. Dietary Supplements: Toxicology and Clinical Pharmacology. Humana Press. 2003.

Web links:

http://www.pharmaceutical-journal.com/1-what-is-a-nutraceutical/20002095.article

http://www.fda.gov.tw/upload/189/content/20140128170435362259.pdf
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4336979/
https://www.ncbi.nlm.nih.gov/pubmed/22360273

Instruction for paper setting: Seven questions are to be set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Six questions will be set from all the three units (two from each unit). Student needs to attempt four more questions out of six, with at least one question from each unit. Each question will be of 20 marks.

Continuous Evaluation :
Sessional I - 30 Marks
Sessional II - 30 Marks
Assignments - 20 Marks
Class Work/Performance - 10 Marks
Attendance - 10 Marks

Course Articulation Matrix

CO Statement (M-BT-226)	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PSO 1**	**PSO 2**
M-BT-226.1	3	2	2	-	-	2	2	3	2
M-BT-226.2	2	1	1	-	-	2	3	3	2
M-BT-226.3	3	1	2	2	1	2	1	3	2
M-BT-226.4	3	1	2	2	1	3	2	3	2
M-BT-226.5	3	1	2	1	1	1	2	3	2
M-BT-226.6	3	1	2	1	1	1	2	3	2

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES, FARIDABAD

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

M-BT-227: CROP IMPROVEMENT

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

Pre-requisites: Knowledge of Undergraduate level Biotechnology
Course Type: Elective

Course Outcomes:

The students will be able to-

M-BT-227.1	describe and select various plant tissue culture techniques for appropriate use.
M-BT-227.2	paraphrase the concepts of in-vitro growth and development of plants.
M-BT-227.3	illustrate the molecular mechanisms inherent in plant biotechnology.
M-BT-227.4	apply different techniques for growth promotion of cultured tissues/plant.
M-BT-227.5	evaluate the pros and cons of biotechnological strategies used in plant breeding.
M-BT-227.6	hypothesize the strategy for improvement of plants through biotechnological approaches.

Unit 1: Breeding Methods for Crop Improvement
Breeding Methods for Self and cross pollinated plants - Mass Selection, Bulk Method, Pedigree Method, Recurrent Selection, theory, Phenotypic and Genotypic Recurrent Selection, Types of cultivars- Pure lines, F1 hybrids, Open pollinated, Synthetics, Clonal, Multilines, Mutation Breeding, Heterosis.

Unit 2: Resistance to Biotic and Abiotic stress
Plant interaction with bacterial, viral and fungal pathogens, plant responses to pests and herbivores, breeding for pest resistance, physiological and molecular responses of plants to water stress, salinity stress, temperature stress, stress signaling pathways, ionic and osmotic homeostasis, oxidative burst and reactive oxygen species and other free radical scavenging.

Unit 3: Nutritional quality improvement in crop plants
Phytonutrients- vitamins, antioxidants, minerals, photosynthetic efficiency and crop yield, Post-harvest stability, biofortification, genetic engineering to improve nutritional profile in crop plants- Protein, carbohydrates and oil content. RNA interference and Gene silencing, Food safety Evaluation of GM crops.

Text Books/ Reference Books:

1. Noureddine Benkeblia, 2017, Phytonutritional Improvement of Crops, John Wiley & Sons Ltd.
2. Stacey, Burris and Evans, 2012, Biological Nitrogen Fixation, CBA Publishers and Distributor, New Delhi, India.
3. Rao, N.S.S., 1996, Biofertilizer in agriculture and Forestry, Oxford & IBM Pvt Ltd. Publication.

Web links:
https://learn.genetics.utah.edu/content/cotton/crop/
https://academic.oup.com/jxb/article/51/342/1/485700
http://www.biologydiscussion.com/crops/crop-improvement-methods-top-6-methods/17641

Instruction for paper setting: Seven questions are to be set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Six questions will be set from all the three units (two from each unit). Student needs to attempt four more questions out of six, with at least one question from each unit. Each question will be of 20 marks.

Continuous Evaluation :
Sessional I - 30 Marks
Sessional II - 30 Marks
Assignments - 20 Marks
Class Work/Performance - 10 Marks
Attendance - 10 Marks

Course Articulation Matrix

CO Statement (M-BT-227)	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PSO 1**	**PSO 2**
M-BT-227.1	2	2	3	-	-	2	2	3	2
M-BT-227.2	1	1	2	-	-	2	3	3	2
M-BT-227.3	1	2	2	2	1	2	1	3	2
M-BT-227.4	1	2	2	2	1	3	2	3	2
M-BT-227.5	1	2	2	1	1	1	2	3	2
M-BT-227.6	1	2	2	1	1	1	2	3	2

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES, FARIDABAD

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

M-BT-228: BIOPHARMACEUTICAL MANUFACTURING

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

Pre-requisites: Knowledge of Undergraduate level Biotechnology
Course Type: Elective

Course Outcomes:
The students will be able to-

M-BT-228.1	describe the regulations, facilities required and process fundamentals of bio-pharmaceutical manufacture
M-BT-228.2	classify the biopharmaceuticals and interpret requirements of their manufacture
M-BT-228.3	apply their fundamental knowledge for process development
M-BT-228.4	analyze the deficiencies in the existing biopharmaceutical manufacture processes
M-BT-228.5	assess suggest improvements in the existing biopharmaceutical manufacture processes
M-BT-228.6	design new biopharmaceutical manufacture processes

Unit 1: Drugs and cosmetics pharmacopoeias
Pharmacopoeias of different countries, Drug and cosmetics act, New Drug Development- filing of INDA (Investigational new drug application), Drug approval processes by FDA and CDSCO, Clinical trials, Manufacture of biopharmaceuticals, regulatory requirements, Good Manufacturing Practices & Quality Assurance.

Unit 2: Biopharmaceutics basics
Bioavailability, Bioequivalence, Absoprtion – Distribution – Metabolism – Excretion (ADME), Drug efficiency and dose response concept. Biosimilar- Case study, Blood and blood products, therapeutic enzyme, gene therapy products

Unit 3: Biopharmaceutical manufacture
Vaccine Classification, vaccines production technology, antibodies in therapy, antibody engineering, monoclonal antibodies, immunoconjugates - specific drug targeting, therapeutic use of cytokines, immunomodulators classification, development of immune-diagnostics

Text Books:

1. A. P. Pawar & R .S. Gaud, 2004, Modern Dispensing Pharmacy, Career Publication.
2. M. E. Aulton, 2015, Pharmaceutics the Science of Dosage form design, Churchill Livingstone Publication.
3. Remington and Martin, 1999, Remington's Pharmaceutical Sciences, Mack Publishing Company.
4. L. Lachman& H. A. Liebermann, 2012, The Theory & Practice of Industrial Pharmacy:, 3rd Ed., Varghese Publishing House, New Delhi.

Web links:
https://www2.deloitte.com/content/dam/Deloitte/us/Documents/life-sciences-health-care/us-lshc-advanced-biopharmaceutical-manufacturing-white-paper-051515.pdf

https://www.nist.gov/sites/default/files/documents/mml/Thomas.pdf
https://www.researchgate.net/publication/256321375_Essentials_of_Pharmaceutical_Technology

Instruction for paper setting: Seven questions are to be set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Six questions will be set from all the three units (two from each unit). Student needs to attempt four more questions out of six, with at least one question from each unit. Each question will be of 20 marks.

Continuous Evaluation :
Sessional I - 30 Marks
Sessional II - 30 Marks
Assignments - 20 Marks
Class Work/Performance - 10 Marks
Attendance - 10 Marks

Course Articulation Matrix

CO M-BT-228	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2
M-BT-228.1	2	2	3	2	-	3	2	3	2
M-BT-228.2	3	2	3	2	2	3	2	2	2
M-BT-228.3	3	3	2	2	2	2	3	2	2
M-BT-228.4	3	3	3	2	2	3	2	1	2
M-BT-228.5	3	3	3	2	2	3	2	1	2
M-BT-228.6	3	3	3	3	3	3	2	1	1

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES, FARIDABAD

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M-BT-229: STEM CELLS THERAPY

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

Pre-requisites: Knowledge of Undergraduate level Biotechnology
Course Type: Elective

M-BT-229.1: explain the need, application of stem cells
M-BT-229.2: classify stem cells and application areas
M-BT-229.3: apply the knowledge of biotechnology for culture, manipulation and delivery of stem cells
M-BT-229.4: analyze the bottlenecks in stem cell therapies
M-BT--229.5: suggest the areas of potential improvements in the present stem cell therapies
M-BT-229.6: design novel stem cell therapies

Unit 1: Stem Cell Treatment
Haematopoietic disorders, Stem cell transplantation- bone marrow stem cells, peripheral blood stem cells and umbilical cord blood stem cells. Stem cells in gene therapy, complications related to the therapy, stem cell banks.

Unit 2: Applications of stem cell therapy
Gene therapeutic approaches: Induced pluripotent stem cell, Somatic cell nuclear transfer prospects in disease treatment, repairing the damaged heart in acute heart attack and chronic coronary artery disease, treatment of diabetes, cystic fibrosis and neurological disorders, prospects and limitations of stem cell research.

Unit 3: Ethical, Legal and Social issues
Ethical issues- embryo destruction and relief of human suffering, viability of embryo, purpose of embryo creation, new and existing cell line, effectiveness of alternative techniques.
Legal and Social aspects- legislations in the field of stem cells, risk- benefits Evaluation , commercial aspects of stem cells and consent of donors.

Text Books:

1. Robert Lanza, 2013, Essential of stem cell biology, Elsevier Science & Technology Books Publication.
2. Marshak, 2001, Stem Cell Biology, Cold Spring Harbar Symposium Publication.
3. S. Sell, 2003, Stem Cell Handbook, Humana Press Publication.

Web links:
https://nptel.ac.in/courses/102106036/27
https://epgp.inflibnet.ac.in/ahl.php?csrno=3
https://nptel.ac.in/courses/118106019/Module%2010/Lecture%201/Lecture%201.pdf

Instruction for paper setting: Seven questions are to be set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Six questions will be set from all the three units (two from each unit). Student needs to attempt four more questions out of six, with at least one question from each unit. Each question will be of 20 marks.

Continuous Evaluation :

Sessional I - 30 Marks
Sessional II - 30 Marks
Assignments - 20 Marks
Class Work/Performance - 10 Marks
Attendance - 10 Marks

Course Articulation Matrix

CO M-BT-229	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2
M-BT-229.1	3	3	3	2	2	2	-	-	1
M-BT-229.2	3	3	3	3	3	2	2	2	1
M-BT-229.3	2	3	3	3	2	1	1	-	2
M-BT-229.4	3	3	3	3	2	2	2	1	2
M-BT-229.5	3	3	1	2	2	1	1	2	1
M-BT-229.6	3	3	2	2	2	1	1	2	1

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES, FARIDABAD

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

M-BT-230: NANOMATERIALS AND APPLICATIONS

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

Pre-requisites: Knowledge of Undergraduate level Biotechnology
Course Type: Elective

Course Outcomes:
The students will be able to-

M-BT-230.1 define the use of nanomaterials owing to its versatility and usefulness.
M-BT-230.2 classify different types of nanometerials.
M-BT-230.3 discover the methods of nanomaterial synthesis.
M-BT-230.4 apply suitable method of synthesis for target nanomaterial.
M-BT-230.5 summarize various methods of nanomaterial synthesis.
M-BT-230.6 characterize the nanomaterial on the basis of different properties.

Unit 1: Nanoparticles and Microorganisms
Microbial Nanoparticle production, Microorganisms for toxicity detection, nanocomposite biomaterials for teeth and bone substitution, Magnetosomes and Bacteriorhopsin, Protein based nanostructures-S layers, Engineered Nanopores, Nanoparticles as non viral transfection agents. Nanoparticle-biomaterial hybrid systems for bioelectronics devices and circuitry. Biomimetic fabrication of DNA based Metallic Nanowires and Networks, Biomimetic Ferritins for high density Data Storage, Therapeutic action of nanoparticles and nanodevices.

Unit 2: Nanomaterials for Solar Energy &Photovoltaics
Introduction of energy storage/conversion devices, State-of-the art status of portable power sources, Solar/photovoltaic (PV) cells as a source of green energy; Fundamentals, Materials, Design and Implementation aspects of PV energy generation and consumption; Solar cell technologies (Si-wafer based, Thin film, GaAs based, dye-sensitized, PESC and organic solar cells), Efficiency of solar cells and PV array analysis, Photovoltaic systemdesign (stand alone and grid connected) and applications

Unit 3: Applications
Two Dimensional Nanostructures: Thin Films and Special Nanomaterials. Chemical and biosensors. Nanomedicine and nanobiotechnology, Nanoparticle Exposure and Nanotoxicology challenges. Nanoparticle Interaction with Biological Membranes. Guidelines for Working with Engineered Nanomaterials

Text/ Reference Books:

1. H. P. Garg And J. Prakash, 1997, Solar Energy: Fundamentals & Applications, Tata Mcgraw Hill.
2. G. N. Tiwari, S. Dubey & Julian C. R. Hunt, 2009, Fundamentals of Photovoltaic Modules And Their Applications, RSC Energy Series.
3. C. S. Solanki, 2011, Solar Photovoltaics: Fundamentals, Technologies And Applications, Prentice Hall.
4. Stephen Fonash, 2010, Solar Cell Device Physics, Academic Press.

Web Links:
http://www.wtec.org/loyola/nano/IWGN.Research.Directions/chapter07.pdf
http://www.nanotech-now.com/current-uses.htm
https://www.nano.gov/you/nanotechnology-benefits

Instruction for paper setting: Seven questions are to be set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Six questions will be set from all the three units (two from each unit). Student needs to attempt four more questions out of six, with at least one question from each unit. Each question will be of 20 marks.

Continuous Evaluation :

Sessional I - 30 Marks
Sessional II - 30 Marks
Assignments - 20 Marks
Class Work/Performance - 10 Marks
Attendance - 10 Marks

Course Articulation Matrix

CO M-BT-230	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2
M-BT-230.1	2	3	2	2	3	-	-	1	-
M-BT-230.2	3	2	1	1	2	-	-	-	-
M-BT-230.3	2	3	1	2	2	1	-	-	2
M-BT-230.4	3	3	1	2	2	1	1	-	2
M-BT-230.5	3	3	1	2	2	-	1	2	1
M-BT-230.6	3	3	1	2	2	-	1	2	1

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES, FARIDABAD

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

M-BT-251: ADVANCED PLANT BIOTECHNOLOGY LAB

Periods/week	Credits	Max. Marks	:100
P: 4	2	Continuous Evaluation : 50	
Duration of Ext. Exam: 3 Hrs		End Semester Examination	: 50

Pre-requisites: None

Course outcomes:

The students will be able to-

M-BT-251.1 learn the sterilization techniques to maintain aseptic conditions.
M-BT-251.2 prepare different nutrient media for tissue culture.
M-BT-251.3 develop plant tissue cultures from various explants.
M-BT-251.4 isolate the plant protoplast by enzymatic method.
M-BT-251.5 demonstrate the techniques to study abiotic stress response in plants.
M-BT-251.6 apply gene transfer methods in plants.

List of Experiments:

1. To study preparation of different plant tissue culture media
2. To study different plant growth parameters
3. To isolate the DNA from cultured cell/plantlet and test for its purity
4. To isolate plant protoplast by mechanical and enzymatic method.
5. To learn the technique of micropropagation using different explants
6. To learn the technique of callus culture using different explants
7. To study the production of secondary metabolites in plant tissue cultures
8. To study abiotic stress response in plants
9. To analyze the distribution of stress protein in different plant parts by SDS PAGE.
10. To study *Agrobacterium tumefaciens* mediated gene transfer method in plants
11. To detect GMO in food products
12. Visit to a commercial Plant Tissue Culture Lab

Reference Books:

1. J.H. Dodde and L.W. Roberts, 1998, Experiments in plant tissue culture, Cambridge University Press Publication.
2. R.J. Henry, 2015, Practical application of Plant Molecular biology, Chapman and Hall Publication.

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

Continuous Evaluation :

Viva	- 30 Marks
File/Records	- 10 Marks
Class Work/ Performance	- 05 Marks
Attendance	- 05 Marks

Course Articulation Matrix

CO Statement (M-BT-251)	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2
M-BT-251.1	3	3	2	2	-	2	3	1	1
M-BT-251.2	3	3	1	-	-	2	3	1	1
M-BT-251.3	3	3	1	2	-	2	3	1	1
M-BT-251.4	3	3	-	-	-	2	3	1	1
M-BT-251.5	3	3	1	-	-	2	3	1	1
M-BT-251.6	3	3	1	-	-	2	3	1	1

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES, FARIDABAD

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

M-BT-252: ADVANCED ENVIRONMENTAL BIOTECHNOLOGY LAB

Periods/week	Credits	Max. Marks :100
P: 4	2	Continuous Evaluation : 50
Duration of Ext. Exam: 3 Hrs		End Semester Examination: 50

Pre-requisites: None

Course outcomes:
The students will be able to
M-BT-252.1 estimate of physical, chemical and biological parameters of water.
M-BT-252.2 determine the different solid contents in wastewater.
M-BT-252.3 determine the alkalinity of water.
M-BT-252.4 determine the hardness of water.
M-BT-252.5 determine electrical conductivity of water samples.
M-BT-252.6 determine the chemical oxygen demand of water.

List of Experiments:

1. To study the Microflora of polluted air.
2. To study the Microflora of polluted water.
3. To study the Microflora of polluted soil.
4. To detect coliphages in water/ sewage.
5. Determination of COD of given water sample
6. To study the ability of a soil bacterial community to adapt to imposed metal stress.
7. To study the process of metal accumulation by white rot fungi.
8. Estimation of Heavy metals in soil/ water samples.
9. To analyze enzymes involved in biotransformation
10. To estimate suspended particulate matter and gases in ambient air.
11. Isolation of Xenobiotic degrading bacteria from given samples.
12. To visit local ETP unit to observe waste water treatment.

Reference books:

1. Alan Scragg, 1995, Environmental Biotechnology, Oxford University Press.
2. Bruce Rittman, Perry L. McCarty, 2012, Environmental Biotechnology-Principles and Applications, McGraw-Hill Publication.
3. Raina M. Maier, Ian L. Pepper, Charles P. Gerba, 2002, Environmental Microbiology, Academic Press Publication.

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

Continuous Evaluation :

Viva	- 30 Marks
File/Records	- 10 Marks
Class Work/ Performance	- 05 Marks
Attendance	- 05 Marks

Course Articulation Matrix

CO (M-BT-252)	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2
M-BT-252.1	3	3	2	2	2	2	3	1	1
M-BT-252.2	3	3	1	-	1	2	3	1	1
M-BT-252.3	3	3	1	2	1	2	3	2	2
M-BT-252.4	3	3	-	-	-	2	3	1	1
M-BT-252.5	3	3	1	-	1	2	3	1	1
M-BT-252.6	3	3	-	-	-	2	3	1	1

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES, FARIDABAD

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M-BT-200 : MINI PROJECT

Periods/week	Credits	Max. Marks	: 200
L: 0 T:0 P:4	2	Continuous Evaluation	: 100
		End Semester Examination	: 100

Pre-requisites: None
Course Type: Project

Course outcomes:
The students will be able to-

M-BT-200.1 survey and review relevant previous work literature to identify the research gaps.
M-BT-200.2 formulate a meaningful and worthwhile research problem that is necessary to bridge the research gap as identified through literature survey.
M-BT-200.3 identify and apply appropriate methodologies to address the research objectives.
M-BT-200.4 work collaboratively with other researchers, demonstrating effective communication and problem-solving skills.
M-BT-200.5 demonstrate the responsible conduct of research with high degree of ethics and standards.
M-BT-200.6 present the research effectively in a conference setting and a written publication.

Every student will have to undertake a research project in the field relevant to Biotechnology. The student can either pursue the project work in-house or in a reputed industry or research organization, which will be approved by the respective Head of Department. During this course of time he/she will be regularly monitored and evaluated by the Departmental Project Committee/ Internal Supervisor/ Project Co-ordinator. Continuous monitoring will include Mid Term Review Presentations and Feedback from supervisor. After completion of the Mini Project, each student will have to submit the Project report (hard bound), deliver a presentation pertaining to research work undertaken and will have to appear for viva during End Semester Examination. The evaluation scheme will be as follows-

Internal Evaluation

Parameters of internal evaluation	Marks
Relevance of Project	10
Implementation of Project	30
Organization and Clarity	20
Technical Content & Conclusion	20
Presentation and Viva	20
TOTAL	**100**

End Semester Examination Evaluation

Parameters of internal evaluation	Marks
Project Report	25
Seminar/Presentation	15
Viva	10
TOTAL	**50**

Continuous Evaluation

Course Articulation Matrix

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

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES, FARIDABAD

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

M-MC-002: ENGLISH FOR RESEARCH PAPER WRITING

Periods/week	Credits	Max. Marks: Nil
L: 2 T: 0 P: 0	AP	

Pre-requisites: None
Course Type: Audit Pass

Course Outcomes:

The students will be able to-

M-MC-002.1 identify how to improve the writing skills and level of readability.
M-MC-002.2 learn about what to write in each section.
M-MC-002.3 understand the skills needed for writing a title.
M-MC-002.4 design the good quality of paper at very first-time submission.

Unit 1
Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing, Redundancy, Avoiding Ambiguity and Vagueness

Unit 2
Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts.

Unit 3
Introduction, Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.

Unit 4
Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature,

Unit 5
Skills needed when writing the Methods, skills needed when writing, the Results, skills needed when writing the Discussion, skills needed when writing the Conclusions

Unit 6
Useful phrases, how to ensure paper is as good as it could possibly be the first- time submission

Reference Books:

1. R. Goldbort, 2006, Writing for Science, Yale University Press.
2. R. Day, 2006, How to Write and Publish a Scientific Paper, Cambridge University Press
3. N. Highman, 1998, Handbook of Writing for the Mathematical Sciences, SIAM, Highman's book.
4. Adrian Wallwork, 2011, English for Writing Research Papers, Springer New York Dordrecht, Heidelberg London.

Program Elective-V

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES, FARIDABAD

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

M-BT-321 : ENTREPRENEURSHIP OPPORTUNITIES IN FOOD INDUSTRY

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

Pre-requisites: Knowledge of Undergraduate level Biotechnology
Course Type: Elective

Course Outcomes:

The students will be able to-

M-BT-321.1 describe the fundamental principles of entrepreneurship.
M-BT-321.2 interpret competencies required forestablishing new venture.
M-BT-321.3 apply business creation dynamics and have the ability to generate food business models.
M-BT-321.4 critically analysing business model strengths and weaknesses.
M-BT-321.5 assess basic financial modelling for new food ventures.
M-BT-321.6 conduct financial planning, control and pricing for a new food venture.

Unit 1: Entrepreneurship and regulatory affairs

Entrepreneurship- basic concepts, Entrepreneur traits and types of motivation, Food business opportunities in India and Case studies, Trademarks: - concept, registration, refusal and opposition, Patent: - types, patentable and non patentable objects and Procedure of filing application patent , Registration of food business, validity, renewal and cancellation of license

Unit 2: Project management and marketing

Concepts of Project management, Search of business idea. Significance and preparation of project report, Market feasibility report and Principles of marketing, Methods of marketing, Significance and importance of market research.

Unit 3: Financial management

Definition and objectives of Financial management, Sources of finance and Capital structure, Criteria of selection and purchase of land, Unit of Sale, Unit Price and Break Even Analysis, Cash flow projections and Budgeting

Text Books/Reference Books

1. Darrah, 2002, Food Marketing, The Ronald Press Comp. New York.
2. R.E. Branson, D.G. Norvell, 2010, Introduction to Agricultural Marketing, McGraw Hill Book Comp. New York.
3. Shepherd, 2014, Marketing of Farm Products,The Lows State College Press, Ames, Lowa.

Instruction for paper setting: Seven questions are to be set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Six questions will be set from all the three units (two from each unit). Student needs to attempt four more questions out of six, with at least one question from each unit. Each question will be of 20 marks.

Continuous Evaluation :

Sessional I - 30 Marks

Sessional II - 30 Marks
Assignments - 20 Marks
Class Work/Performance - 10 Marks
Attendance - 10 Marks

Course Articulation Matrix

CO M-BT-321	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2
M-BT-321.1	3	3	3	2	2	2	-	-	1
M-BT-321.2	3	3	3	3	3	2	2	2	1
M-BT-321.3	2	3	3	3	2	1	1	-	2
M-BT-321.4	3	3	3	3	2	2	2	1	2
M-BT-321.5	3	3	1	2	2	1	1	2	1
M-BT-321.6	3	3	2	2	2	1	1	2	1

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES, FARIDABAD

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

M-BT-322: MOLECULAR BREEDING AND TRANSGENIC PLANTS

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

Pre-requisites: Knowledge of Undergraduate level Biotechnology
Course Type: Elective

Course Outcomes:
The students will be able to-

M-BT-322.1	describe the conventional techniques of plant breeding.
M-BT-322.2	interpret the concepts of genetic inheritance and evolutionary plant breeding.
M-BT-322.3	appraise the significance of transgene transcription
M-BT-322.4	assess the usefulness of bioengineering technology in plant breeding.
M-BT-322.5	apply molecular techniques in plant breeding.
M-BT-322.6	critically evaluate the transgene technology as a strategy for crop improvement

Unit 1: Genetic bases of plant breeding
Centres of origin and patterns of evolution in crop plants, Gene pool concept and gene introgression, Single gene and multiple gene concepts, Heritability and genetic advance: Heterosis and inbreeding depression, Breeding of self-pollinated, cross-pollinated and asexually propagated crops, Hybrid breeding, population improvement and Clonal selection, Mutation breeding, use of polyploidy and distant hybridization in plant breeding, Molecular markers, tagging of genes, Molecular assisted selection and molecular maps.

Unit 2: Introduction to Transgenic Plants
Crop improvement, Strategies for introducing Biotic stress resistance, Strategies for introducing Abiotic stress resistance, Bioengineering crops for biofuel, Production of recombinant proteins from plant cells (drugs, vaccines, antibodies), Molecular genetics of T-DNA transfer from Agrobacterium to plants, Recombinant DNA technology for enhanced gene expression

Unit 3: Transgene transcription
Stabilities and instabilities in transgene Expression, Gene silencing, Role of post-transcriptional control in transgenic gene design, Analysis of transgenic plants: Standard molecular techniques for the analysis of transgenic plants, Case Studies: Insect & Herbicide Resistance, Golden Rice, Nutritious potato, Enzymes etc., Relevance of transgenic crops in Indian agriculture, Biosafety testing for transgenes and transgenic events.

Text / Reference Books:

1. S.S. Bhojwani and M.K. Razdan, 2010, Plant Tissue culture: Theory and Practice, Elsevier Science Publication, Netherlands.
2. B.R. Glick, J.J. Pasternak, 2010, Molecular Biotechnology: Principles and Applications of recombinant DNA, ASM press Publication, Washington DC.
3. P.K. Jaiwal, R.P. Singh, 2009, Plant Genetic Engineering, Metabolic engineering and Molecular farming, Studium Press LLC Publication, U.S.A.

Instruction for paper setting: Seven questions are to be set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Six questions will be set from all the three units (two from each unit). Student needs to attempt four more questions out of six, with at least one question from each unit. Each question will be of 20 marks.

Continuous Evaluation :

Sessional I - 30 Marks
Sessional II - 30 Marks
Assignments - 20 Marks
Class Work/Performance - 10 Marks
Attendance - 10 Marks

Course Articulation Matrix

CO (M-BT-322)	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2
M-BT-322.1	3	3	3	2	2	2	-	-	1
M-BT-322.2	3	3	3	3	3	2	2	2	1
M-BT-322.3	2	3	3	3	2	1	1	-	2
M-BT-322.4	3	3	3	3	2	2	2	1	2
M-BT-322.5	3	3	1	2	2	1	1	2	1
M-BT-322.6	3	3	2	2	2	1	1	2	1

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES, FARIDABAD

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

M-BT-323 : ADVANCES IN FERMENTATION TECHNOLOGY

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

Pre-requisites: Knowledge of Undergraduate level Biotechnology
Course Type: Elective

Course Outcomes:
The students will be able to-

M-BT-323.1	explain the advanced concepts in fermentation technology
M-BT-323.2	interpret the requirements for maximization of profitability of fermentation process
M-BT-323.3	apply the knowledge of biotechnology for culture, manipulation and application of industrially useful microorganisms
M-BT-323.4	analyze the bottlenecks in fermentation processes for industrial biotechnology
M-BT-323.5	suggest the areas of potential improvements in the bioprocess for existing products
M-BT-323.6	design bioprocess for novel products

Unit 1: General Principles of fermentation
Products of fermentation, Isolation, screening and maintenance of Selection industrially important microorganisms, Metabolic regulations in industrial fermentation Strain improvement, Fermentation economics

Unit 2: Antibiotics and amino acids
Enzymatic bioconversions e.g. starch and sugar conversion processes; high-fructose corn syrup; application of enzymes in baking, wine and beer making, and cheese making, production of amino acids and vitamins, production of probiotics and prebiotics

Unit 3: Production of Biologicals
Industrial production of penicillin via fungal route, insulin from recombinant E. coli; Production of metabolites such as shikonin using plant cell culture, astaxanthin from algae, and biotransformation routes for novel/specialty chemicals; Production of HBsAg using yeast cultures, erythropoietin using CHO cells, monoclonal antibodies such as Humira using mammalian cells

Text Books/ Reference Books:

1. Gregory Stephanopoulos, Aristos Aristidou, Jens Nielsen, 2003, Metabolic Engineering: Principles and Methodologies, Academic Press Publications.

2. Gregory Stephanopoulos, 2005, Metabolic Engineering, Elsevier India Publication.

3. P.F. Stanbury, and A. Whitaker, 1984, Principles of Fermentation Technology, Pergamon Press.

Instruction for paper setting: Seven questions are to be set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Six questions will be set from all the three units (two from each unit). Student needs to attempt four more questions out of six, with at least one question from each unit. Each question will be of 20 marks.

Continuous Evaluation :
Sessional I - 30 Marks
Sessional II - 30 Marks
Assignments - 20 Marks
Class Work/Performance - 10 Marks
Attendance - 10 Marks

Course Articulation Matrix

CO M-BT-323	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2
M-BT-323.1	3	3	3	2	2	2	-	-	1
M-BT-323.2	3	3	3	3	3	2	2	2	1
M-BT-323.3	2	3	3	3	2	1	1	-	2
M-BT-323.4	3	3	3	3	2	2	2	1	2
M-BT-323.5	3	3	1	2	2	1	1	2	1
M-BT-323.6	3	3	2	2	2	1	1	2	1

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES, FARIDABAD

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

M-BT-324 : BIOETHICS IN STEM CELL TECHNOLOGY

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

Pre-requisites: Knowledge of Undergraduate level Biotechnology
Course Type: Elective

Course Outcomes:
The students will be able to-

M-BT-324.1	define stem cells, their applications and related ethical considerations
M-BT-324.2	interpret the inherent difficulties and issues in applications of stem cell technology.
M-BT-324.3	apply the principles of bioethics in implementation of stem cell technologies.
M-BT-324.4	analyze pros and cons of stem cell technologies.
M-BT-324.5	suggest the areas of potential improvements in the stem cell technology.
M-BT-324.6	design guidelines for bioethical situations to stem cell technology related issues.

Unit 1: Introduction to Stem cells:
Features of Stem Cells, Molecular basis of pluripotency and self renewal, Types of stem cells: Embryonic stem cells, Hematopoietic stem cells, Mesenchymal stem cells, adult stem cells and induced pluripotent cells, Stem cell nitches; Fate Mapping Techniques.

Unit 2: Bioethics in Stem cell Technology
Social and ethical issues in Stem Cell Therapy; The legal and socioeconomic impacts; Public education of the processes of stem cell therapy; Public acceptance issues; Medical uses and social responsibility.

Unit 3: Regulations for Stem cell Technology
FDA perspective; Ethical, moral and legal issues in Stem Cell Research; gene therapy; therapeutic cloning; bone marrow transplantation; Stem cell banking; induced pluripotent cells; SCNT; stem cell lines.

Text Books/ Reference Books:

1. Lori Gruen, Laura Grabel, 2013, Stem Cell Research: Ethical Issues, Peter Singer Publisher Willey.
2. Robert Lanza, 2013, Essential of stem cell biology, Elsevier Science & Technology Books Publication.
3. Marshak, 2001, Stem Cell Biology, Cold Spring Harbar Symposium Publication.
4. S. Sell, 2003, Stem Cell Handbook, Humana Press Publication.

Instruction for paper setting: Seven questions are to be set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Six questions will be set from all the three units (two from each unit). Student needs to attempt four more questions out of six, with at least one question from each unit. Each question will be of 20 marks.

Continuous Evaluation :

Sessional I	- 30 Marks
Sessional II	- 30 Marks
Assignments	- 20 Marks
Class Work/Performance	- 10 Marks
Attendance	- 10 Marks

Course Articulation Matrix

CO M-BT-324	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2
M-BT-324.1	3	3	3	2	2	2	-	-	1
M-BT-324.2	3	3	3	3	3	2	2	2	1
M-BT-324.3	2	3	3	3	2	1	1	-	2
M-BT-324.4	3	3	3	3	2	2	2	1	2
M-BT-324.5	3	3	1	2	2	1	1	2	1
M-BT-324.6	3	3	2	2	2	1	1	2	1

MANAV RACHNA INTERNATIONALINSTITUTE OF RESEARCH AND STUDIES, FARIDABAD

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

M-BT-325: NANOSCALE DEVICES

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

Pre-requisites: Knowledge of Undergraduate level Biotechnology
Course Type: Elective

Course Outcomes:

The students will be able to-

M-BT-325.1	define the use of nanomaterials owing to its versatility and usefulness.
M-BT-325.2	discover the methods of nanomaterial synthesis.
M-BT-325.3	explain role of nanomaterial based barcoding systems for various uses.
M-BT-325.4	appraise the fabrication of nanoscale electronic and mechanical devices.
M-BT-325.5	assess the application of nanotechnology in pharmaceutics.
M-BT-325.6	design assess the application of nanotechnology in pharmaceutics.

Unit 1: Nano-electronics, Nano-machines and Nano-barcodes
Nanoelectronics and its development; Strategies for fabrication of nano devices; Development of Electronics-Semiconductor Transistors; Some tools of Micro-and Nanofabrication. Nanobarcodes Technology: Nanobarcode particle technology for SNP genotyping; Q-dot nanobarcode for multiplexed gene expression profiling; Biobarcode assay for proteins; Barcoding system for DNA analysis;

Unit 2: Nano-biosensors and Nano-pharmaceuticals
Carbon nanotube biosensors; FRET based DNA nanosensors; Optical biosensors; Nanowire biosensors; Nanolasers for drug discovery; Cells targeting by nanoparticles; Dendrimers as drugs; Fullerenes as drug candidates; Nanoparticle-based drug delivery –Trojan; Self-assembling nanoparticles; Liposomes; Nanospheres; Nanotubes; Nanomolecular valves for controlled drug release.

Unit 3: Nano-molecular Diagnostics
Rationale of nanotechnology for molecular diagnostics; Nanoarrays for molecular diagnostics; Nanofluidic/ Nanoarray devices to detect a single molecule of DNA-self-assembling protein nanoarrays; Fullerene photo-detectors for chemiluminescence detection; Protein microarray for detection of molecules with nanoparticles; Gold nanoparticles & Quantum Dots for molecular diagnostics; Use of nanocrystals in immunohistochemistry; Imaging applications of nanoparticles.

Text/ Reference Books:

1. Eisberg, Robert; Resnick, Robert, 2014, Quantum Physics of Atoms, Molecules, Solids, Nuclei, and Particles,John Wiley Publication.
2. Harold P. Klug, Leroy E. Alexander, 2002, X-Ray Diffraction Procedures: For Polycrystalline and Amorphous Materials, Wiley Publication.
3. CNR Rao, 2010, Chemistry of nanomaterials: Synthesis, properties and applications, Wiley Publication.

Instruction for paper setting: Seven questions are to be set in total. First question will be conceptual covering entire syllabus and will be compulsory to attempt. Six questions will be set from all

the three units (two from each unit). Student needs to attempt four more questions out of six, with at least one question from each unit. Each question will be of 20 marks.

Continuous Evaluation :

Sessional I - 30 Marks
Sessional II - 30 Marks
Assignments - 20 Marks
Class Work/Performance - 10 Marks
Attendance - 10 Marks

Course Articulation Matrix

CO M-BT-325	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2
M-BT-325.1	3	3	3	2	2	2	-	-	1
M-BT-325.2	3	3	3	3	3	2	2	2	1
M-BT-325.3	2	3	3	3	2	1	1	-	2
M-BT-325.4	3	3	3	3	2	2	2	1	2
M-BT-325.5	3	3	1	2	2	1	1	2	1
M-BT-325.6	3	3	2	2	2	1	1	2	1

MANAV RACHNA INTERNATIONAL INSTITUTE OF RESEARCH AND STUDIES, FARIDABAD

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M-BT-300: DISSERTATION PHASE – I

Periods/week	Credits	Max. Marks	:300
P: 20	10	Continuous Evaluation	:200
Duration of Ext. Exam: 3 Hrs		End Semester Examination	:100

Pre-requisites: None
Course Type: Dissertation

Course outcomes:
The students will be able to-
M-BT-300.1 survey relevant research literature.
M-BT-300.2 learn to communicate effectively.
M-BT-300.3 assimilate the purpose of research through literature survey.
M-BT-300.4 acquire ability to identify the gaps in research.
M-BT-300.5 appraise the importance of ethics in research.
M-BT-300.6 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 allotted 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 Dissertation 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 Dissertation Phase-II. During this course of time he/she will be regularly monitored and evaluated by the Departmental Dissertation Committee/ Internal Supervisor/ Dissertation Coordinator. Continuous monitoring will include Seminar Presentations and Feedback from supervisor. At the end of the Dissertation Phase-I, each student will have to submit a Synopsis (hard bound), deliver a presentation pertaining to the research work and will have to appear for viva during End Semester Examination.

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

Internal Evaluation-

1.	Seminar/ Presentation- I	:	75 marks
2.	Seminar/ Presentation- II	:	75 marks
3.	Feedback from Supervisor	:	50 marks
	TOTAL	**:**	**200 marks**

End Semester Examination Evaluation-

1.	Dissertation	:	50 marks
2.	Presentation	:	25 marks
3.	Viva	:	25 marks

TOTAL : 100 marks

Continuous Evaluation :

Literature Review - 40 Marks
Synopsis - 40 Marks
Presentation and viva - 40 Marks
Project selection - 40 Marks
Attendance - 40 Marks

Course Articulation Matrix

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

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M-BT-400: DISSERTATION PHASE II

Periods/week	Credits	Max. Marks	:600
Duration: 16 weeks (minimum) :400	16	Continuous Evaluation	
Duration of Ext. Exam: 3 Hrs		End Semester Examination	:200

Pre-requisites: None
Course Type: Dissertation

Course outcomes:
The students will be able to-
M-BT-400.1 identify various methodologies to conduct relevant experiments.
M-BT-400.2 customize and design the experiments for accomplishment of the research objectives.
M-BT-400.3 collect and assimilate the data through lab/ field experiments.
M-BT-400.4 assimilate and critically analyze the data .
M-BT-400.5 draw conclusions and inferences from the acquired data to address the research problem.
M-BT-400.6 compose a suitable research paper to communicate the research finding to the scientific community.

Every student will have to undertake a research project culminating into a Dissertation, for minimum 20 weeks, in the field relevant to Biotechnology. The student can either pursue the dissertation work in-house or in a reputed industry or research organization, which will be approved by the respective Head of Department. During this course of time he/she will be regularly monitored and evaluated by the Departmental Dissertation Committee/ Internal Supervisor/ Dissertation Coordinator. Continuous monitoring will include Mid Term Review Presentations and Feedback from supervisor. At the end of the Dissertation Phase-II, each student will have to submit the Dissertation report (hard bound), deliver a presentation pertaining to research work undertaken during the training and will have to appear for viva during End Semester Examination.

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

Internal Evaluation-

4.	Mid Term Review- I	:	150 marks
5.	Mid Term Review- II	:	150 marks
6.	Feedback from Supervisor	:	100 marks
	TOTAL	**:**	**400 marks**

End Semester Examination Evaluation-

4.	Dissertation	:	100 marks
5.	Presentation	:	50 marks
6.	Viva	:	50 marks

TOTAL : 200 marks

Continuous Evaluation

Course Articulation Matrix

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

Appendix A

Course having focus on Regional, National or Global requirements.

M.Tech in Biotechnology				
Course Code	**Course Title**	**Regional**	**National**	**Global**
M-BT-101	Genetic Engineering			√
M-BT-102	Applied Bioinformatics			√
M-BT-151	Genetic Engineering Lab			√
M-BT-152	Applied Bioinformatics Lab			√
M-MC-100	Research Methodology and IPR			√
M-BT-124	Stem Cell Biology			√
M-BT-129	Stem Cells based Tissue Engineering			√
M-MC-001	Stress Management by Yoga	√	√	
M-BT-201	Advanced Plant Biotechnology	√		
M-BT-202	Advanced Environmental Biotechnology	√		
M-BT-251	Advanced Plant Biotechnology Lab	√		
M-BT-252	Advanced Environmental Biotechnology Lab	√		
M-BT-200	Mini Project		√	
M-BT-221	Food Packaging Technology	√		
M-BT-226	Nutraceuticals & Functional Foods		√	√
M-MC-002	English for Research Paper Writing		√	√
PE-BT-M-321	Entrepreneurship Opportunities in Food Industry	√		
OE-HM-M-301	Human Resource Management		√	
BT-M-300	Dissertation Phase - I			√
BT-M-400	Dissertation Phase - II			√

Appendix B

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

Course Code	Course	Employability	Entrepreneurship	Skill development
M-BT-102	Applied Bioinformatics			√
M-BT-124	Stem Cell Biology	√		
M-BT-129	Stem Cells based Tissue Engineering	√		
M-BT-151	Genetic Engineering Lab			√
M-BT-152	Applied Bioinformatics Lab			√
M-MC-100	Research Methodology and IPR	√		
M-BT-201	Advanced Plant Biotechnology		√	
M-BT-202	Advanced Environmental Biotechnology		√	
M-BT-221	Food Packaging Technology		√	
M-BT-226	Nutraceuticals & Functional Foods	√		
M-BT-251	Advanced Plant Biotechnology Lab		√	
M-BT-252	Advanced Environmental Biotechnology Lab	√		
PE-BT-M-321	Entrepreneurship Opportunities in Food Industry		√	
OE-HM-M-301	Human Resource Management	√		

Appendix C

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

Course Code	Course	Environment & Sustainability	Professional Ethics	Human Values
M-BT-127	Plant Protection	√		
M-BT-202	Advanced Environmental Biotechnology	√		
M-BT-252	Advanced Environmental Biotechnology Lab	√		
M-BT-227	Crop Improvement	√		
OE-M-306	Waste to Energy	√		
M-MC-100	Research Methodology and IPR		√	
M-BT-228	Biopharmaceutical Manufacturing		√	
PE-BT-M-321	Entrepreneurship Opportunities in Food Industry		√	
PE-BT-M-324	Bioethics in Stem Cell Technology		√	
OE-HM-M-301	Human Resource Management		√	
OE-HM-M-302	Strategic Human Resource Management		√	
OE-M-301	Business Analytics		√	
OE-M-302	Industrial Safety		√	
OE-M-303	Operations Research		√	
OE-M-304	Cost Management of Engineering Projects		√	
OE-M-305	Composite Materials		√	
OE-M-306	Waste to Energy		√	
M-MC-001	Stress Management by Yoga			√