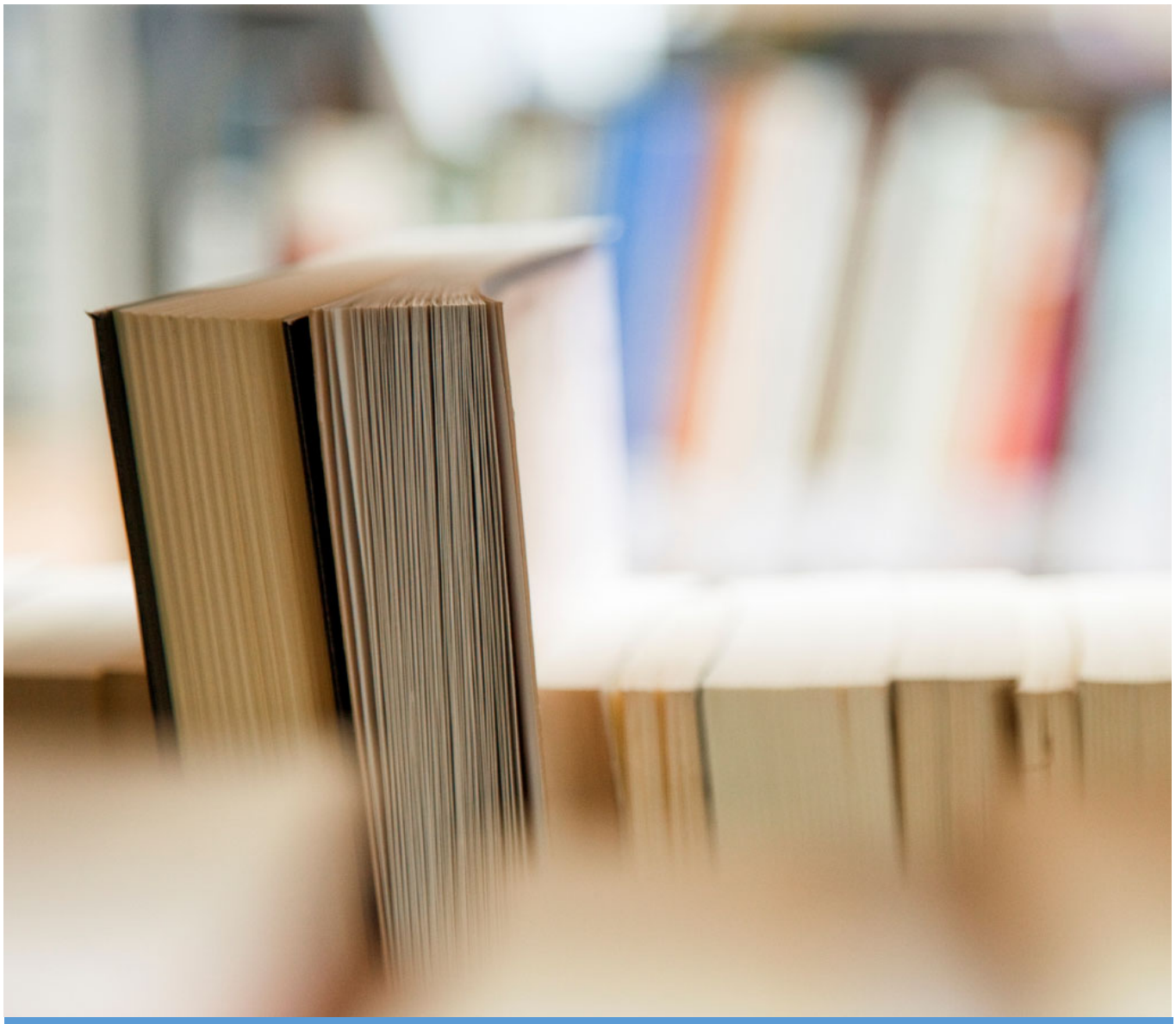
BHARATI VIDYAPEETH
(DEEMED TO BE UNIVERSITY), PUNE

FACULTY OF SCIENCE
M.Sc. - BIOTECHNOLOGY
New Syllabus



BVDU-RGITBT-M.Sc. Biotechnology Syllabus

2018

BHARATI VIDYAPEETH DEEMED TO BE UNIVERSITY

PUNE

REVISED SYLLABUS FOR

MASTER OF SCIENCE

M.Sc. IN BIOTECHNOLOGY

UNDER

FACULTY OF SCIENCE

SYLLABUS OF SEM I – SEM IV UNDER

CHOICE BASED CREDIT SYSTEM

To be effective from Academic Year

2018-19

Bharati Vidyapeeth Deemed To Be University is a multidisciplinary, multicampus university having 32 Institutions imparting quality education in various disciplines. All programmes of the University are approved by UGC and respective statutory councils. BVDU has been re accredited for the third time with 'A+' grade by NAAC in 2017. UGC has accorded 12B Status [UGC ACT1956] to the university. Ministry of Human Resource and Development, Government of India has awarded "A" category to the University in 2012 based on parameters including innovative programs, research and infrastructure facilities. The University is a member of Association of Indian Universities [AIU] which has ranked BVDU among top 10 universities of India for International students' enrollment. BVDU is also a member of International Association of Universities.

Rajiv Gandhi Institute of IT and Biotechnology is a constituent unit of BVDU established in 2003. The Institute is approved by UGC to conduct graduate and post graduate courses in Biotechnology. The Institute has excellent infrastructure, state-of-the-art laboratories and competent faculty facilitating appropriate learning environment. The Institute offers one undergraduate and four postgraduate programmes in Biotechnology.

INTRODUCTION

The Master of Science (M.Sc.) in Biotechnology is a full time post graduateprogramme offered by Bharati Vidyapeeth Deemed to be University (BVDU) in its constituent unit Rajiv Gandhi Institute of IT and Biotechnology. The course was initiated in the year 2005 and was designed to facilitate empowerment of students to face cutting edge technological applications in biotechnology sector. The main advantage of proposing this course was availability of the expertise in biotechnology, health and environment disciplines on the same campus. The course received very encouraging response from all its stakeholders. On its implementation for 13 years, the curriculum is being revised to embrace newer emerging disciplines and value added courses. The revised M.Sc. Biotechnology is a full time 102 credits Programme to be implemented in Rajiv Gandhi Institute of IT and Biotechnology from the academic year 2017-18. The feedback of students, alumni, faculty, employers and parents has a substantial contribution in designing of this curriculum.

OBJECTIVES

1. To impart deep knowledge of the discipline
2. Develop skills in relevant areas to enhance employment opportunities
3. Introduce emerging areas of pharma and biotech sector
4. Build interdisciplinary approach
5. Foster global competence among students
6. Inculcate social and moral values and sense of scientific responsibilities in students

ELIGIBILITY FOR ADMISSION TO THE COURSE

Candidates satisfying following criteria are eligible to apply for M.Sc. Biotechnology Course

1. The candidate should have passed the Bachelors degree course in Biotechnology/ any branch of life science from the recognized university with minimum of 50% or 45% aggregate marks for open and SC / ST category respectively at graduate level university examination.
2. Subject to above conditions, the admission will be based on the merit at Entrance Examination conducted by Bharati Vidyapeeth Deemed to be University.

DURATION OF THE COURSE

The course will be executed in four semesters. The medium of instruction and examination will be only English.

RULES FOR THE COURSE

1. The entire course is of 102 credits.
2. One credit for theory course is equivalent to 15 lectures/tutorials; while one credit for practical course is equivalent to 25 – 30 hrs. of lab /field work or demonstration.
3. The curriculum comprises of Core and Value Added courses. The Core Courses are compulsory where as Value Added are elective.
4. The Core Courses are aimed at providing fundamental knowledge of the discipline. The Value Added Courses intend to develop skills in relevant Biotechnology Industry sector.
5. The teaching schedule for the 3 credits and 2 credits theory courses will be 3 and 2 lectures per week respectively. All courses will have one tutorial fortnightly.
6. The respective elective course will be implemented only if more than 10 students enroll for that course.
7. Some of the core courses in Semester I and Semester II are common in two master's programmes; M.Sc. Biotechnology and M.Sc. Medical Biotechnology.
8. The teaching and evaluation for these courses will be combined for both disciplines.
9. The shared courses are coded as MBT&MedBT whereas the courses which are exclusive for M.Sc. Biotechnology are coded as MBT
10. All core courses will be evaluated by University Examination. The elective courses will be evaluated by Continuous Assessment.
11. Two extra credits will be awarded to students if there is any significant outcome of their dissertation study. The research outcome in terms of publication in indexed national/International journal; filing of patent; or commercialization of technology will be considered for the award of credits.

RULES FOR EXAMINATION

A: Nature of Examination:

1. Each course will have 40% marks for internal assessment and 60% marks for semester-end examination.
2. The assessment for 1, 2, 3 and 4 Credits courses will be as given in following table

Table 1: Evaluation pattern for one to four Credit Courses

Course Credits	Marks for UE (60% Weightage)	Marks for IE (40% weightage)	Total Marks for evaluation
2	30	20	50
3	60	40	100

3. The duration of 60 Marks UE theory paper will be 2.5 Hrs; for 30 Marks 2.00 Hrs respectively.
4. The Internal Assessments (IA) will be conducted by the Institute and an end-of-the term University Examination (UE) conducted by the university. The UE will be based on the entire syllabus.
5. The performances at UE and IA will be combined to obtain the Grade Point Average (GPA) for the course.

STANDARD OF PASSING

A: Grading System: A 10-point absolute grading system will be adapted for grading in each head of passing. The system will have seven grade points, the highest being 10. The grading system shall be as shown in Table-2 below. The performance indicators O, A+, A, B+, B, C, and D shall respectively mean Outstanding, Excellent, Very Good, Good, Average, Satisfactory, and Poor.

Table-2: The grading system under CBCS

Range of Marks (out of 100)	Grade Point	Grade
$80 \leq Marks \leq 100$	10	O
$70 \leq Marks \leq 80$	9	A+
$60 \leq Marks \leq 70$	8	A

55 ≤ *Marks* ≤ 60	7	B+
50 ≤ *Marks* ≤ 55	6	B
40 ≤ *Marks* ≤ 50	5	C
Marks <40	0	D

1. The grade point average (GPA) for a course shall be calculated by first finding the total marks out of 100 for the course. The corresponding GP (as per the table-2) shall be the GPA for the course.
2. Two kinds of performance indicators, namely, the Semester Grade Point Average (SGPA) and the Cumulative Grade Point Average (CGPA) shall be computed at the end of each term. The SGPA measures the cumulative performance of a learner in all the courses in a particular semester, while the CGPA measures the cumulative performance in all courses up to and including the current semester. The CGPA of a student when he/she completes the programme is his/her final result.
3. The SGPA is calculated by the formula , $SGPA = \frac{\sum Ck \times GPAk}{\sum Ck}$ where *Ck*is the credit-value assigned to a course and *GPAk*is the GPA obtained by the student in the course. In the above, the sum is taken over all the courses that the student has undertaken for the study during the semester, including those in which he/she might have failed or those for which he/she remained absent. The SGPA shall be calculated up to two decimal place accuracy.
4. The CGPA is calculated by the formula , $CGPA = \frac{\sum Ck \times GPAk}{\sum Ck}$ where *Ck*is the credit-value assigned to a course and *GPAk*is the GPA obtained by the student in the course. In the above, the sum is taken over all the courses that the student has undertaken for the study from the time of his/her enrolment and also the during the semester for which CGPA is calculated, including those in which he/she might have failed or those for which he/she remained absent. The CGPA shall be calculated up to two decimal place accuracy.
5. The CGPA, calculated after the minimum credits specified for the programme are 'earned', will be the final result grace marks of 1, 2 or 3 may be awarded to a candidate at UE as per the university rules. B: Standards of Passing and ATKT rules:

1. For all Core Courses, both UE and IE constitute separate heads-of-passing (HoP). In order to pass in such courses and to 'earn' the assigned credits

   (a) the learner must obtain a minimum grade point of 5.0 (40% marks) at UE and also a minimum grade point of 5.0 (40% marks) at IA;

   OR

   (b) If he/she fails in IA, then also the learner passes in the course, **provided that a minimum of 25% is obtained in IA and GPA for the course is at least 6.0 (50%marks) in aggregate**. The GPA for a course will be calculated only if the learner passesin that course.

1. A student who fails at UE in a course has to reappear only at UE as a backlog candidate and clear the HoP. Similarly, a student who fails in a course at IA has to reappear only at IA as a backlog candidate and clear the HoP. **A student who passes in aggregate in a course need not reappear even if he failed at IA if he/she obtains 25% at IA.**
2. The students of Semester I and II & III will be admitted to next Semester even if he/she gets backlog in any of the course. They can reappear in the next semester examination as a backlog candidate.

C: AWARD OF HONOURS:

1. A student who has completed the minimum credits specified for the programmeshall be declared to have passed in the programme. The final result will be in terms of letter grade and CGPA only and is based on the CGPA of all courses studied and passed. The criteria for the award of honoursare given in Table 3.

Table 3: Criteria for the award of honours at the end of the programme

Range of CGPA	Final Grade	Performance Descriptor	Equivalent Range of Marks (%)
$9.50 \leq CGPA \leq 10.00$	O	Outstanding	$80 \leq Marks \leq 100$
$9.00 \leq CGPA \leq 9.49$	A+	Excellent	$70 \leq Marks \leq 80$
$8.00 \leq CGPA \leq 8.99$	A	Very Good	$60 \leq Marks \leq 70$
$7.00 \leq CGPA \leq 7.99$	B+	Good	$55 \leq Marks \leq 60$

6.00 ≤ *CGPA*≤ 6.99	B	Average	50 ≤ *Marks* ≤ 55
5.00 ≤ *CGPA*≤ 5.99	C	Satisfactory	40 ≤ *Marks* ≤ 50
CGPA Below 5.00	F	Fail	Marks below 40

THE FORMAT OF THE TRANSCRIPTS

The transcripts may be acquired by the students indicating his/her performance in every semester examination. The transcript shall show the performance indicators given in the following table, in addition to any other information.

Course Number	Course Description	Number of Credits	University Examination		IA/CA		Grade Point Average (GPA)	Result
			Grade	Grade Point	Grade	Grade Point		
Total Cumulative Credits Completed		SGPA	CGPA	Equivalent Marks (%)	Note: GPA is calculated by adding the UE marks out of 60 and IA marks out of 40. The total marks out of 100 are converted to Grade Point, which will be GPA			

PATTERN FOR ASSESSMENT

A: Pattern of Evaluation for Internal Assessment of Theory Courses:

The weightage for Internal Assessment is 40%. Students for IA of every theory course will be assessed for total of 30 marks for 3 credit course and for 20 marks for 2 credit course which will be cumulative marks obtained in two separate assessments specified below.

1. Two internal written examinations of 15 marks each for 3 credit course and 10 marks each for 2 credit course.A total of the two tests will be considered.
2. An optional assignment/ oral/ open book examination may be undertaken if desired.

B. Pattern of Evaluation for Internal Assessment of Practical Courses:

The Internal Assessment for every practical course will be of 20 Marks for 2 credits and 40 marks for 4 credits practical courses. The students for IA will be assessed on the basis of;

1. Performance for every practical: 10 Marks/20 Marks for 2/4 Credits practical courses respectively. (Marks to be distributed depending on total number of practicals)
2. Assignment/ Oral examination/Tour Report: 10/20 Marks for 2/4 Credits courses

C: Pattern of question paper at University Examination

University Examination for 3 credit and 2 credit theory course will be of 45 marks and 30 marks respectively. For 3 credit course, the question paper will comprise of 6 questions, 3 questions each in section I and section II. Q1 of section I will be of 6 marks while Q2 and Q3 will be of 8 marks each .Q 4 of section II will be of 7 marks while Q 5 and Q6 will be of 8 marks each .All questions will be compulsory. The pattern of question paper will be as given on next page.

Pattern of question paper for 3 Credit Course of university theory examination of M.Sc. Biotechnology 2018 CBCS Course(Total Marks:45, Tme:2.00 Hrs.)

Instructions to Paper Setter:

I. Question paper of each course will comprise of total 6 questions,
II. Section I will have 3 questions and Section II 3 questions.
III. All questions will be compulsory. Each question will carry an internal option of one extra sub-question.
IV. Q. no 1 will be objective, comprising of 7 questions of 1 mark each. They will be based on entire portion of Section I. Students will have to attempt any 6 out of these.
V. Q no 4will be objective, comprising of 8 questions of 1 mark each. They will be based on entire portion of Section II. Students will have to attempt any 7 out of these.

VI. Questions 2 & 3 of **Section I** and 5 & 6 of **Section II** will be descriptive and contain 3 sub-questions of 4 marks each out of which students will attempt any two.

VII. Q 2 and 3will be based solely on Unit I and II whereas Q 5 and 6 will be based on Unit III and IV of the syllabus respectively.

VIII. Students will attempt answers to Section I and Section II in separate answer books

SECTION I

Q. 1		Attempt **Any Six** of the following	(06)
	a		
	b		
	c		
	d		
	e		
	f		
	g		
Q. 2		Attempt **Any Two** of the following	(08)
	a		
	b		
	c		
Q. 3		Write short notes on **Any Two** of the following	(08)
	a		
	b		
	c		

SECTION II

Q. 4		Attempt **Any Seven** of the following	(07)
	a		
	b		
	c		
	d		
	e		
	f		
	g		
	h		
Q. 5		Attempt **Any Two** of the following	(08)
	a		
	b		
	c		
Q. 6		Write short notes on **Any Two** of the following	(08)

a
b
c

Question Paper Pattern for 2 Credits Theory Course at University Examination

For 2 credit course, the question paper will comprise of 4 questions, 2 questions each in section I and section II. Q1 of section I and Q3 of section II will be of 7 marks each while Q2 and Q4 will be of 8 marks each .All questions will be compulsory. The pattern of question paper will be as given on next page.

Pattern of question paper for 2 credit course of university theory examination of M.Sc. Biotechnology 2018 CBCS Course
(Total Marks:30, Tme:1.50 Hrs.)

Instructions to Paper Setter:

IX. Question paper of each course will comprise of total 4 questions,
X. Section I will have 2questions and Section II 2 questions.
XI. All questions will be compulsory. Each question will carry an internal option of one extra sub-question.
XII. Questions 1 of section I and 3 of section II will be objective,and contain 8 questions of 1 mark each out of which students will attempt any 7. They will be based on entire portion of Section I and section II respectively.
XIII. Questions 2 of **Section I** and 4 of **Section II** will be descriptive and contain 3 sub-questions of 4 marks each out of which students will attempt any two.
XIV. Q 2 and 4 will be based solely on Unit I and II of the syllabus respectively..
XV. Students will attempt answers to Section I and Section II in separate answer books

SECTION I

Q. 1 Attempt **Any Seven** of the following (07)

a
b
c
d
e
f
g
h

Q. 2 Attempt **Any Two** of the following (08)

a

b
c

SECTION II

Q. 3	Attempt **Any Seven** of the following	(07)
a		
b		
c		
d		
e		
f		
g		
h		
Q. 4	Attempt **Any Two** of the following	(08)
a		
b		
c		

D: Pattern for question paper of University Practical Examination of M.Sc. Biotechnology 2018 CBCS Course

(Total Marks:30/60 for 2/4 credit courses, Time: 3 .00/6.00 Hrs.)

Q. 1	Major Practical	(10/20)
Q. 2	Spotting/Minor Experiment	(10/20)
Q. 3	Viva	(05/10)
Q. 4	Journal	(05/10)

Course structure of M.Sc. Degree Course in Biotechnology

Under Choice Based Credit System

SEMESTER I

Course No. & Description	Title	Credits	IA	Univ. Exam	Total Credits
MBT&MedBT 101 Core Course-Theory	Microbiology	3	40	60	
MBT&MedBT 102 Core Course –Theory	Biochemistry	3	40	60	
MBT&MedBT 103 Core Course –Theory	Cell & Developmental Biology	3	40	60	
MBT&MedBT 104 Core Course –Theory	Genetics	3	40	60	
MBT&MedBT 105 Core Course –Theory	Molecular Biology	3	40	60	
MBT&MedBT 106 Core Course –Practical	Biochemistry & Molecular Biology Lab	4	40	60	
MBT&MedBT 107 Core Course –Practical	Cell Biology & Genetics Lab	4	40	60	
MBT&MedBT 108 Core Course –Practical	Microbiology Lab	2	40	60	25

SEMESTER II

Course No. & Description	Title	Credits	IA	Univ. Exam	Total Credits
MBT&MedBT 201 Core Course –Theory	Genetic Engineering	3	40	60	
MBT&MedBT 202 Core Course –Theory	Analytical Biotechnology	3	40	60	
MBT&MedBT 203 Core Course –Theory	Immunology	3	40	60	

MBT&MedBT 204 Core Course –Theory	Genomics & Proteomics	3	40	60	
MBT&MedBT 205 Core Course - Theory	Nanobiotechnology	2	40	60	
MBT 206 Core Course -Theory	Animal Tissue Culture	2	40	60	
MBT&MedBT 207 Core Course –Practical	Genetic Engineering and Genomics Lab	4	40	60	
MBT&MedBT 208 Core Course –Practical	Analytical Techniques and Proteomics Lab	4	40	60	
MBT&MedBT 209 Core Course - Practical	Immunology & Nanotechnology Lab	4	40	60	
MBT&MedBT 210 Elective Course I	Bioentrepreneurship/ IPR I	2	Continuous Assessment		30

Elective Courses in Sem II:

1) MBT 210: Elective Course I; Option I: Bioentrepreneurship, Option II: IPR I

SEMESTER III

Course No. & Description	Title	Credits	IA	Univ. Exam	Total Credits
MBT 301 Core Course –Theory	Environmental Biotechnology	3	40	60	
MBT 302 Core Course –Theory	Plant Biotechnology	3	40	60	
MBT 303 Core Course –Theory	Microbial Technology	3	40	60	
MBT 304 Core Course –Theory	Food Biotechnology	2	40	60	
MBT&MedBT 305 Core Course-Theory	Biostatistics	2	40	60	
MBT&MedBT 306 Core Course-Theory	Research Methodology	2	40	60	
MBT 307 Core Course-Practical	Environment &Plant Biotech Lab	4	40	60	
MBT 308 Core Course-Practical	Microbial & Food Biotech Lab	4	40	60	
MBT 309 Core Course-Practical	Biostatistics Lab	2	40	60	27

MBT&MedBT 310 Elective Course II	Biomedical Waste Management/ Drug designing/ IPR II	2	Continuous Assessment	

Elective Courses in Sem III:

1) MBT 310: Elective Course I; Option I: Biomedical Waste Management, Option II:Drug designing, Option III: IPR II

SEMESTER IV

Course No. & Description	Title	Credits	IA	Univ. Exam	Total Credits
MBT 401 Core Course	Research Project	20	40	60	20

Total Credits Offered: 25 C,Sem I+ 30 C, Sem II +27 C,Sem III+ 20C,Sem IV = 102 C

SEMESTER I

MBT&MedBT 101: Microbiology Core Course – Theory; 3 Credits	Total 45L
UNIT I	
1 Microbial diversity: Bacteria Archaea	3
2 Cell structure and functions of bacteria.	3
3 Cell structure and functions of archaea and fungi.	4
UNIT II	
4 Microbial growth: Growth kinetics, cytokinesis, factors affecting growth of microorganisms.	4
5 Growth on different environment Extremophiles and their adaptations	3
6 Anaerobic microorganisms, cultivation and applications.	3
UNIT III	
7 Microbial interactions: Symbiotic interactions, parasitism, ammensalism and competition;	5
8 Microbial flora of healthy human host: Distribution and occurrence of normal flora inhumans	5
9 Microbial pathogenesis: Host-microbe interactions; Bacterial, fungal and protozoalpathogenesis in humans.	4
UNIT IV	
10 Effect of Antimicrobial drugs: on bacterial, fungal and viral pathogens	4
11 Virology: Diversity, Classification of virus, Cytopathic effect of virus	3
12 Taxonomy, Molecular methods, Bergey's manual of systematic bacteriology.	4

References

1. Brock Biology of Microorganismsm 13th eds, , Michael T.Madigan
2. Prescott's Microbiology, 9th eds, Joanne M. Willey
3. Microbiology–6th Edition (2006), Pelczar M.J., Chan E.C.S., Krieg N.R., The McGraw Hill Companies Inc. NY
4. General Microbiology - Stanier R.Y., 5th edition, (1987)Macmillan Publication UK.
5. Introduction to Microbiology, 2nd Edn. Ingraham, J. L. and Ingraham C. A., Thompson Asia Pvt. Ltd., Singapore (2002).

MBT&MedBT 102: Biochemistry		Total
Core Course – Theory; 3 Credits		45L
UNIT I: Biomolecules structure, functions		
1	**Introduction:** Scope and importance of biochemistry in biotechnology.	1
2	**Carbohydrates, lipids and proteins -** Structure, properties and biological role (functions) of carbohydrates, Proteins and lipids. Protein structure and Lectins- overview. Lipids and cell membranes – types of membrane lipids, phospholipids and glycolipids from bimolecular sheets. Monoglycerides and diglycerides- structure, properties and applications.	7
3	**Hydrolytic products of polysaccharides & their applications.** Bulk production of Malt, peptides, malto-dextrin, glue.	3
UNIT II: Metabolism		
4	**Metabolism of carbohydrates and protein**- Glycolysis, Glucogenesis, Citric acid cycle and Glycogen metabolism. Protein turnover and Amino acid catabolism, Biosynthesis of amino acids, urea cycle. Biosynthesis of carbohydrate and proteins-overview	5
5	**Fatty acid metabolism and nucleic acid metabolism**- Overview of Fatty Acid Metabolism, synthesis and degradation of fatty acids, De novo synthesis of Nucleotides	4
6	**Oxidative phosphorylation and photophosphorylation** Oxidative Phosphorylation – regulation – light reactions of Photosynthesis	3
UNIT III: Enzymology		
7	**Introduction to enzymes-** Classification of enzymes, specificity of enzyme action – monomeric and oligomeric enzymes. Allosteric enzymes. Structural Components of Enzymes – apoenzymes, prosthetic group, cofactors,	4
8	**Mechanisms of reactions catalysed by enzymes** – Metal activated enzymes – metalloenzymes –involvement of co enzymes, Enzyme Inhibition	4
9	**Biotechnological applications of enzymes** in various industries like fruit juice extraction, leather processing, Meat tenderization, Baking and dairy industry.	3
UNIT IV: Techniques		
10	**Free and immobilised enzyme kinetics**- Rationale and Methods of immobilization of enzymes: covalent coupling, cross-linking and entrapment methods. Properties of immobilized enzymes, Whole cell immobilization, Advantages of immobilization, Types of Carriers,. Applications of Immobilized	4

enzymes:Production of High fructose corn syrup, invert sugar, synthetic penicillin.

11 Chromatography- Principle, types- gel, affinity, ion exchange, applications 3

12 Electrophoresis Principle of separation, factors affecting separation, types -paper, agarose gel, PAGE, 2D- gel electrophoresis, western blotting 4

References

1. Biochemistry by Jeremy M.Berg, John L.Tymozko, LubertStryer, 5th Eds,
2. Lehninger Principles of Biochemistry Edition 4, Nelson, David L. Cox, Michael M. Lehninger, Albert L. W, H Freeman & Co
3. Student Companion to Accompany Biochemistry, Richard I. Gumport, Jeremy M. Berg, Nancy Counts Gerber, Frank H. Deis, Jeremy Berg, W H Freeman & Co

MBT&Med BT 103: Cell & Developmental Biology — Total 45L

Core Course – Theory; 3 Credits

UNIT I

1 Structure of cell 6

Structure of cell organelles: Endoplasmic reticulum, mitochondria, golgi apparatus, lysosomes, chloroplast, nucleus, cell wall. Comparison of prokaryotic and eukaryotic cells

2 Cytoskeleton: Organization and functions cytoskeleton, Actin filaments, actin binding proteins, Intermediate filaments, Microtubules, Structure and functions of cilia and flagella. 5

UNIT II

4 Plasma Membrane: 7

Plasma membrane structure and functions, membrane models, Transport across membrane- passive diffusion, osmosis, active transport, Ion Channels, Na+ and K+ pump, Ca2+ ATPase pump, co-transport, symport, antiport, endocytosis and exocytosis. Membrane vesicle trafficking

5 Specialized Cells (Muscle & Nerve cells): 4

Structure & functions of muscles (Straited, nonstraited and cardiac). Structure of neuron, Neurotransmitters and their receptors

UNIT III

6 Cell – Cell Interactions 3

Cell adhesion molecules, cadherins, Integrins, transmembrane proteoglycanc, Claudins and occludens, gap junctions, tight junctions, adherens, desmosomes and hemidesmosomes, plasmodesmata

7 Cell Cycle 2

Molecular events of cell division and cell cycle, regulation of cell cycle events- Cyclins, Cyclin dependent kinases, inhibitors. Apoptosis and necrosis.

8 Cell Signaling 6

General principles of cell signaling, signaling via G-protein coupled receptors, kinase receptors, role of secondary messengers.

UNIT IV

9	Developmental Biology Gametogenesis (Spermatogenesis, Oogenesis), Meiosis and its significance, types of eggs, fertilization and implantation, types and patterns of cleavage, Blastulation	5
10	Stages of fetal development Gastrulation in Frog, Germ layer formation, fetal membranes, placenta formation in mammals	4
11	Concept of dedifferentiation, redifferentiation, transdifferentiation and regeneration	3

References

1. Alberts, B., Bray, D., Lewis, J., Raf, M., Roberts, K., Watson, J.D. (1994). Molecular Biology of the Cell
2. Cooper, G.M. (1997).The Cell: A molecular approach, ASM Press, USA.
3. Hallwell, B., Gutteridge, J.M.C. (2002). Free Radicals Biology and Medicine. Oxford Press.UK.
4. Karp, G. (1996). Cell and Molecular Biology concepts and experiments, John Wiley and Sons Inc. NY.
5. Lodish, H., Baltimore, D., Berk, A., Zipursky, B.L., Mastsydaira, P., Darnell, J. (2004). Molecular Cell Biology, Scientific American Books Inc. NY.
6. Matthews, C.A. (2003). Cellular physiology of nerve and muscle. 4thEdn. Blackwell publishers.
7. Development Biology, 9th edition, (2010), Gilbert S.F.(Sinauer Associates, (USA).
8. Human Embryology and Developmental Biology, Author: Carlson, Bruce M.Edition: 3, Publisher: Elsevier - Health Sciences Division ISBN-13: 9780323014878.
9. Balinsky : introduction to Embryology (CBS College Publishers)
10. Subramanyan, T : Developmental Biology (Narosa Publishing House) Arumugam N.A. text book of embryology (Saras publication)

MBT&Med BT 104: Genetics		Total
Core Course – Theory; 3 Credits		45L
UNIT I		
1	Overview of genetics: Genes and Expression, Allele, multiple alleles, pseudoallele, complementation tests, Genetic variation, Molecular basis of allelic variation. Methodologies used in genetic studies, Model organisms. Genes-Environment interaction.	5
2	Modes of inheritance: Mendelian and Non Mendelian Inheritance: Lethal alleles, Epistasis, Penetrance and expressivity, Pleiotropy, Phenocopies, mitochondrial inheritance	6
UNIT II		
3	Structure and function of human chromosome: Ultra structure of human chromosome, Classification of chromosomes, Sex chromosome, Origin of Y chromosome, SRY genes and its effects. Dosage compensation	3

4	**Human chromosomal Abnormalities**: Aneuploidy and Structural, associated syndromes	4
5	**Pedigree analysis of human:** X linked and autosomal disorders. Linkage maps,Lod scores to assess linkage in human pedigrees	2
6	**Diagnostics:** Prenatal diagnosis, Karyotype analysis, FISH, Genetic counseling	3
UNIT III		
7	**Population genetics:** Population genetics – Populations, Gene pool, Gene frequency; Hardy-Weinberg Law;concepts and rate of change in gene frequency through natural selection, migration andrandom genetic drift; Adaptive radiation; Isolating mechanisms; Speciation; Allopatricity and Sympatricity; Convergent evolution; Sexual selection; Co-evolution.	5L
8	**Brain, Behavior and Evolution:** Approaches and methods in study of behavior; Proximate and ultimate causation;Altruism and evolution-Group selection, Kin selection, Reciprocal altruism; Neural basis of learning, memory, cognition, sleep and arousal; Biological clocks; Developmentof behavior; Social communication; Social dominance; Use of space and territoriality;Mating systems, Parental investment and Reproductive success; Parental care;Aggressive behavior; Habitat selection and optimality in foraging; Migration, orientationand navigation; Domestication and behavioral changes.	6L
Unit IV		
9	**Cancer genetics;** genetic control of cell cycle, mutations that prevent normal checkpoints, inherited cancer syndromes, cancers acquired due to chromosomal abnormalities	6L
10	**Reproductive Technologies**	5L

References:

1. Human genetics: Concepts and applications. Ricky Lewis. 11th Ed. Mc Graw – Hill Higher Education IncPubl 2015
2. Essential genetics, A genomics perspective. Daniel L. Hartl. 6th Ed. Burlington, Mass Jones & Bartlett Learning Publ. USA, 2014
3. Human molecular genetics, 4th Ed. T Stranchan and A. Read. Garland Publishing, Taylor & Francis Group, NY, USA. 2010
4. Human Genetics. A Gardner, T. Davies. 2nd Ed. Springer VerlagPubl 2010.

MBT&Med BT 105: Molecular Biology	Total
Core Course – Theory; 3 Credits	45L
UNIT I	
1 **Genomes and its content**	8

Basic concepts, flow of information transfer, genetic code, types of mutations
Genome sizes of different organisms, C Value
Gene families, clusters, pseudogenes, super-families, organelle genomes
Organization of prokaryotic genome, Structure of nucleosome and organization of chromatin, structure of chromosome, centromere and

telomere

UNIT II

2	DNA replication & repair DNA polymerases, mechanism of replication in prokaryotes and eukaryotes, DNA damage, Mechanisms of DNA repair in prokaryotes and eukaryotes,	6
3	Homologous and site specific recombination	4
	Insertion elements	3

UNIT III

4	Transcription and posttranscriptional mechanisms RNA polymerase and mechanism of prokaryotic transcription Eukaryotic RNA polymerases and their promoters, activating transcription, role of enhancers, gene silencers, CpG Islands, post transcriptional modifications, RNA splicing reactions, catalytic RNA, Regulatory RNA, MicroRNAs & RNA interference	12

Unit IV

5	Translation Mechanism of translation in prokaryotes and eukaryotes, post translational modifications, transport of proteins, role of chaperons	7
6	Gene regulation Operon, Induction and repression, positive and negative regulation, attenuation, lactose, arabinose and tryptophan operon, Eukaryotic transcription regulation	5
7	Epigenetic effects Heterochromatin nucleation, Chromatin remodeling, epigenetic inheritance, genomic imprinting.	2

References:

1. Human genetics: Concepts and applications. Ricky Lewis. 11th Ed. Mc Graw – Hill Higher Education IncPubl 2015
2. Essential genetics, A genomics perspective. Daniel L. Hartl. 6th Ed. Burlington, Mass Jones & Bartlett Learning Publ. USA, 2014
3. Human molecular genetics, 4th Ed. T Stranchan and A. Read. Garland Publishing, Taylor & Francis Group, NY, USA. 2010
4. Human Genetics. A Gardner, T. Davies. 2nd Ed. Springer VerlagPubl 2010.

MBT&Med BT 106: Biochemistry & Molecular Biology Lab
Core Course –Practical; 4 Credits
Biochemistry Lab

1	To prepare an Acetic - Na Acetate Buffer system and validate the Henderson-Hasselbach equation.	2
2	To determine an unknown protein concentration by plotting a standard graph of BSA using UV-Vis Spectrophotometer and validating the Beer- Lambert's Law.	2
3	Titration of Amino Acids and separation of aliphatic, aromatic and polar amino acids by TLC.	2

4	AN ENZYME PURIFICATION THEME (such as E.coli Alkaline phosphatase or any enzyme of choice). (a) Preparation of cell-free lysates (b) Ammonium Sulfate precipitation (c) Ion-exchange Chromatography (d) Gel Filtration (e) Affinity Chromatography (f) Generating a Purification Table	6
5	Enzyme Kinetic Parameters: Km, Vmax and Kcat	3
6	Assessing purity by SDS-PAGE Gel Electrophoresis	2
7	Estimation of diagnostic markers- glucose, urea	3

Molecular Biology Lab

1	Understanding of basic principles, equipments and molecular biology grade reagents, Preparation of buffers and reagents	1
2.	Isolation of DNA from bacteria and eukaryotic cells, blood & plant	5
3.	Analysis of DNA preparations by UV spectrometry and agarose gel electrophoresis	2
4.	Isolation and estimation of RNA from bacteria/yeast/eukaryotic cells	2
5.	Amplification of DNA by PCR	
6.	Evaluation of gene expression using Real Time PCR (Demonstration)	2
7.	DNA sequencing (Demonstration)	1

References:

1. Sambrook J and Russell D. (2011) Molecular cloning A Laboratory Manual 3rd Ed, Cold spring harbor laboratory press, New York.
2. Wilson K. and Walker J. (2005) Principles and Techniques of Biochemistry and Molecular Biology, Cambridge University Press, New York.

MBT&Med BT 107: Cell Biology & Genetics Lab

Core Course –Practical; 4 Credits

Cell Biology Lab

1	Study of mitosis with onion root tip chromosomes	1
2	Observation of permanent slides of meiosis	1
3	Temporary preparation of Polytene chromosomes from Chironomus salivary gland	2
4	Isolation of nuclei from rat liver	2
5	To determine Erythrocyte (*RBC*) & Leucocytes (*WBC*) count of a blood sample	2
6	Chlorophyll estimation: Spectrum and light scatter	1
7	Study of frog development, observation of frog embryo of different development stages	2
8	Study of eggs and sperms from animal samples	2

Genetics Lab

1	Planting of blood culture	1
2	Preparation of chromosome spreads from lymphocyte culture	2
3	Banding of metaphase slides	1

4	Karyotyping and analysis	1
5	Isolation and staining of lampbrush chromosomes	2
6	Cultivation of drosophila and study of Mendelian inheritance	5
7	Demonstration of cytogenetic analysis using FISH	1

References:

1. Development Biology, 9th edition, (2010), Gilbert S.F.(Sinauer Associates, (USA)
2. Principles of Development, 4th edition (2010), Wilbert L and Tickle C, Publisher: Oxford University Press, USA.
3. Developmental Biology Laboratory Manual. S.R. Scadding and S. Frombach. 5th Ed.
4. Essential genetics, A genomics perspective. Daniel L. Hartl. 6th Ed. Burlington, Mass Jones & Bartlett Learning Publ. USA, 2014
5. Human molecular genetics, 4th Ed. T Stranchan and A. Read. Garland Publishing, Taylor & Francis Group, NY, USA. 2010
6. Human Genetics. A. Gardner, T. Davies. 2nd Ed., Springer VerlagPubl, 2010

MBT&MedBT 108: Microbiology Lab

Core Course – Practical; 2 Credits

1	Microscopy	2
2	Isolation of thermophile / halophile from soil, (media preparation, serial dilution, spread plating, streaking, staining and microsopy)	3
3	Checking the purity of pharmaceutical samples.	3
4	Use of deferential media for isolation of various bacteria	2
5	Isolation of fungi from soil / clinical samples	2
6	Isolation of actinomycetes from soil/ water samples.	2
7	Cultivation of lactiobacillus under anaerobic condition	2
8	Antibiotic susceptibility testing	2
9	Ames test	2

References:

1. Brock Biology of Microorganismsm 13theds, , Michael T.Madigan
2. Prescott's Microbiology, 9theds, Joanne M. Willey
3. Microbiology–6th Edition (2006), Pelczar M.J., Chan E.C.S., Krieg N.R., The McGraw Hill Companies Inc. NY
4. General Microbiology - Stanier R.Y., 5th edition, (1987)Macmillan Publication UK.
5. Introduction to Microbiology, 2nd Edn. Ingraham, J. L. and Ingraham C. A., Thompson Asia Pvt. Ltd., Singapore (2002).

SEMESTER II

MBT&Med BT 201: Genetic Engineering		Total
Core course- Theory; 3 credits		45L
UNIT I : Fundamental techniques and Vectors		
1	Restriction-modification systems, Various enzymes in gene manipulation: nucleases, polymerases, kinases, phosphatases, ligases.	1
2	Cohesive and blunt end ligation	1
3	Plasmid based vectors (pBR and pUC)	1
4	λ based vectors	1
5	Cloning vectors for eukaryotes	2
6	Special purpose vectors e.g. expression vectors, tag vector	3
7	DNA labelling methods	1
8	Different methods to introduce recombinant DNA into host cell	1
UNIT II : Gene cloning and Sequencing		
9	Construction of genomic and cDNA library	1
10	Library screening methods (hybridization and immunochemical methods	1
11	Polymerase chain reaction and its types e.g. real time PCR, multiplex PCR Reverse transcriptase PCR, Inverse PCR, Nested PCR	3
12	DNA sequencing- Maxam-Gilbert method, Sanger's Dideoxychaintermination method, Automated DNA sequencing method.	3
13	Pyrosequencing- microarrays technology	2

14	Human genome sequencing	1
15	Genetic and Physical mapping techniques	1
UNIT III: Gene Expression and Mutagenesis		
16	Tools for analyzing gene expression: Reporter genes, Analysis of gene regulation, Techniques for transcript analysis	3
17	Techniques for analysis of translation product	1
18	Introduction to si RNA technology: principle and applications	2
19	Micro RNA and detection methods	1
20	Differential gene expression, Protein-protein interactions: phage-display, yeast two-hybrid system	2
21	Mutagenesis techniques	1
22	Nucleic acid hybridization assays and micro-assays	2
Unit IV : Applications		
23	Production of recombinant proteins from pro and eukaryotic hosts	2
24	Expression of industrially important products	1
25	Electrophoretic methods for mutation detection: SSCP, hetero-duplex analysis, DGGE MCC (Mismatch Chemical Cleavage),ASA (Allele Specific Amplification), PTT (Protein Truncation Test)	3
26	Gene therapy – ex vivo, in vivo, gene delivery systems, viral and non viral	3
27	Bio-pharming	1

References:

1. Brown T. A., 7th edition (2016), Gene cloning and DNA analysis, Blackwell publishing, UK
2. Primrose S., Twyman R. M. , 8th edition (2016), Principles of Gene Manipulation and Genomics, Blackwell Publishing, UK
3. Nicholl D. S. T., 2nd edition (2002), Introduction to Genetic Engineering, Cambridge University Press, UK
4. Channarayappa (2006), Molecular Biotechnology: Principles and Practices, University Press, New Delhi, India
5. Watson J. and Stephen, 7th edition (2014), Molecular biology of the gene, Pearson, US
6. From Genes to Genomes, 2nd edition, (2008), J.Dale and M.Schantz, John Wiley & Son Ltd.USA
7. From Gene to Clones ; Introduction to gene technology, 4th edition, (2003), E. Winnacker, Panima Publisher, India
8. Molecular Biology Problem solver: A laboratory guide (2004), A. Gerstein, A John Wiley & Sons, Inc., Publication, USA

MBT&Med BT 202: Analytical Biotechnology		Total
Core Course – Theory; 3 Credits		45L
UNIT I		
1	Introduction: Scope and importance of various techniques in biotechnology. The goal of structural biology.	2
2	Cell disruption methods: physical and chemical	2
3	Filtration techniques: Gross filtration, steri-pad filtration, membrane filtration	5

	(macro-filtration, micro-filtration, ultra-filtration), reverse osmosis, dialysis, their applications in industry. Merits and limitations	
UNIT II		
4	**Centrifugation-** Table top, high speed, microfuge, refrigerated, ultra, density gradient centrifugation, applications in biotech industry.	3
5	**Microscopy**: Structure and working of bright field and dark field microscopes. Principle, working and applications of phase contrast microscope,	4
6	**Advance microscopy**: confocal microscopy, fluorescence microscope, electron microscope, atomic force microscopy,	4
UNIT III		
7	**Biophysical methods**: Analysis of biomolecules using UV/visible spectrophotometer, fluorescence, circular dichroism	4
8	NMR and ESR spectroscopy, structure determination using X-ray diffraction	3
9	Different types of mass spectrometry, MALDI-TOF and surface plasma resonance methods.	4
Unit IV		
10	**Radio labeling techniques**: Properties of different types of radioisotopes normally used in biology, their detection and measurement; safety guidelines. Incorporation of radioisotopes in biological tissues and cells. Molecular imaging of radioactive material	3
11	**HPLC-** Concept, principle, procedure (analytical and preparatory), separation on the basis of detectors, accuracy, applications in research and quality control	4
12	**GC**: Concept, principle, procedure (analytical and preparatory), separation on the basis of detectors, accuracy, applications in research and quality control	4

References:

1. Principles and Techniques of Biochemistry and Molecular Biology, Wilson, K. and Walker, J. Cambridge University Press, New York (2005).
2. Analytical Biotechnology, C. van Dijk, Elsevier Science,The Netherlands,
3. Analytical Biotechnology, Thomas G.M. Schalkhammer, Springer Basel AG, 2002
4. Analytical Biochemistry & Separation Techniques, Dr. P. Palanivelu, IV Edition - Lab manual (IV Edition, 2009), Twenty first Century Publications
5. Techniques and Methods in Biology, Ghatak K.L.Prentice Hall India Learning Private Limited (2011)

MBT&Med BT 203: Immunology		**Total**
Core Course – Theory; 3 Credits		**45L**
UNIT I : Introduction		
1	**Immunity** – Types of Immunity, components of Innate and Acquired Immunity Cells and organs of immune system, Antigen presenting cells, endogenous and exogenous pathways of antigen presentation, presentation of non-peptide antigens	4
2	**Antigens** - Immunogenecity versus Antigenicity, Factors that influence immunogenecity, Epitopes - Properties of B-cell epitopes and T-cell epitopes, haptens and adjuvants, Antigen engineering-Increasing Immunogenicity	3
3	**Antibodies** - Basic structure of Immunoglobulins - The role of multiple myeloma in understanding Ig structure, domains-variable and constant region,	3

	Immunoglobulin classes and functions, application and engineering of monoclonal antibodies	
UNIT II : Lymphocyte ontology		
4	**B- cell maturation, activation and differentiation** Antigen dependant and antigen independent stages of B- cell maturation, B-cell activation and proliferation by Thymus independent and Thymus dependant antigens, B-cell differentiation, class-switching and generation of plasma cells and memory cells, primary and secondary response kinetics, significance in vaccination programs.	3
5	**T cell maturation, activation and differentiation** Stages of T cell maturation, Positive and negative selection in thymus, role of TH1 and TH2 cells, mechanism of CTL mediated cytotoxicity, co-stimulatory molecules and signals, super antigen induced T cell activation, NK cell mediated lysis, ADCC	3
6	**Complement system and Cytokines** Classical, alternate and lectin pathways of complement activation and function of complement system, Types and general properties Cytokines, receptors, cytokine network, Immunoregulatory role of IL-4, IFN-ϒ and TNB-β.	3
UNIT III : Immunogenetics		
7	**Immunoglobulin genes and proteins** Multigene organization of Ig genes, Generation of antibody diversity.	3
8	**TCR genes, gene products and co-repressors:** Structure and types (αβ and γδ), gene organization and rearrangement, T cell accessory membrane molecules, Role of TCR-CD3 complex in immune activation and signal transduction pathways.	3
9	**Major Histo-compatibility complex** General organization and inheritance of MHC; MHC Haplotypes, the structure of MHC class-I and class-II molecules; organization of MHC class I and class II genes, peptide binding of MHC molecules, Polymorphism of MHC class I and class II molecules; the role of HLA typing in organ transplantation and disease susceptibility/resistance.	3
Unit IV : Clinical Immunology		
10	**Clinical Immunology** **Hypersensitivity** – Type I, II, III and IV- outline of mechanism with examples.	2
11	**Immune tolerance and autoimmunity** - establishment and failure of tolerance; Autoimmunity; Types of autoimmune diseases with one example; Mechanism and role of CD4+ T cells.	3
12	**Transplantation immunology** - basis and manifestation of graft rejection, General immune-suppressive therapy. Specific immune suppressive therapy. Immune tolerance to allograft.	3
13	**Tumor immunology-** Malignant transformation of cells and immune responses. Tumor antigens, Tumor evasion of the immune system, immuno-surveillance,Cancer immune-therapy.	3
14	**Immunotechniques:**Immuniprecipitation, agglutination, RIA, ELISA, ELISPOT, Western blotting, fluorescence based imaging technique, HLA typing, Flow cytometry, and animal systems	

References:

1. Immunology and Serology in Laboratory Medicine Turgeon Mary Louise4th Ed. 2009
2. A Textbook of Microbiology & Immunology, ParijaSubhash Chandra 2009
3. Immunology , Kuby, 7th edition, Richard A. Goldsby, T. J. Kindt and B. A. Osborna, WHfreeman and Co., New-York
4. Riott's essential Immunolgy, I. M. Riott, Evan M. riot and Peter J. Delves, 10th edition

MBT&Med BT 204: Genomics and Proteomics	Total
Core Course – Theory; 3 Credits	45L
UNIT I	
1 Introduction to Bioinformatics: Introduction to Bioinformatics: Definition, History, Goal, Scope, Applications, Limitations	1
2 Introduction to Biological Databases: Hierarchy of Biological databases: Primary, Secondary, Derived and knowledgebase	5
3 Sequence Alignment & Analysis • Sequence alignment methods: Local and global, Pairwise sequence alignment, Multiple sequence alignment • Sequence alignment algorithm: Needleman &Wunsch , Smith & Waterman • Sequence Similarity Search Tools: Dot Plot, BLAST, FASTA, ClustalW, ClustalX • Sequence analysis methods: AMAS, CINEMA, MaxAlign	6
UNIT II	
4 Genomics: Genome sequencing: strategies & approaches, conventional DNA sequencing methodologies, NGS(Next generation sequencing), Third generation sequencing, Microarray Technology	3
5 Genomics Tools: • Tools for Genomic Data Mining: Basic Aspects of Genome Annotation • Database Search Engines: Special tools for searching genomic data • Prediction of genes: ORFs, Prediction of Signal sequences (Promoters, Primers, splice sites, UTRs etc.), Operons • Identification of Disease Genes: Identification of Drug Targets, Metabolic diseases and Pathogenic diseases, Gene Expression Analysis • Structural Genomics and Functional Genomics • Genetic Disorders Databases: OMIM, OMIA, Genetic Association Database, Genetic Disorder Guide, IGDD, DisGenet, Genetic Disorder UK	6
6 Genome mapping: Genetic maps and physical maps	2
UNIT III	
7 Comparative genomics and it's applications Methods:	4

- Genome Alignments: BLAST2, MUMmer , PipMaker , VISTA
- Comparison of Gene Order: GeneOrder , Gene synteny
- Comparative Genomics of organisms: Viruses, Microbes, Pathogens, Eukaryotes
- Comparative GenomicsDatabases : COG, VirGen, CORG, HOBACGEN, Homophila, XREFdb

8 **Proteomics:** 1

Introduction to proteomics, scope

9 **Classification of proteins**: Primary, secondary, tertiary, quaternary. 6

Protein Primary Databases: Protein database on NCBI/ Protein database on EMBL, PIR-PSD, UniProt KB/SwissProt, Expasy, InterPro

Unit IV

10 **Proteomics Applications:** 4

Strategies for protein identification, Protein sequencing, Protein engineering: Protein chips and functional proteomics; Clinical and biomedical application of proteomics.

11 **Proteomics tools:** 5

Structural databases: PDB, MMDB, SCOP, CATH.

3D structure visualization tools: Rasmol, Pymol, SPDBV, Cn3D

Secondary structure prediction algorithms: Chou Fasman, Jpred, Psipred, GOR methods; analysis of results.

3D structure validation databases: PROSA, Ramchandran Plot, Procheck

12 **Protein-protein interaction :** 2

Protein-Protein Interaction Networks, databases and software:

BIND - Biomolecular Interaction Network Database, STRING

References:

1. Guide to Human Genome Computing by Martin J. Bishop, Academic Press. ISBN 0-12-102051-7.
2. From Genome to Therapy: Integrating new technologies with drug development by Novartis Foundation, John Wiley. ISBN 0-471-62744-5.
3. Genome mapping and sequencing By Ian Dunham, Horizon, ISBN1-898486-50-6.
4. The Genome by Ram S. Verma, VCH, ISBN 1-56081-043-2.
5. Bioinformatics - from genomes to drugs (vol. 1), basic technologies (vol.1) by Lengauer, T., Germany, Wiley-VCH, 2002.
6. Principles of Genome Analysis And Genomics (3rd Ed.) by Primrose, S.B. &Twyman, R.M., UK. Blackwell Publishing Company, 2003.
7. Bioinformatics approach Guide to the analysis of genes and proteins by AndceasBaxevanis and B.F. Francis Ouellettee. John Wiley 2004.
8. Fogel, G.B. and Corne, D.W., Evolutionary Computation in Bioinformatics.
9. Patterson, B.K., Techniques in Quantification and Localization of Gene Expression.
10. Singer, M. and Barg, P. Exploring Genetic Mechanism.
11. Bowtell, D. and Sambrook, J. DNA Microarrays.
12. Fundamentals of Data Mining in Genomics and Proteomics, By Werner Dubitzky, Martin Granzow, Daniel P. Berrar, 2007, Springer Science + Bussiness Media, LLC.

MBT&MedBT 205: Nanobiotechnology Core Course – Theory; 2 Credits		Total 30L
UNIT I		
1	**Introduction to nanoscience**, properties of nanoparticles, Types of nanomaterial Carbon nanomaterials (fullerene, nanotube, nanofibres, nanowires) Quantum dots, magnetic nanoparticles	5
2	**Nanostructures:** Organic and Inorganic nanoparticles, Bionanostructures-protein, carbohydrate and lipid, DNA based	4
3	**Synthesis of nanoparticles,** Top down and Bottom up approach, Physical, Chemical and Biological methods of synthesis	5
UNIT II		
4	**Characterization of nanoparticles:** Optical (UV-Vis, FTIR, Photoluminescence spectroscopy) X-ray diffraction, Microscopy (SEM,TEM,AFM,STM) Surface and composition (ECSA, EDAX), Particle size analysis and charge distribution analysis, Toxicity Evaluation of nanomaterials; Cyto-toxicity, Geno-toxicity In vivo tests/assays etc containment	7
5	**Applications of Nano-Materials in Biosystems;**Nanomedicines, Targeted Drug Delivery, Disease diagnosis at proteomic level, Biosensors (Nucleic acid based, protein based), Lab on Chip, Applications in Gene therapy, cancer Biology. Bionanomachines	5
6	**Application of nanobiotechnology in agriculture and environment:** desalination, monitoring water quality, detection of pollutants	4
	References:	
	1. T. Pradeep, Nano, The Essentials, Understanding Nanoscience and Nanotechnology, Tata McGraw-Hill Limited, 2007	
	2. Tuan Vo, Dinh. Ed. Nanotechnology in Biology and Medicine: methods, device and applications. CRC Press, 2007	
	3. NANOBIOTECHNOLOGY BioInspired Devices and Materials of the Future, Shoseyov, Oded, Levy, Ilan, Springer, 2008	
	4. Nanoscience: Nanobiotechnology and Nanobiology, Boisseau, Patrick, Lahmani, Marcel, Springer, 2009.	
	5. Nanobiotechnology Inorganic Nanoparticles vs Organic Nanoparticles, Jesus M. de la Fuente and V. Grazu, Elsevier, 2012	

MBT 206: Animal Tissue Culture Core Course – Theory; 2 Credits		Total 30L
UNIT I		
1	Introduction to animal tissue culture: Overview of its applications in research, industry & therapeutics	1
2	Systems of tissue culture with distinguishing features, advantages and limitations	3
3	Growth characteristics of normal diploid and transformed cells growing in culture, anchorage dependent and independent cells	3
4	Aseptic techniques and its significance in ATC	2
5	Tissue culture media: role of balanced salt solution, individual constituents	5

and serum; Serum free media

UNIT II

6	**Primary culture and routine maintenance:** Disaggregation of tissue, techniques for primary culture, subculture and routine maintenance of cell lines, suspension culture,	3
7	**Cryopreservation**: Cryopreservation and revival of cell lines	6
8	**Quantitation of cells**: Estimation of viability,	2
9	**Scale up:** Scale up of anchorage independent and dependent cells, bioreactors, microcarriers, hollow fibers, perfused cultures	3
10	**Applications of animal cell culture** for *in vitro* testing of drugs, in production of monoclonal antibodies, viral vaccines and therapeutic proteins	2

References:

6. Ian Freshney, Culture of Animal cells (5th edition)2006, Wiley-Liss publication
7. Ed. John, Masters RW, Animal Cell Culture-Practical Approach, 2000, Oxford Press
8. Ed. Jenni, P Mather, David Barnes, Methods in Cell Biology, Vol 57, Animal cell culture methods. Academic Press 1998
9. R.Lanza, J. Geachartet. Al. (Eds.) Essentials of stem cell biology (2009), Elsevior Academic Press
10. R. Lanza, I Klimanskaya. Essential stem cell methods. (2009), Academic Press

MBT&Med BT 207: Genetic Engineering and Genomics Lab
Core Course – Practical; 4 Credits
Genetic Engineering Lab

1	Competent cells preparation and GFP cloning in *E.Coli*	4
2	Southern Hybridization	3
3	DNA fingerprinting	2
4	Phage titration	3
5	Restriction mapping	2

Genomics Lab

1	**Explore primary resource institutes NCBI, EBI, DDBJ** Explore Genomic databases Explore Sequence Alignment & Analysis • Sequence Similarity Search Tools: Dot Plot, BLAST, FASTA, ClustalW, ClustalX • Explore Sequence analysis methods: AMAS, CINEMA, MaxAlign	5
2.	**Explore comparative genomics databases:** • COG • VirGen, • CORG, • HOBACGEN, • Homophila, • XREFdb,	5

- o Grameneetc

3. Explore Comparative genomics and it's applications Methods: 5
   - Genome Alignments: BLAST2, MUMmer , PipMaker , VISTA
   - Comparison of Gene Order: GeneOrder , Gene synteny
   - Comparative Genomics Databases : COG, VirGen, CORG, HOBACGEN, Homophila, XREFdb
   - o
   - Explore NGS data analysis methods: Bowtie, TopHat

References:

1. Green and Sambrook, 4th edition (2012), Molecular Cloning: A Laboratory Manual,Cold Spring Harbor Laboratory Press
2. Molecular cloning: a laboratory manual, Volume 1, Joseph Sambrook, E. F. Fritsch, Tom Maniatis, Edition2, Cold Spring Harbor Laboratory, ISBN0879693096, 9780879693091.
3. Guide to Human Genome Computing by Martin J. Bishop, Academic Press. ISBN 0-12-102051-7.
4. From Genome to Therapy: Integrating new technologies with drug development by Novartis Foundation, John Wiley. ISBN 0-471-62744-5.
5. Genome mapping and sequencing By Ian Dunham, Horizon, ISBN1-898486-50-6.
6. The Genome by Ram S. Verma, VCH, ISBN 1-56081-043-2.
7. Bioinformatics - from genomes to drugs (vol. 1), basic technologies (vol.1) by Lengauer, T., Germany, Wiley-VCH, 2002.
8. Principles of Genome Analysis And Genomics (3rd Ed.) by Primrose, S.B. &Twyman, R.M., UK. Blackwell Publishing Company, 2003.
9. Bioinformatics approach Guide to the analysis of genes and proteins by AndceasBaxevanis and B.F. Francis Ouellettee. John Wiley 2004.
10. Bioinformatics in the Post-Genomic Era: Genome, Transcriptome, Proteome, and Information-Based Medicine, Jeff AugenAddison-Wesley Professional , 2004 ISBN:0321173864.
11. Fundamentals of Data Mining in Genomics and Proteomics, By Werner Dubitzky, Martin Granzow, Daniel P. Berrar, 2007, Springer Science + Bussiness Media, LLC

MBT&Med BT 208: Analytical Techniques and Proteomics Lab
Core Course – Lab; 4 Credits
Analytical Techniques Lab

1	Sterilization of bioactive molecules by membrane filtration	2
2	Separation of biomolecules using dialysis technique	2
3	Fractionation sub-cellular components by density gradient centrifugation	2
4	Separation of biolomecules by size exclusion chromatography	2
5	Determination of pKa value of p-nitrophenol by using UV-visible spectrophometer	2
	Visit to research institute or Biotechnology Industry/institutes	2

Protein Analysis Lab

6 Explore Protein Primary Databases: Protein database on NCBI/ Protein database on EMBL, PIR-PSD, UniProt KB/SwissProt, Expasy, InterPro — 5

7 To explore: — 5
- Structural databases: PDB, MMDB, SCOP, CATH.
- 3D structure visualization tools: Rasmol, Pymol, SPDBV, Cn3D
- Secondary structure prediction algorithms: Chou Fasman, Jpred, Psipred, GOR methods; analysis of results.
- 3D structure validation databases: PROSA, Ramchandran Plot, Procheck

8 Explore Proteomics databases:
- Trans-Proteomic Pipeline (TPP)
- PeptideProphet
- iProphet
- ProteinProphet
- Xpress &ASAPRatio
- SpectraST
- Corra& PIPE2
- PeptideAtlas&SRMAtlas
- PIPE2, TIQAM, & ATAQS

9 Explore Protein-Protein Interaction Networks, databases and software:
- DIP (Database of Interacting Proteins)
- PPI Server
- BIND - Biomolecular Interaction Network Database
- PIM –Hybrigenics
- PathCalling Yeast Interaction Database
- MINT - a Molecular Interactions Database
- GRID - The General Repository for Interaction Datasets
- InterPreTS - protein interaction prediction through tertiary structure

10 To explore:
- Structural databases: PDB, MMDB, SCOP, CATH.
- 3D structure visualization tools: Rasmol, Pymol, SPDBV, Cn3D
- Secondary structure prediction algorithms: Chou Fasman, Jpred, Psipred, GOR methods; analysis of results.
- 3D structure validation databases: PROSA, Ramchandran Plot, Procheck

3. Explore Proteomics databases: — 5
- Trans-Proteomic Pipeline (TPP)
- PeptideProphet
- iProphet
- ProteinProphet
- Xpress &ASAPRatio
- SpectraST
- Corra& PIPE2
- PeptideAtlas&SRMAtlas

- PIPE2, TIQAM, & ATAQS

References:

1. Introductory Practical biochemistry, S.K sawhney&Randhir Singh (eds) Narosa Publishing House, New Delhi, ISBN 81-7319-302-9, p 195-303
2. Standard Methods of Biochemical Analysis, S.K Thimmaiah (ed), Kalayani Publishers, Ludhiana ISBN 81-7663-067-5, p12-18
3. Experimental Biochemistry: A Student companion, BeeduSasidhar Rao & Vijay Deshpande (ed), I.K International Pvt. LTD, New Delhi ISBN 81-88237-41-8, p 13-17, p 49-72
4. Practical Biochemistry, R.C Gupta & Bhargava (eds) CBS Publishers and distributors, New Delhi, ISBN 81-239-0124-0 p 9-27
5. Practical Clinical Chemistry, Harold Varley, CBS Publishers and distributors, New Delhi.
6. Gradwhols Clinical Laboratory Techniques. Stanley & Raphael. W.E. company, London, UK
7. http://www.proteomecenter.org
8. Protein Microarray Technology ,Kambhampati, D. (ed) (2004) Front Matter, Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim, FRG. doi: 10.1002/3527601554.
9. Bioinformatics in the Post-Genomic Era: Genome, Transcriptome, Proteome, and Information-Based Medicine, Jeff AugenAddison-Wesley Professional , 2004 ISBN:0321173864.
10. Modern Protein Chemistry: Practical Aspects edited by Gary C. Howard, William E. Brown, 2002. CRC Press.
11. Fundamentals of Data Mining in Genomics and Proteomics, By Werner Dubitzky, Martin Granzow, Daniel P. Berrar, 2007, Springer Science + Bussiness Media, LLC.
12. Protein Arrays, Biochips and Proteomics: The Next Phase of Genomic Discovery edited by Joanna S. Albala, Ian Humphery-Smith, ISBN-0-8247-4212-1, 2003, Marcel Dekker

MBT&Med BT 209: Immunology and Nanobiotechnology Lab
Core Course – Practical; 4 Credits

Immunology Lab

1	Ouchterlony double diffusion	1
2	Radial immune diffusion	1
3	Lymphocyte separation from blood	1
4	Lymphocyte transformation	2
5	ELISA	2

Nanobiotechnology Lab

1	Synthesis of Gold nanoparticles by reduction method	1
2	Synthesis of Silver nanoparticles by reduction method	1
3	Synthesis of Metal oxide nanoparticles (MONs)	1

4	Purification of nanoparticles	1
5	Synthesis of Magnetic nanoparticles co-precipitation method	1
6	Green Synthesis of nanoparticles (Using Microorganisms, Plants)	1
7	Characterization of nanoparticles using UV-Vis absorption technique	1
8	Study on stabilization of nanoparticles	2
9	Effect of Gold and silver nanoparticles on growth of pathogenic bacteria and fungi	2
10	Visit to different laboratories	

References:

1. Goldsby A., Thomus J.K., Barbara A. O. and Kuby J. Immunology, 5th eds.
2. Deives P.J., Seamus J.M. and Raoitt E. M. (2006) Essential Immunology, 11th eds. Blackwell Publ.
3. Jaeway C. Travers, Walport and ShlomchikImmunobiology 6th eds. Garland Sc. Publ.
4. 4. Nanoscience: Nanobiotechnology and Nanobiology, Boisseau, Patrick, Lahmani, Marcel, Springer, 2009.

MBT&Med BT 210: Option I (210.1) Bio-entrepreneurship		Total
Elective Course I – Theory; 2 Credits		30L
UNIT I		
1	Sectors: Pharma, Biotech, Food, Agri-biotech, Research, Diagnostics, Analytic Labs	3
2	Developing flair for business in students	1
3	Short-term opportunities available for business	2
4	Import substitute product list	2
5	Regulatory Affairs: SSI, MSME, FICCI, MCC, IEC	3
6	Firm registration, GST registration, SME Loan, ISO 22000/14000 etc.,	3
7	Export counsel	1
UNIT II		
8	Finance: Banking, MoFPI, SIDBI, Foreign collaboration, Investors	3
9	Subsidies: BIRAC, SSI, MSME, MoFPI	2
10	Marketing: Promotion, Distribution, Rolling Cycle	2
11	Business Concept and Competitors' knowledge	1
12	Export benefits, procedures	2
13	Make In India	1
14	Knowledge about taxation, GST, custom duty, excise	3
15	Packaging suitability knowledge	1

References:

1. Forbat, John, "Entrepreneurship" New Age International. 2. Havinal, Veerbhadrappa, "Management and Entrepreneurship" New Age International 3. Joseph, L. Massod, "Essential of Management", Prentice Hall of India.
2. Principles of Management – P.C.Tripathi, P.N.Reddy – Tata McGraw Hill,

3. Dynamics of Entrepreneurial Development & Management – Vasant Desai – Himalaya Publishing House 3. Entrepreneurship Development – Poornima.M.Charantimath – Small Business Enterprises – Pearson Education – 2006 (2& 4). 4. Management Fundamentals – Concepts, Application, Skill Development – RobersLusier – Thomson – 5. Entrepreneurship Development – S.S.Khanka – S.Chand& Co. 6. Management – Stephen Robbins – Pearson Education/PHI – 17 th Edition, 2003.

MBT&MedBT 210: Option II (210.2) – Intellectual property rights I (IPR-I)	Total
Elective Course I – Theory; 2 Credits	30L
UNIT I	
1 Introduction to Intellectual Property General Introduction to IP & IPR; Introduction, History & role of International Conventions & Treaties- GATT, WTO, WIPO, TRIPS,Budapest Treaty, CBD, Nagoya Protocol;International framework for the protection of IP; IP as a factor in R&D; IPs of relevance to Biotechnology, Agriculture, Bioinformatics and Pharma sector	15
UNIT II	
2 Types of IP Industries: Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications, Plant variety andProtection of New GMOs	8
3 Concept of 'prior art' Need of Prior Art for IP types, Classification search and its implications; Invention in context of "prior art"; Patent databases; Searching International Databases; Country-wise patent searches (USPTO, EPO, India etc.); Analysis and Report formation	7

References:

1. Intellectual property rights in agricultural biotechnology By Frederic H. Erbisch, Karim M. Maredia, Biotechnology in Agriculture Series No 28,
2. The role of intellectual property rights in biotechnology innovation By David Castle, Edward Elgar Publishing
3. http://www.wipo.int/portal/index.html.en
4. http://www.ipr.co.uk/IP_conventions/patent_cooperation_treaty.html
5. www.patentoffice.nic.in
6. www.iprlawindia.org/ - 31k - Cached - Similar page
7. http://www.cbd.int/biosafety/background.shtml

SEMESTER III

MBT 301: Environmental Biotechnology Core Course- Theory; 3 Credits		Total 45L
UNIT I : Environment and Waste water treatment technology		
1	**Basic concepts,** Its ingredients – soil, water, air, biota and non-biota and its significance	3
2	**Environmental issues, Environmental pollution** - Types, measurement, effects on health & food, Air pollution and its control through Biotechnology, Water pollution and its control, Soil pollution sources, pesticides, heavy metals and agrochemical and its control, Noise pollution: effects and control, Degradation of Xenobiotic compounds in Environment	4
3	**Detection and control of micro-organisms** in environmental fresh water, in source and drinking water; Potable and non-potable water Biosensors - types and applications in environmental pollution detection and monitoring	4
UNIT II		
4	**Biological treatment:** stabilization pond, aerated lagoon, activated sludge process, trickling filter anaerobic treatment	2
5	Sewage and waste water treatments systems; Primary, secondary and tertiary treatments; Measurement of treatment efficiencies	3
6	Bioreactors for waste water treatments; Reactors types and design; Reactors in series; Development and optimization of membrane bioreactor process for use in sanitary and industrial sewage treatment	3
	Biological treatment: stabilization pond, aerated lagoon, activated sludge process, trickling filter anaerobic treatment	2
UNIT III		
7	**Global Environmental Issues** Solid waste Management, physicochemical characters, hazardous and non hazardous wastes, bio-degradable and non-biodegradable wastes, collection and transport of solid waste, composting, vermin-composting and methane production.	4
8	Global warming: climate change, ozone depletion, UV- B and green house effects, acid rain, its effects	3
9	Biotechnological approaches for solid waste management	3
10	Carbon credit	1
Unit IV		
	Biotechnological approach for improving the Environment:	
11	Characteristics of industrial effluents, Conventional treatments, kinetics of biodegradation of waste, Advances in aerobic and anaerobic treatments, genetically modified organisms for improving the environment, Techno-economic feasibility of conversion of waste into energy.	2
12	Environmental pollution control- Bioremediation, Bioaugmentation,	2

	Biostimulation and Phytoremediation	
13	Desalination technique: Reverse osmosis, quality of input and output water, cost effectiveness, byproducts of desalination and industrial application	2
14	Biotechnological approach for improving the Environment:	2
15	Characteristics of industrial effluents, Conventional treatments, kinetics of biodegradation of waste, Advances in aerobic and anaerobic treatments, genetically modified organisms for improving the environment, Techno-economic feasibility of conversion of waste into energy.	2
16	Environmental pollution control- Bioremediation, Bioaugmentation, Biostimulation and Phytoremediation	2

References:

1. Rittamann B. E. and Mc Carty P. L. (2001), Environmental Biotechnology: Principles and Applications, International Edition, McGraw-Hill, New York
2. Methods of Air Sampling & Analysis (1977), 2nd Edition –APHA intersociety Committee APHA, Washington D.C
3. Standard Methods for the Examination of Water and Wastewater (1986) 15th Edition APHA-AWWA-WPCF
4. Brunner R.C., (1989), Hazardous Waste Incineration, McGraw Hill Inc.
5. Milton Wainwright, An Introduction to Environmental Biotechnology, Kluwer Academic Publishers, Boston.Hardbound, 1999.

Med BT 302: Plant Biotechnology		Total
Core Course – Theory; 3 Credits		45L
UNIT I		
1	Biodiversity hotspots in India: Characterization of biodiversity through different biochemical and molecular methods (chemical printing of biodiversity),	3
2	Conservation strategies of biodiversity, threatened and extinct species	2
3	Bio-prospecting of biodiversity for product development	2
UNIT II		
4	Plant tissue culture and micropropagation Introduction, Different systems and stages in axillary shoot proliferation, organogenesis, somatic embryogenesis with examples..	4
5	Cell culture technology and its application for the production of artificial seeds and secondary metabolites..	4
6	Homozygous plant production through anther and pollen culture, Embryo rescue and embryo culture in rearing viable hybrid plants, Endosperm culture and production of triploids, Somaclonal and gametoclonal variations and their applications	4

7	**Protoplast technology** for the production of somatic hybrids and cybrids.Applications in crop improvement.	3

UNIT III

8	**Transgenic Plants** Introduction, vertical versus horizontal gene transfer, vectors, reporter genes	3
9	**Direct and indirect methods for gene transformation,** plant cell and chloroplast transformation,	3
10	**Introduction to markers**, Marker – Assisted Crop Improvement, Genetic Markers and Linkage Maps	3

Unit IV

10	**Applications of transgenic plants** Development of transgenes for the production of biofuels, single cell proteins, pigments, neutraceuticals, pharmaceuticals, biopesticides, pharmaceuticals, vaccines, plantibodies, value addition, bio-fortification.	3
11	**Selection and characterization of transformants** for biotic and abiotic stress tolerance, for increase in crop and timber productivity	3
12	**Marker Technology** in Crop Improvement	3

References:

1. Altman A, Hasegawa PM (Ed) (2012) – Plant Biotechnology and agriculture. Prospects for the 21st century (Academic press).
2. Bhojwani S S. &Razdan M K (1996). - Plant Tissue Culture : Theory and Practice (Elsevier)
3. Slater A, Scott NW, Fowler MR (2008) – Plant Biotechnology: the genetic manipulation of plants (Oxford Press)
4. Plant Molecular Breeding, (2009), Newbury HJ, John Wiley and Sons., USA.

MBT 303: Microbial Technology		Total
Core Course – Theory; 3 Credits		45L

UNIT I

1	Introduction	
2	Microbial metabolites and recombinant products	1
3	Batch, continuous and fed batch culture , growth kinetics	2
4	Culture preservation methods	1
5	Improvement of industrial microorganisms	3
6	Fermentation media and media sterilization	2
7	Statistical designs	2

UNIT II

6	Sterilization: Del factor, filter sterilization	2
7	Inoculum development: bacterial and fungal processes	1

8	Fermenter design	2
9	Types of fermenters e.g. air lift fermenter, packed tower fermenter	1
10	Aeration and agitation: Determination of K_La value and factors affecting K_La value	2
11	Measurement of Process variables: Temperature, pressure, foam, dissolved oxygen, pH, redox	2
12	Downstream processing	1

UNIT III

13	Production of organic acids e.g. lactic acid	1
14	Microbial enzymes and applications	2
15	Production of antibiotics e.g penicillin	2
16	Production of vitamins e.g. vitamin B12	1
17	Biopolymers e.g xanthan, PHA	3
18	Biotransformation of sterols	2

Unit IV

19	Plant growth promoting bacteria (PGPB): Nitrogen fixation and genetic engineering of nitrogenase gene cluster, Improved nitrogen fixation Nodulation,Hydrogenase	5
20	Microbial insecticides: *Bacillus thuringiensis* toxin, mode of action and genetic engineering of toxin genes	3
21	Biocontrol of pathogens: siderophorres, antifreeze proteins	2
22	Small biological molecules: indigo, lycopene	2

References:

1. L.E.J.R. Casida, 2nd edition (2016), Industrial Microbiology, New Age International Publishers
2. Glick B.R., Pasternack J.J., Patten C.L., 4th edition (2010), Molecular Biotechnology, ASM Press, Washington, DC
3. PeppleransPeriman , 2nd edition (2004), Microbial technology, Academic Press, New York
4. Barredo, José-Luis (Ed.), (2005),Microbial Processes and Products. Springer
5. Glare, Travis R., Moran-Diez, Maria E. (Eds.) (2016) Microbial-Based Biopesticides, Springer

MBT 304: Food Biotechnology		Total
Core Course – Theory; 2 Credits		30L

UNIT I

1	Introduction: Scope and importance of food processing: national and international perspectives	1
2	Food additives like preservatives, antioxidants, emulsifiers, sequesterants, humectants, stabilizers with respect to chemistry, food uses and functions in formulations.	4

3	Neutraceuticals, functional foods, fortified foods	4
4	Food reheology and texture	3
5	Nutrigenomics	3

UNIT II

6	Fermented foods: Fermented milk products. cheese, cheese spread, Youghurt, dahishrikhand and similar products Other fermented foods like beer, wine and vinegar, Traditional fermented foods like idli and dosa.	6
7	Mushroom cultivation: use of biotechnological methods to produce high quality mushrooms	3
8	Role of Biotechnology in food packaging	2
9	Natural food colours and flavors	2
10	Genetically modified foods: safety, risks and public concerns	2

References:

1. K. Shetty, G. Paliyath, A. Pometto, R. Levin (Eds), 2nd edition, (2006) Food Biotechnology, CRC Press
2. John E. Smith, Biotechnology , Fifth edition (2009), Cambridge University Press
3. S. Bielecki J. Polak J. Tramper (Eds), Food Biotechnology, Volume 171st Edition (2000), Elsevier
4. W.A. Gould , Fundamentals of Food Processing and Technology 1st edition, (1997), Woodhead Publishing
5. Toledo, Romeo T. (2007) Fundamentals of Food Process Engineering, Springer

MBT&Med BT 305: Biostatistics — Total 30L

Core Course -Theory; 2 Credits,

UNIT I

1	Introduction to Biostatistics, Common terms, notions and Applications; . Statistical population and Sampling Methods	5
2	Types of variables; Independent and dependant variables; Nominal, Ordinal, ratio and discrete variable types	5
3	Classification and tabulation of Data, Diagrammatic and graphical presentation; Frequency Distribution, Measures of central value	5

UNIT II

6	Descriptive Statistics; Measures of variability; Standard deviation, standard Error, Range, Mean, Deviation, Coefficient of variation, Analysis of variance	4
7	Inferential Statistics; Statistical power; Hypothesis testing, Test of significance; t-test, chi-square test;	3
8	Regression; Basic of regression, regression analysis, Estimation, Testing, Prediction, checking	3
9	Non-parametric statistical methods; Man-Whiteny U test, Wilcoxon test; Kruskal-Wallis test.	3
10	Descriptive Statistics; Measures of variability; Standard deviation, standard	3

Error, Range, Mean, Deviation, Coefficient of variation, Analysis of variance

References:

1. Biostatistics: A guide to design, Analysis and Discovery, Peter Fritz, Elsevier India.
2. Biostatistics: A foundation for analysis 7th Edition, Ferric Darvas
3. Applied statistical designs for the researcher, Neil Ed Taylor and Francis Groop.

MBT&MedBT 306: Research Methodology		Total
Core Course – Theory; 2 Credits		30L
UNIT I		
1	Basic concepts of Research Introduction, Definition and basic concepts, objectives of research, Research approaches, types of research, techniques of research, hypothesisation, literature survey, selection of topic, compiling records.	5
2	Research Design Important concepts in research design – basic principles of research design, need of research design, features of good research design.	5
3	Sampling and Data collection & Analysis Collection of primary and secondary data - parameters, techniques for data collection, methods of data presentations, classification and tabulation of data, graphical representation	5
UNIT II		
6	Data Analysis Statistical methods of data analysis: Applications of statistics in research, measures of central tendency and dispersion	4
7	Testing hypothesis What is a Hypothesis, Basic Concepts Concerning Testing of Hypotheses, Procedure for Hypothesis Testing, Flow Diagram for Hypothesis Testing, Measuring the Power of a Hypothesis Test, Tests of Hypotheses, Important Parametric Tests, Hypothesis Testing of Means	3
8	Technical Writing: Different types of scientific documents, review paper, book reviews, research paper, thesis, project reports (for the scientific community), Plagiarism, Research Ethics, Patents and IPR.	3

Objective:

To provide the knowledge of how to define research problem, hypothesis testing, literature survey, research designs, data collection and analysis. Topics covered in this course includes, from meaning of research to technical writing.

Teaching – Learning Methodology:

Lectures and Tutorials: This is a compulsory subject offered by RGIITBT for all M Sc. Biotech students. Lectures, tutorials, group discussion, paper presentation, assignments will be used as a teaching – learning process. There

will be a recommended course books. Students are expected to read the research / review articles of their chosen topic of interest, develop research problem for their research project to be undertaken in the forthcoming semester.

Expected Learning Outcome:

Students are expected to learn key concepts in research methodology, data collection and data analysis, presentation of data, interpretation and technical write-up. It is expected that students will learn how different research methods are useful in developing working hypothesis, establish theories, models or concepts. It is expected that the students will practice reading and interpreting research papers, review articles, understanding key concepts of research approaches used by investigators, literature survey, data analysis, interpretation and presentation.

Through this course, it is expected that students should able to independently develop a research plan or research ideas in their areas of research interest for the forthcoming semester.

References:

1. Research Methodologies: Methods and Techniques. Kothari CK. 2004, 2nd Ed, New Age International, New Delhi
2. Research Methodologies, Paneerselvam R, 2004, Pentice Hall of India, New Delhi
3. Research Methodologies, Bulakh PM, Patki PS, Choudhary AS, 1st edition, Expert Trading Corporation, Mumbai
4. Introduction to Biostatistics and Research Methodology, 4th edition, Sunder Rao P.S.S, J.Richard
5. Fundamentals of statistics Gupta, S.C. (2013).Himalaya Publishing House.
6. The Role of IPR in Biotechnology Innovations by David Castle, Edward Elgar Publishing
7. Profits and plagiarism: The case of medical ghostwriting – Anekwe TD, Bioethics, 2010. 24(6): 267–272.

MBT 307: Environment & Plant Biotech Lab
Core Course – Practical; 4 Credits
Environmental Biotechnology Lab

1	Determination of particulate matter 10□ (PM) concentration from ambient air by high volume sampler	1
2	Determination of SOx and NOx concentration from ambient air by high volume sampler	1
3	Determination of equivalent noise level (Leq) of the surrounding air	1
4	Determination of dissolved oxygen (DO) in given water sample	1
5	Determination of biochemical oxygen demand (B.O.D) in given water sample	2

6	Determination of chemical oxygen demand (C.O.D) in given water sample	2
7	Determination of organic matter phosphate/ calcium / magnesium from given soil sample	2
8	Determination of sodium / potassium	2
9	Visit to waste water treatment plant(Industrial visit)	4
10	Determination of particulate matter 10□ (PM) concentration from ambient air by high volume sampler	4

Plant Biotech Lab

11	Nutrient media composition, preparation and sterilization	1
12	Micropropagation via adventitious shoot proliferation	1
13	Micropropagation via somatic embryogenesis	1
14	Anther/microspore/embryoculture	1
15	Protoplast isolation and culture	1
16	Histological and cytological techniques for plant cultures	1
17	*Agrobacterium*- mediated transformation studies	1
18	Extraction and quantification of secondary metabolites from callus	1
19	Visit to commercial Plant Biotechnology industry	1

References:

1. D.S. Ramtake and C. A. Moghe, Manual on water and waste water analysis, NEERI, Nagpur, 1988
2. Gabriel Bitton, Wastewater Microbiology, 2nd Edition. Wiley-Liss; 2nd Edition, 1999.
3. Trivedy,R.K. and Goel,P.K.(1987).Practical Methods in Ecology and Environmental Science,Environmental Publications, Karad.
4. Standard Methods for Waste and Water Analysis APHA 21stEdition
5. Gaurd.R.S. Gupta.G.D and Gukhade.S.B.2000. Practical Biotechnology: Nirali park Ashan Publishers. Pune
6. Tejovathi.G, Vimala.Y and RekhaBhadauria, 1996. A practical manual for plant
7. Biotechnology. CBS publishers and distributors. New Delhi.

MBT 308: Microbial & Food Biotech Lab

Core Course: Practical 4 Credits

Microbial Technology Lab

1	Isolation, screening and optimization of conditions for production	1
2	Solid state fermentation: enzymes, alcohol	1
3	Submerged fermentation: enzymes, exopolysaccharide, organic acids	1
4	Estimation, recovery and purification of fermentation products-enzymes, antibiotics, organic acids, alcohol, exopolysaccharide	1
5	Influence of different parameters on immobilization of cells and enzymes	1
6	Isolation of probiotic culture from various sources • Evaluation and efficacy of probiotic culture	1
7	Production of fermented food and characterization of acidity, alkalinity and its microbial profile	1

Food Biotech Lab

11	Detection of siderophore production by *Azospirillum and Pseudomonas*	1
12	Analysis of milk , milk pasteurization and sterilization. Analysis of milk products	1
13	Preparation of cream, butter, cheese, paneer, milk sweets and ice cream. Visit to dairy plants.	1
14	Sensory analysis and hedonic rating of food.	1
15	Identification and ranking of food product attributes, sensory and instrumental methods for measuring food attributes.	1
16	Determination of food additives in foods.	1
17	Rheological properties of foods. Detection of adulteration of fats and oil.	1

References:

1. Joslyn, M.A. Ed. 1970. Methods in Food Analysis. Academic Press, New York.
2. King, R.D. Ed. 1978. Developments in Food Analysis Techniques-1. Applied Science Publishers Ltd., London.
3. Morris, C.J. and Morris, P. 1976. Separation Methods in Biochemistry 2nd Ed. Pitman Pub., London.
4. Raghuramulu, N., Madhavan Nair, K., and Kalyanasundaram, S. Ed. 1983. AManual of Laboratory Techniques. National Institute of Nutrition, ICMR, Hyderabad.
5. Aneja, K.R.Experiments in Microbiology, Plant Pathology, Tissue Culture and Microbial Biotechnology (2018), 5th edition

MBT 309: Biostatistics Lab

Core Course – Practical; 2 Credits

Biostatistics Lab:

1	Numerical Excercises: Elementary statistics using Spread sheets, Representation of Data using Charts	1
2	Scatter Plots,Curve fitting on Spread sheets , Add trendline Tool	1
3	Outside Class room Activity: One sample survey (mini) using Google forms and inferencing - simple frequencies , means and std deviation (to be counted as a Practical)	1
4	Excercises: Creating PDF, PMF using Spread sheets	1
5	Numerical Excercises : On spread sheet, data analysis tool-pack t,z - Tests for a single Mean Comparing Two Means ,t-tests: Paired – Unpaired Inference for Proportions	1
6	Excercises : One way ANOVA, Two way ANOVA (using Data Analysis pack on Spread sheet or On SPSS/PSPP), F-tests, and Use of Least significant differences, Excercises: Using SPSS or Data Analysis pack on spread sheets.	2

References:

1. Probability statistics, and reliability for engineers by Boca Raton, Ayyub B. M. &McCuen, R H, CRC Press, 1997.
2. Statistical methods in bioinformatics: an introduction by Ewens, W. J. & Grant, G. R., New York. Springer, 2001.
3. Handbook of computational statistics: concepts and methods by Gentle, J.E.,

Hardle, W. & Mori, Y., Berlin, Springer-Verlag, 2004.
4. Statistical design and analysis of industrial experiments by Ghosh, Subir, Ed., 1990.
5. Scan Statistics by Glaz, J., Naus, J. & Wallenstein S, New York, Springer, 2001.
6. Statistical design for research by Kish, L., Wiley series in probability and mathematical statistics, New York, John Wiley $ Sons, 1987.
7. Introduction to probability and statistics by Lipschutz, S. & Schiller, J. J., New York. McGraw-Hill, 1999.
8. Ian Freshney, Culture of Animal cells (5th edition)2006, Wiley-Liss publication.

MBT&Med BT 310: Option I (310.1) – Biomedical Waste Management — Total
Elective Course II – Theory; 2 Credits — 30 L

UNIT I

1 **Introduction,** definition, classification/ categories, composition and sources. — 15
Radioactive waste
Health Impacts, direct and Indirect hazards
Modern technology for handling biomedical waste
Basic steps in waste management, segregation, collection and handling of waste
On site pre-treatment of waste
Mechanical treatment and chemical disinfections
store and off-site transportation
Common treatment facilities in-site and off-site
Liquid waste treatment and different technologies, cost aspect

UNIT II

2 Technologies available for treatment of biomedical waste — 15

Conventional treatment technologies

a) Wet thermal technology
b) Incineration - different models

Treatment of general/non-infectious waste

a) Composting, rotating jumbling system French composting
b) Vermi-composting

Disposal Technologies

a) Sharp disposal pit
b) Deep- burial pit
c) Secured land

Controls applied to waste management,
Environmental safety, risks & public issues,
Instrumentation and monitoring, Crematories,
Risk management in hospitals -Environment issues in hospitals -Risk analysis

Legislation and policies on health care waste management.

References:

1. Principles of Hospital Management - S. A. Tabish
2. Hospital Management - S. L. Goel
3. Hospital Administration - Francis
4. Bio-Medical Waste Act & Rules Govt. of India
5. Current Issues In BMW Waste Handling-ISHA, Bangalore
6. Management and Handling Rules for: municipal solid waste, biomedical waste, hazardous waste and radioactive wastes, Government of India Publications.
7. Bio-Medical Waste Management- SushmaSahai

MBT &Med BT 310: Option II (310.2): Drug Designing Elective Course II – Theory; 2 Credits		Total 30 L
UNIT I		
1	Drug discovery process, role of Bioinformatics in drug design.	2
2	Target identification and validation, lead optimization and validation. Structure-based drug design and ligand based drug design.	2
3	Modeling of target-small molecule interactions.	2
4	Structure Activity Relationship:QSARs and QSPRs, QSAR Methodology.	3
5	Various descriptors used in QSARs: Electronics; Topology; Quantum Chemical based descriptors. 3D QSAR techniques: CoMFA and CoMSIA.	3
6	Training data, test data and external validation data, applicability domain in QSAR, Cross validation techniques, PubchemBioAssay data for QSAR studies.	3
UNIT II		
7	Pharmacophore features, Pharmacophore model, Receptor-based and ligand-based pharmacophore modeling.	3
8	Virtual screening based on pharmacophore model.	4
9	Receptor site, molecular docking study, flexible docking, rigid docking, molecular interactions.	4
10	Scoring functions, correlation between ligand-based and receptor-based studies	4

References:

1. Computer-Aided Molecular Design: Theory and Applications by Jean-Pierre Doucet, J. P. Doucet, Jacques Weber, Elsevier Science & Technology Books.
2. Receptor-based Drug Design edited by Paul Leff, Marcel Dekker Inc., New York.
3. Advanced Drug Design and Development: A Medicinal Chemistry Approach by P. N. Kourounakis, 1994, Taylor & Francis.
4. Biopharmaceutical Drug Design and Development by Susanna Wu-Pong, Yon Rojanasakul, 2008, Humana Press.
5. Combinatorial Library Design and Evaluation: Principles, Software, Tools, and Applications in Drug Discovery by Arup Ghose, VellerkadViswanadhan, 2001.
6. Computer-Aided Drug Design and Delivery Systems by Ahindra Nag, Baishakhi De, 2010, McGraw-Hill Professional.

MBT& Med BT 310: Option III (310.3) – Intellectual property rights II (IPR II)	Total
Elective Course II - Theory; 2 Credits	30 L

UNIT I

1	Basics of Patents Indian Patent Act 1970; Patent Rules, 2003; Recent Amendments; Definitions, non-patentable subject matter, patentability criteria, anticipation, infringement, opposition, biopiracy;Precautions before patenting-disclosure/non-disclosure.	5
2	Types of patents Provisional and Complete specification; Contents of specification	5
3	Introduction to Patent drafting National, PCT and Convention patent applications; PCT and Implications; Role of a Country Patent Office; Procedure for filing requirements Nationaland international Patent application, Forms, fees and timelines Cost and financial assistance for patenting, introduction to existing schemes	5

UNIT II

4	Relevant case studies (3-4 cases) related to patentability criteria, anticipation, infringement, opposition, bio-piracy	12
5	Career opportunities in the field of IPR.	3

References:

1. Erbisch, Karim M. Maredia,Intellectual property rights in agricultural biotechnology By Frederic H. Biotechnology in Agriculture Series No 28,
2. David Castle, The role of intellectual property rights in biotechnology innovation, Edward Elgar Publishing
3. http://www.wipo.int/portal/index.html.en
4. http://www.ipr.co.uk/IP_conventions/patent_cooperation_treaty.html
5. www.patentoffice.nic.in
6. www.iprlawindia.org/ - 31k - Cached - Similar page
7. http://www.cbd.int/biosafety/background.shtm

SEMESTER IV

MBT&MedBT 401: RESEARCH PROJECT

Core Course – 20 Credits

Guidelines for Research Project and Dissertation Submission during Sem IV for Master of Science (M. Sc.) in Biotechnology

Eligibility:

- If student fails to pay any of the pending dues before the beginning of the project date, he/ she will not be considered to be eligible to undertake research project.

Project Duration, Dissertation writing and Submission:

- The project duration will be from beginning till the end of Semester IV
- Students shall submit dissertation title, name of research guide, name of co-guide (for off-campus only), name & place of research work within 10 days after the start date of semester IV. (As per the format enclosed).
- Student must have to submit Two hard copies (copy of Library/ Co-Guide & Student's copy) and one soft copy (Guide) of Dissertation only in the prescribed format (read below), duly approved by Research Guide(s) on or before April 15th of every year. The dissertation will not be accepted for evaluation for those who submit after March 15th, their presentation will be taken along with the next year batch.
- Students must acknowledge all the figures, maps, tables, methods, texts, etc., that are used, taken from other sources for writing the dissertation, except for original work that they have carried out. Dissertation having more than 10 % of plagiarism found will not be considered for evaluation.
- Dissertation must be written in specified format only as mentioned below:
  a. The paper used for printing shall be of A4 size;
  b. Printing shall be in a standardized form (word size of 12, font in Times New Roman) on one side of the paper and in 1.5 line spacing;
  c. A margin of 1.5 inches shall be on the left hand side, top, bottom and right hand margin shall be of 1 inch.
  d. The card for cover shall not be more than 330 GSM.
  e. The title of the dissertation, name of the candidate, degree, name of the guide, co-guide, place of research and the date, month and year of submission shall be printed on the title page and on the front cover.
  f. The hard- bound thesis cover shall be of black color. Spine of the binding [side cover] should mention 'M Sc. Biotechnology or Medical Biotechnology or Bioinformatics dissertation on the top, name of the candidate and date, month and year.
- Student must follow following chapter scheme for Dissertation submission:

Chapter Scheme of Dissertation :

- ✓ Introduction
- ✓ Review of Literature
- ✓ Aims and Objectives
- ✓ Materials & Methods
- ✓ Observations and Results
- ✓ Discussion
- ✓ Summary
- ✓ Conclusions
- ✓ Bibliography –Reference etc.

Place of Research Project:

- ➢ Student may prefer to undertake his/ her research project in-house or off-campus. Students those preferring to pursue research at off-campus will have to undertake research work only in any of the Department of Scientific and Industrial research (DSIR), Government of India recognized laboratory (Government, State-Government, Private).

Research Guide(s):

- ➢ Students who are opting for off-campus will have one Major Research Guide from the host organization (Preferably a Ph D. qualified scientist), however, a Co-Guide from RGIITBT will be appointed.

Dissertation Evaluation:

- ➢ Students will have to submit Two progress reports (45 days of Intervals) (Format Enclosed) and One evaluation report from Research Guide having 40 % weight age (Format Enclosed) at the time of dissertation submission on the execution of research project duly signed by Guide / Co-Guide. The progress report will include, attendance percentage, review collection, research progress, sincerity, topic understanding, and systematic execution of research project, data collection and management. The evaluation report will include attendance, review work, project execution, critical thinking, originality of work, presentation of result, understanding of research, dissertation write-up, presentation of tables, figures, maps, references, etc.
- ➢ Student will have to give 20 min presentation on the work done in the presence of expert committee (between April 21 to May 5 of every year). (Note only working dates will be considered). The power point presentation format shall contain project title, name of candidate, place of research work, name of Guide/ Co-Guide, introduction, review, objectives, significance of the work, methodology, results &

discussion, conclusion, references and acknowledgement. The presentation shall be of 12-15 min with 5-8 minutes of discussion.

- The presentation will carry 60 % of weight age based on the following consideration. The overall understanding of the research project, objectives, methodology. The outcome of research work, data analysis and statistics, clarity in presentation and question – answer session (Format Enclosed).
- Student will be assigned a grade as per the Rules mentioned.

RAJIV GANDHI INSTITUTE OF IT AND BIOTECHNOLOGY

"Write here **approved title** of the Dissertation in all upper-case (capital letters) with a 'centre' alignment. Place this title on the upper central part of the cover with sufficient margin from top and both sides. Use font size suitable to length of the title"

A DISSERTATION SUBMITTED TO

RAJIV GANDHI INSTITUTE OF I.T. AND BIOTECHNOLOGY,
BHARATI VIDYAPEETH DEEMED UNIVERSITY, PUNE

FOR AWARD OF DEGREE OF
MASTER OF SCIENCE in BIOTECHNOLOGY

SUBMITTED BY
……..

UNDER THE GUIDANCE OF
……..
……

Name of Co-Guide
Name of Guide

RESEARCH CENTRE
……
……..
……..

WRITE HERE DATE, MONTH & YEAR OF SUBMISSION

CERTIFICATE

This is to certify that the work incorporated in the dissertation entitled "……." for the degree of 'Master of Science' in the subject of Biotechnology under the faculty of Interdisciplinary Science has been carried out by Mr/ Mrs……. Rajiv Gandhi Institute of I.T and Biotechnology, BharatiVidyapeeth Deemed University, Dhankawadi, Pune (OR NAME OF THE LABORATORY, PLACE OF THE WORK) during the period from …… to……under the guidance of Dr…….

Place: Pune

Date :

(Signature of Head of the Institute with seal)

Principal / Director

Seal

CERTIFICATION OF GUIDE

This is to certify that the work incorporated in the dissertation entitled "……..……
…"

Submitted by……. for the degree of 'Master of Science' in the subject of 'Biotechnology' under the faculty of Interdisciplinary Science has been carried out in the Department (laboratory) of……, RGIITBT, BVDU (**Institute/ Private Lab, Govt Lab etc**) ……, Pune (**OR Place**) during the period from …….to……, under my direct supervision/ guidance.

Place : (Signature of Research Guide)

Date : (Name & Designation)

Place : Pune (Signature of Research Co-Guide)

Date : (Name & Designation)

DECLARATION BY THE CANDIDATE

I hereby declare that the dissertation entitled **"** _____ **"** submitted by me to

(Title of thesis)

theBharatiVidyapeeth University, Pune for the degree of Master of Science (M Sc.) in Biotechnology under the Faculty of Interdisciplinary Scienceis original piece of work carried out by me under the supervision of _____ **(Name of Guide)** and _____. I further declare that it has not been submitted to **(Name of Co-guide (if any)**

this or any other university or Institution for the award of any degree or Diploma.

I also confirm that all the material which I have borrowed from other sources and incorporated in this dissertation is duly acknowledged. If any material is not duly acknowledged and found incorporated in this dissertation, it is entirely my responsibility. I am fully aware of the implications of any such act which might have been committed by me advertently or inadvertently.

Place :
Date : / /

Name & signature of
Research Student

BHARATI VIDYAPEETH DEEMED UNIVERSITY
(Re-accredited with **A grade** by NAAC in 2011, Accredited with **A+ Grade** by NAAC in 2017)
Rajiv Gandhi Institute of Information Technology and Biotechnology
Pune-Satara Rd, Katraj, Pune – 411 046

Proforma of Progress Report – I

(To be submitted to Principal, RGIITBT, BVDU., Pune)

Name of the Student :
Registration Number of the Student :
Degree Program :
Project Title :
Name of the Research Guide :
Name of Internal Guide (Co-Guide) :
(Only in case of off-campus student)
Period under report : Dec 1 – Jan 15

Name & Place of Research Work :
Objectives of Research Work : 1)
2)
3)

(**Tick mark, wherever applicable**)

	Very Good	**Good**	**Poor**	**Special Remark, if any**
Percent Attendance				
Getting well acquainted with colleague and laboratory procedures, sincerity				
Technical Aspects: Understanding research topic, review collection, systematic execution of research project, research progress, data collection and management				
Overall Performance				

Name of Research Guide with signature and seal:

Place & Date:

BHARATI VIDYAPEETH DEEMED UNIVERSITY
(Re-accredited with **A grade** by NAAC in 2011, Accredited with **A+ Grade** by NAAC in 2017)
Rajiv Gandhi Institute of Information Technology and Biotechnology
Pune-Satara Rd, Katraj, Pune – 411 046

Proforma of Progress Report – II

(To be submitted to Principal, RGIITBT, BVDU., Pune)

Name of the Student :
Registration Number of the Student :
Degree Program :
Project Title :
Name of the Research Guide :
Name of Internal Guide (Co-Guide) :
(Only in case of off-campus student)
Period under report : Jan 16 – Feb 28

Name & Place of Research Work :
Objectives of Research Work: 1)
2)
3)

(**Tick mark, wherever applicable**)

	Very Good	**Good**	**Poor**	**Special Remark, if any**
Percent Attendance				
Getting well acquainted with colleague and laboratory procedures, sincerity				
Technical Aspects: Understanding research topic, review collection, systematic execution of research project, research progress, data collection and management				
Overall Performance				

Name of Research Guide with signature and seal:

Place & Date:

BHARATI VIDYAPEETH DEEMED UNIVERSITY

(Re-accredited with **A grade** by NAAC in 2011, Accredited with **A$^+$ Grade** by NAAC in 2017)

Rajiv Gandhi Institute of Information Technology and Biotechnology

Pune-Satara Rd, Katraj, Pune – 411 046

Proforma of Internal Evaluation Report

(To be submitted to Principal, RGIITBT, BVDU., Pune)

Name of the Student :
Registration Number of the Student :
Degree Program :
Project Title :
Name of the Research Guide :
Name of Internal Guide (Co-Guide) :
(Only in case of off-campus student)

Name & Place of Research Work :
Completion of Research Objectives : (Yes / No)

(**of 40 % weight age**)

	Out of	**Marks obtained**
Percent Attendance	10	
Getting well acquainted with colleague and laboratory procedures, sincerity	5	
Technical Aspects: Understanding research topic, review collection, systematic execution of research project, research progress, data collection and management	20	
Overall Performance	5	
Total		

1.Name of Research Guide with signature and seal:

2. Name of Research Guide:

Place & Date:

BHARATI VIDYAPEETH DEEMED UNIVERSITY
(Re-accredited with A grade by NAAC in 2011, Accredited with A$^+$ Grade by NAAC in 2017)
Rajiv Gandhi Institute of Information Technology and Biotechnology
Pune-Satara Rd, Katraj, Pune – 411 046

Proforma of Evaluation Report on Presentation

(To be submitted to Principal, RGIITBT, BVDU., Pune)

Name of the Student :
Registration Number of the Student :
Degree Program :
Project Title :
Name of the Research Guide :
Name of Internal Guide (Co-Guide) :
(Only in case of off-campus student)

Name & Place of Research Work :
Completion of Research Objectives : (Yes / No)

(**of 60 % weight age**)

	Out of	**Marks obtained**
Overall understanding of the research project - Research Objectives	10	
Significance of Research / Review	10	
Results – Data presentation, statistical analysis, Softwares used, Result Interpretation	15	
Presentation – Clarity, power point slides, communication skills, question – answer session.	15	
Significant outcome – Technical abstract, Seminar, etc.	10	
Total		

Name & Signature of Expert Pane - 1. (External):

- 2. (Internal):

- 3. (Internal):

Signature of Principal (RGIITBT):

BHARATI VIDYAPEETH DEEMED UNIVERSITY
(Re-accredited with A grade by NAAC in 2011, Accredited with A^{+} Grade by NAAC in 2017)
Rajiv Gandhi Institute of Information Technology and Biotechnology
Pune-Satara Rd, Katraj, Pune – 411 046

Plan of Research Outline

(To be submitted to Principal, RGIITBT, BVDU., Pune)

Name of the Student :
Registration Number of the Student :
Degree Program :
Proposed Project Title :
Name of the Research Guide :
Name of Internal Guide (Co-Guide) :
(Only in case of off-campus student)

Name & Place of Research Work :
Proposed Research Objectives :

Start Date of Research project :

Likely Date of Project Completion :

Significance of Research Project :

Name & Sign of Student

Approved by

1.Name of Research Guide with signature and seal:

Place & Date:

2. Name of Research Guide (Co-Guide) with signature and seal:

Place & Date:

BHARATI VIDYAPEETH
(DEEMED TO BE UNIVERSITY), PUNE

FACULTY OF SCIENCE
M.Sc. - BIOTECHNOLOGY
Old Syllabus

BHARATI VIDYAPEETH DEEMED UNIVERSITY, PUNE

FACULTY OF SCIENCE

MASTER OF SCIENCE IN BIOTECHNOLOGY PROGRAMME

REVISED SYLLABUS FOR SEMESTER I TO IV

(UNDER CHOICE BASED CREDIT SYSTEM)

TO BE EFFECTIVE FROM 2012 -13 AT SEMESTER I

BHARATI VIDYAPEETH DEEMED UNIVERSITY

FACULTY OF SCIENCE

Board of Studies in Biotechnology

Structure of Master of Science in Biotechnology Program

(Under Choice Based Credit System)

To be effective from 2012 – 13 at Semester I

INTRODUCTION

The Master of Science (M.Sc.) program in Biotechnology is a full time 114 Credits program offered by Bharati Vidyapeeth Deemed University (BVDU) in its constitutive unit Rajiv Gandhi Institute of IT and Biotechnology, Pune. Bharati Vidyapeeth Deemed University is reaccreditated by NAAC with prestigious 'A' grade. The Institute has excellent infrastructure, faculty, state-of-art laboratories, and library to provide appropriate learning facilities and environment. The Institute is approved by UGC to conduct graduate and post graduate courses in Biotechnology. The expectations of the Biotechnology industry and research are envisaged while designing the M.Sc. Program. The feedback of students, faculty, employers and parents has contributed in giving an industrial accord to this curriculum.

VISION STATEMENT

To generate professionally competent human resource in Biotechnology to serve the academia, research, agriculture, health and industry.

MISSION STATEMENT

Social transformation through dynamic education

OBJECTIVES

The objective of the M.Sc. program is to prepare the young students to take up a career in Biotechnology industry or research. The course curriculum is designed to strengthen the fundamentals in basic subjects and provide hands on practice in all important disciplines of biotechnology. The curriculum also aims in developing 'scientific thinking', skills to 'analyze and apply knowledge' through one minor and one major project, exposure to industries and fields and interaction with experts. The yearlong project work intend to develop the scientific approach and research attitude, to plan and implement experiments, interpret data on the basis of existing knowledge and communicate through clear and concise English. Genetic Engineering, agricultural and animal biotechnology, microbial biotechnology, and nanotechnology are necessary interdisciplinary subjects, which are hoped to seek solutions to the problems of society.

The curriculum in addition to core courses offers number of elective courses. Each elective course is designed to make a job oriented professional course which will facilitate the placement of students and also develop technical skills for biotechnology entrepreneurship. To keep pace with rapid progress in Biotechnology, a specialization is introduced in the final year curriculum.

ELIGIBILITY FOR ADMISSION TO THE COURSE

Admission to the course is open to any graduate of any recognized university satisfying the following conditions

i. The candidate should have obtained the Bachelors degree in Biotechnology/ Biochemistry/ Zoology/ Microbiology/ Botany/ Chemistry/ Agriculture/ Pharmacy/ Medicine including homeopathy and ayurveda.
ii. The candidate should have secured at least 50% (45% for SC/ST) in aggregate at graduate level university examination
iii. Subject to the above conditions, the final admission is based solely on the merit of the all India entrance test (MBT) conducted by Bharati Vidyapeeth Deemed University

DURATION OF THE COURSE

The duration of this course is two years divided in four semesters. The medium of instruction and examination will be only English.

RULES AND REGULATIONS

1. The entire Course is of 114 credits and will be executed in 4 semesters.
2. One credit is equivalent to 15 hrs of interaction of student with facilitator while one credit for practical course is equivalent to 45 hrs. of practical work
3. The total of 25 core credits and 4 elective credits are offered in Semester I. 24 core, 26 core and 4 elective credits are offered in Semester II and III respectively. 16 core credits and 11 elective credits are offered in Semester IV.
4. Thus of the total 114 credits about 91 credits are offered as Core Credits which include the fundamental and advance biotechnology subjects. The elective courses are offered in every semester. Of the

total 60 credits elective courses, about 23 credits can be acquired by students as elective credits. A specialization in Biotechnology can be selected in the final semester curriculum.

5. The student will undertake a project in the final year for which about 10 credits are allotted. The dissertation will be assessed for 100 marks. The distribution of these marks will be as follows;
    i. 25 Marks for literature survey and framing of Aims & Objectives of the selected dissertation topic.
    ii. 25 Marks for progress of work (based on day – to – day work)
    iii. 25 Marks for fulfillment of objectives
    iv. 25 Marks for presentation/ Viva (External evaluation)
6. The field/ industrial/ academic institute visits will be organized for demonstration of advance experimental techniques. The students are expected to submit a visit report on the basis of the observations carried out during the visit.
7. Student must have minimum 70% attendance to fulfill the term. A student who does not have the required attendance may not be allowed to appear for the university term.

Rules for Examination

1. Examination for the theory and practical courses will be conducted at the end of each respective semester.
2. The weightage allotted for internal assessment is 40%. Thus 40 marks out of 100 will be allotted for internal assessment which will be conducted throughout the semester in the form of tests/tutorials/seminars/oral presentations etc.
3. The university shall conduct an examination for 60 marks.
4. The elective courses and general courses will be evaluated by the instructor on the basis of continuous assessment.

STANDARD OF PASSING

1. The 10–point scale would be used to convert marks out of 100 to grades and grade points according to the following table.

Marks as percentage	Grade	Grade point
[75, 100]	O	10.0
[70, 74.9]	A+	9.0
[65, 69.9]	A	8.0
[60, 64.9]	B+	7.0
[55, 59.9]	B	6.0
[50, 54.9]	C+	5.5
[45, 49.9]	C	5.0
[40, 44.9]	D	4.5
[00, 39.9]	F	0.0

2. For courses which have University Examination (UE) and Internal Assessment (IA) In order to pass at the University Examination, a student must obtain at least 'D' grade at the university examination and a minimum GPI of 4.0 in aggregate of UE and AI. There will be a separate grade assigned for performance in IA. There is no minimum grade for passing in IA. The grade point index (GPI) will be calculated for a course as and when the student passes in the UE by combining UE and IA percent marks with weights 60% and 40%. A student who fails in a course, must clear the course by re-appearing at UE only as a backlog candidate.
3. For courses which have no University Examination:
   For some courses, there is no UE. The respective institutes conduct 'continuous assessment' and report the grade. For such courses the corresponding grade point would be the GPI. In order to pass in such courses the student must obtain a minimum GPI of 4.0.

4. At the end of each semester, a cumulative grade point average (CGPI) will be calculated as a weighted average of the GPI of all courses in which the student have passed till that semester.

5. A student who passes in all the courses will be declared to have passed the entire M.Sc. program with the following honours.

   CGPI in [0.00, 3.99] -- Fail
   CGPI in [4.00, 4.99] -- Pass Class
   CGPI in [5.00, 5.49] -- Second Class
   CGPI in [5.49, 5.99] – Higher Second Class
   CGPI in [6.00, 7.99] -- First Class
   CGPI in [8.00, 10.00] -- Distinction

6. The percent marks equivalent a CGPA/SGPA is calculated by the formula:

$$\%\text{Marks} = \begin{cases} 10 * \text{CGPA} & \text{if CGPA is in } [4.00, 6.00], \\ 5 * \text{CGPA} + 30 & \text{if CGPA is in } [6.00, 9.00], \\ 25 * \text{CGPA} - 150 & \text{if CGPA is in } [9.00, 10.00] \end{cases}$$

SEMESTER-WISE COURSE INFORMATION

SEMESTER I

Course Number	Course Title	Credit Value	# Lec.	#Tut.	#Lab	Weightage for EoTE/IA	EoTM
MBT101	Biological chemistry	4	3	2	-	0.6/0.4	Univ.
MBT102	Cell Biology	4	3	2	-	0.6/0.4	Univ.
MBT103	Microbiology Basic and Applied	4	3	2	-	0.6/0.4	Univ.
MBT104	Biochemistry lab	3	-	-	4	0.6/0.4	Univ.
MBT105	Cell Biology lab	3	-	-	4	0.6/0.4	Univ.
MBT106	Microbiology lab	3	-	-	4	0.6/0.4	Univ.
MBT 107	Elective-I **Nutrition & Diet/Fermentation Technology**	2	2	-	-	Continuous Assessment	Institute
MBT 108	Lab Elective-I	2	-	-	3	Continuous Assessment	Institute
MBT109	Personality and Communication Skill Development	2	2	-		Continuous Assessment	Institute
MBT110	Group Project	2	-	-		Continuous Assessment	Institute

Total Credits offered in Sem I: 29 (25 Core, 4 Elective)

Notations: - Core Course, – Elective Course,

– General Course , # - Number

–

SEMESTER II

Course Number	Course Title	Credit Value	# Lec.	#Tut.	#Lab	Weightage for EoTE/IA	EoTM
MBT201	Molecular Biology	4	3	2	-	0.6/0.4	Univ.
MBT202	Genetic Engineering & applications	4	3	2	-	0.6/0.4	Univ.
MBT203	Immunology	4	3	2	-	0.6/0.4	Univ.
MBT204	Molecular Biology Lab	3			4	0.6/0.4	Univ.
MBT205	Genetic Engineering Lab	3	-	-	4	0.6/0.4	Univ.
MBT206	Immunology lab	2	-	-	3	0.6/0.4	Univ.
MBT207	Elective-II **Virology/Clinical Biochemistry**	2	2	-	-	Cont. Assessment	Institute
MBT208	Lab Elective-II	2	-	-	3	Cont. Assessment	Institute
MBT209	Technical Writing	2	2	-	-	Cont. Assessment	Institute
MBT210	Journal club	2	-	-	-	Cont. Assessment	Institute

Total Credits offered in Sem II: 28 (24 Core, 4 Elective)

SEMSTER III

Course Number	Course Title	Credit Value	# Lec.	# Tut.	# Lab	Weightage for EoTE/IA	EoTM
MBT301	Environmental Biotechnology	4	3	2	-	0.6/0.4	Univ.
MBT302	Plant Biotechnology	4	3	2	-	0.6/0.4	Univ.
MBT303	Animal Tissue Culture	2	2	-	-	0.6/0.4	Univ.
MBT304	Human Genetics	2	2	-		0.6/0.4	Univ.
MBT305	Environmental Biotech. Lab	3	-	-	4	0.6/0.4	Univ.
MBT306	Plant Biotech. Lab	3	-	-	4	0.6/0.4	Univ.
MBT307	Animal Tissue Culture Lab	2	-	-	3	0.6/0.4	Univ.
MBT308	Genetics Lab	2	-	-	3	0.6/0.4	Univ.
MBT309	Elective-III **Floriculture/Food Biotechnology**	2	2	-	3	Cont. Assessment	Institute
MBT310	Lab Elective-III	2	-	-	3	Cont. Assessment	Institute
MBT311	Special Topics	2	2		-	Cont. Assessment	Institute
MBT312	Research Methodology	2	2		-	Cont. Assessment	Institute

Total Credits offered in Sem III: 30 (26 Core, 4 Elective)

SEMSTER IV

Course Number	Course Title	Credit Value	# Lec.	#Tut.	#Lab	Weightage for EoTE/IA	EoTM
MBT401	Specialization Subject*	4	3	2	-	0.6/0.4	Univ.
MBT402	Practical Course in Specialization Subject	3	-	-	4	0.6/0.4	Univ.
MBT403	Biostatistics	2	2	-	-	0.6/0.4	Univ.
MBT404	Bioinformatics	2	2	-	-	0.6/0.4	Univ.
MBT405	Biostatistics & Bioinformatics Lab	2	-	-	3	0.6/0.4	Univ.
MBT406	Project	10	-	-	-	0.6/0.4	Univ.
MBT407	Elective-IV **Plant breeding &Methodology/ Nano-biotechnology**	2	2	-	-	Cont. Assessment	Institute
MBT408	Lab Elective-III	2			3	Cont. Assessment	Institute

Total Credits offered in Sem IV: 27 (16 Core and 11 Elective)

***Titles of Specialization subjects proposed in Semester IV:**

1. Enzymology and its industrial applications
2. Animal cell culture applications
3. Pharmaceutical and medical microbiology
4. Herbal biotechnology

Total Credits offered in all four semesters: 114 (91 Core and 23 Elective)

MASTER OF SCIENCE IN BIOTECHNOLOGY PROGRAMME

Course-wise Syllabus

Semester I

COURSE MBT101: Biological Chemistry

(4 Credits, 3L + 1T, Core Course)

Unit 1 **15L**

1. Simple and complex carbohydrates: Monosaccharides, Disaccharides & Polysaccharides – types, sources, linkage structure & properties. Hydrolytic products of polysaccharides & their industrial applications. Complex carbohydrates – glycoproteins, proteoglycans & Glycolipids, lectines- structure, role & applications in biology.
2. Amino acids, peptides & proteins: classification, physical and chemical properties. Peptide bond, peptides with biological activity. Proteins - classification, concept of protein structure- primary, secondary, tertiary and quaternary, complex proteins – metalloproteins, phosphoproteins, chromoproteins and their significance, functions of proteins.
3. Fatty acids – chain length, saturated and unsaturated fatty acids, degree of unsaturation, PUFA, properties. Simple and mixed triglycerides - fats and oils, as storage lipids and energy source. Reasons for rancidity and spoilage, superior methods of storage. Monoglycerides and diglycerides- structure, properties and industrial applications. Structural lipids –phospholipids, sphingolipids and glycolipids as components of cell membrane. Other lipids -waxes, fat soluble vitamins, cholesterol, steroid hormones, prostaglandins. Their health implications.
4. Bases, sugars, nucleosides, nucleotides, RNA and DNA. Types of RNAs and their functions. Watson and Crick model of DNA, denaturation and renaturation of DNA, Experimental evidences for DNA as a genetic material. Functions and applications in biology.

Unit 2
15 L

1. **Carbohydrate Metabolism-** Involvement of enzymes, coenzymes, cofactors, activators and prosthetic groups. Glyolytic pathway - aerobic glycolysis anaerobic glycolysis, regulation and energetics of glycolysis. Alcohol and lactic acid production by anaerobic glycolysis. Feeder pathways. TCA cycle-Overview, entry of pyruvate in TCA cycle. Reactions, regulation and energetics of TCA cycle. Amphibolic nature of TCA cycle. Industrial production of citric acid and succinic acid. Other pathways of carbohydrate metabolism- Pentose phosphate pathway- regulation and its significance. Glucose-6-phosphate dehydrogenase deficiency and its significance. Gluconeogenesis, Cori cycle, glycogen metabolism
2. **Lipid metabolism-** Oxidation of fatty acids containing odd and even no. of carbon atoms. Trans- fatty-acids. Oxidation of saturated and unsaturated fatty acids. Regulation and energetics of fatty acid metabolism. Role of lipases. Ketone bodies. Cholesterol-biological significance, atheroscelorosis, role of statins.

Unit 3 **15L**

1. **Electron transfer chain (ETC) and oxidative phosphorylation -** Ultrastructure of mitochondria. Components of ETC and their organization in different complexes. Oxidation-reduction reactions in biological systems. Concept of redox potential. Free energy change during electron transport. Oxidative phosphorylation. ATP synthase. Mitchell's hypothesis for coupling ETC and oxidative phosphorylation. Inhibitors and uncouplers.
2. **Amino acid metabolism-** Digestion of proteins. Deamination and transamination reactions. Urea cycle. Precursor role of amino acids.
3. **Photosynthesis-**Structural organization of chloroplast. Light reactions.

Harvesting light energy. Photophosphorylation-cyclic & non-cyclic. Dark reaction -Calvin cycle & its regulation. Photorespiration: C4 pathway. Photosynthesis in bacteria. Carbon sequestration.

Unit 4 **15L**

1. **Basic enzymology**: Nomenclature of enzymes, definition, classification, substrate specificity, optimum conditions for activity, Michalis – Menton constant, cofactors, activators and inhibitors, assay methods, applications in diagnosis & industry.
2. **Hormones:** Definition, classification, chemical nature, mechanism of action, role of second messengers. Clinical significance. Role of pancreatic hormones -insulin and glucagon in regulation of blood glucose level. Thyroid hormones and basal metabolic rate, hypo and hyperthyroidism. Growth hormones- Estrogen and progesterone and their applications. Glucocorticoid – stress hormone. Aldosterone - life saving hormone. Adrenaline and noradrenalineemergency hormone.
3. **Vitamins:** Definition, classification. Rich sources of fat soluble and water soluble vitamins, their metabolic, therapeutic and clinical significance. Significance of minerals – Na, K, phosphate, Ca, Mg, Fe, I, Cu, Zn, Co – for body functions.

References

1. Nelson and Cox (2008), Principles of Biochemistry by A. Lehninger, W.H. Freeman and Company, New York, USA.
2. Berg Jeremy M., Tymoczko J. L. and Stryer L. (2003), Biochemistry, W.H. Freeman and Company, New York, USA.
3. Voet D., Voet J. and Pratt Charlotte W. (2006) Fundamentals of Biochemistry- Life at the Molecular Level, John Wiley and Sons, Asia Pvt. Ltd.

COURSE MBT 102: Cell Biology

(4 Credits, 3L + 1T, Core Course)

UNIT 1 **15 L**

1. **Tools used for studies in Cell Biology**

   Microscopy- Light microscopy, Fluorescence microscopy, Contrast microscopy, Electron microscopy-scanning and transmission electron microscopy. Cell separation-subcellular fractionation by differential centrifugation, ultracentrifugation, density gradient centrifugation, cell culture.

2. **Structure of cell**

   Structure of cell organelles, nucleus, mitochondria, endoplasmic reticulum, Golgi apparatus, lysosomes, chloroplast and glyoxysomes. Prokaryotic cell and Plant cell. Structure of specialized cells- neurons, muscle cells and rod and cone cells and transformed cell. .

3. **Cytoskeleton and cell-cell interactions**

   Organization and functions of actin-microfilaments, intermediate filaments and microtubules, cell- cell interactions, tight junctions, gap junctions, desmosomes and hemidesmosomes, plasmodesmata, extracellular matrix.

Unit II **15 L**

1. **Cell membrane**

   Components of membrane-Membrane lipids, membrane proteins and carbohydrates and their organization in membrane, fluid mosaic model, functions of membrane.

2. **Membrane transport**

   Transport of small molecules across membrane-Passive diffusion, facilitated diffusion, active transport-primary and secondary active transport, group translocation, phosphotransferase system, ion channels-leak channels, gated channels, structure and function of Na^+/K^+ ATPase, Ca^+ ATPase. Transport of macromolecules-receptor mediated endocytosis.

Unit III **15 L**

1. **Cell cycle**

   Cell cycle-Phases of cell cycle, events occurring in different phases of cell cycle. Regulation of cell cycle-Role of CD kinase and p53

2. **Cell division**

   Mitosis-molecular events in different stages of mitosis, meiosis-Importance of prophase I in meiosis. Comparision of mitotic and meiotic cell division, spermatogenesis and oogenesis.

Unit IV **15 L**

1. **Cell signaling**

   Signalling molecoles, signal receptors, second messengers, signal transducers, signal transduction pathways, significance.

2. **Cell death**

   Apoptosis- apoptotic changes in the cell and role of caspases, pathways of apoptosis and significance of apoptosis.

References:

1. Alberts B. and Jhonson A.4th edition (2002) Molecular Biology of the cell, Garland science.
2. Berg J., Tymcoczko J, and Styrer L, 5th edition(2002) Biochemistry, W. H. Freeman and company, New York.
3. Cooper G.M., Hausman R. E. The cell: A molecular approach. 5th edition. ASM Press and Cinauer Associates Inc. 2009

COURSE MBT 103: Microbiology Basic and Applied

(4 Credits, 3L + 1T, Core Course)

Unit 1 **15L**

1. Microbial Characteristics

General characters, Structure and taxonomy of Bacteria, Archaea, fungi
Characteristics of aerobes, anaerobes, cyanobacteria, actinomycetes
Nutrition in Microorganisms and assimilation of nutrients
Microbial growth and growth curve
Pure Culture Concepts
Sterilization and disinfection

Unit 2 **15L**

Microscopy

Light, Phase contrast, Fluorescent, Transmission electron microscope, Scanning electron microscope, Confocal microscope.
Cell division, DNA replication, mutation, recombination, repair
Gene transfer among bacteria (transformation, conjugation and transduction)
Mobile DNA and plasmids
Reproduction in fungi

Unit 3 **15L**

Virology

Classification of viruses
Propagation of viruses
Morphology and ultra structure of plant (TMV) and animal (Adenovirus) viruses
Replication of Animal viruses
RNA viruses: polio (+ve strand) influenza (-ve strand)
DNA viruses: pox, adeno, Retro viruses
Replication of Bacteriophages

Unit 4 **15L**

Applied Microbiology

Primary and secondary metabolites, fermenter and types, submerged and solid state fermentation
Production and applications of biofertilizers and biopesticides
Production of alcohol, enzymes (amylase) and biomass
Significance of extremophiles in industry

References

1. Prescott, Harley, and Klein's microbiology by Joanne M. Willey, Linda Sherwood, Christopher J. Woolverton, Lansing M. Prescott (2008) McGraw-Hill Higher Education
2. Dubey R C and Maheswari D K (2005), A text book of Microbiology, Revised edition, S.Chand Publishers, New Delhi.
3. Pelczar & Kreig (2006). Microbiology5th edition. Tata McGraw Hill, New Delhi
4. Salle, AJ (2001). Fundamentals & Principles of Bacteriology. 7th edition. Tata McGraw-Hill, Davis
5. Conrat H F, Kimball PC and Levy JA. (1988) Virology II edition. Prentice Hall, Englewood Cliff, New Jersey.
6. Roger Hull. Mathews' Plant Virology 4thEdition (2002) Academic press-A Harcourt Science and technology company, New York.
7. Fields B N, Knipe D M, Chanock R M, Hiresh M J (editors) (1996) Fields Virology, Second Edition New York, Raven Press
8. Principles of fermentation technology by Stansbury, P.F., A. Whitaker and S.J. Hall (1997), Pergamon Press, Oxford.
9. Raina Maier, Ian L. Pepper, Charles P. Gerba (2000) Environmental Microbiology Academic press
10. Brock Biology of Microorganisms Michael T Madigan, John M Martinko, Paul V, 12th Edition (2008) Benjamin Cummings.

COURSE MBT 104: Biochemistry Lab (Practical Course in Biochemistry (3 Credits, 2P, 6.00 Hr)

1. Isolation and characterization of starch from corn, casein from milk, lecithin from egg yolk 4P
2. Separation of amino acids by paper chromatography / TLC, sugars by paper chromatography- ascending & descending
   4P
3. Quantitative estimation of total carbohydrates by phenol-sulphuric acid method, DNSA, 3P
4. Estimation of amino acids by ninhydrin method
   1P
5. Estimation of proteins by Biuret method, Lowry's method, Spectrophotometric method
   4P
6. Estimation of cholesterol 1P
7. Determination of iodine number, acid value and saponification value of fatty acid
   1P
8. Assays for some enzymes 4P

References:

1. Plummer D.T. (2005), An Introduction to Practical Biochemistry, Tata-McGrow Hill Publishing Company, New Delhi.
2. Jayraman J. (2007), Laboratory Manual in Biochemistry, New Age International (P) Ltd., New Delhi.
3. Sawhney S. K. and Singh R. (2000). Introductory Practical Biochemistry , Narosa Publishing House, New Delhi
4. Wilson K. and Walker J. (2005) Principles and Techniques of Biochemistry and Molecular Biology, Cambridge University press, New York.

Course MBT 105: Cell Biology Lab (Practical Course in Cell Biology)
(3 Credits, 2P, 6.00 Hr, Core Course)

1. Microscopy: Simple, Compound, phase contrast
   Observation of permanent slides, polytene chromosome, mitosis, meiosis, cell organelles 3P
2. Micrometry: Calibration of ocular micrometer and measurement of blood cells on hemocytometer. Calibration and measurement of biological samples 3P
3. Demonstration of animal handling for experimental purposes: Cervical dislocation, dissection of rat, cardiac puncture, blood sample preparation and its handling, osmatic fragility of RBC's
   5P
4. Isolation of chloroplast and its analysis 2P
5. Isolation of rat liver nuclei
   3P
6. Chlorophyll estimation: Spectrum and light scatter 1P
7. Guidelines for biological handling and waste disposal 1P
8. Visit to the research laboratory for demonstration of study of cell surface markers by staining with fluorescent dye.
   3P

References:

1. Alberts B. and Jhonson A.4th edition (2002) Molecular Biology of the cell, Garland science.
2. Berg J., Tymcoczko J, and Styrer L, 5th edition(2002) Biochemistry, W. H. Freeman and company, New York.
3. Cooper G.M., Hausman R. E. The cell: A molecular approach. 5th edition. ASM Press and Cinauer Associates Inc. 2009

COURSE MBT106: Microbiology I Lab

(3 Credits, 2P, 6.00 Hrs, Core Course)

1. Pure culture techniques (serial dilution, streaking, spread plating technique) 4P
2. Staining techniques (Gram staining, Negative staining, Endospore staining, Acid fast staining) 4P
3. Isolation and characterization of cyanobacteria and fungi 3P
4. Isolation of bacteriophages from sewage sample 3P
5. Isolation of nitrogen fixing bacteria and estimation of leghemoglobin 2P
6. Isolation of phosphate solubilizing bacteria. 3P
7. Studies on growth curve of bacteria 3P
8. Ethanol fermentation 4P
9. Bacteriological examination of water by multiple tube fermentation test 2P
10. Industrial visits 2P

References

1. Harley Prescott, (2002) Laboratory Exercises in Microbiology, 5th edition, The McGrawHill Companies.
2. R. Vasanthakumari, (2009), Practical Microbiology, BI publications, New

Delhi.
3. Emanuel Goldman and Lorrence H Green (editors), (2008), Practical Handbook of Microbiology, Second Edition, CRC press.

COURSE MBT 107: Elective Course: Nutrition and Diet

(2 Credits, 1L, 1T, Elective Course I)

Unit 1 **15**

L

Food Biochemistry

1. Concept and significance of food nutrition.

Nutrition classification of food; Five-food group plan (ICMR),
Basic food groups; Fuel value of carbohydrates, fats and protein
(Unit of energy); Analytical techniques in food biochemistry; recent
advances in food biotechnology research

2. Balanced Diet: - Concept and significances

Types of therapeutic diet; Representative diets in various ailments –
Diabetes mellitus, cardio vascular diseases, kidney, anemia and gastrointestinal diseases, brief rational for each type of diet.

3. Food allergy; Food adulteration and its health implication; Anti-nutritional factors;

Food safety and food security;

Unit 2

15L

Nutritional Biochemistry

1. Nutrition and its physiological role

Definition for nutrition, nutrients, body weight body composition, measurement of energy expenditure – calorimeter, BMR, SDA and RQ. Physico chemical properties and physiological actions of dietary fibre, protein energy malnutrition.

2. Significance of water in metabolism

Dehydration and oedema, Significance, preservation of physiological pH and, anion and cation balance, Acid – base balance in body fluids.

3. Vvitamins and Minerals

Outlines of vitamins and minerals. Classification of vitamins – Fat soluble and water soluble. Dietary source, structures, RDA, functions and deficiency states. Dietary sources, structures, RDA, functions and deficiency of Iron, Calcium,

phosphorus and magnesium, Iodine, zinc and copper. Dietary requirement in pregnancy, lactation, infants children and adolescent.

References:

1. Food biochemistry and Food processing, Y. H. Hui, Blackwell publishing,
2. Food: The chemistry and its components; Tom Coultate, RSC publishing,

COURSE MBT 107: Elective Course: Fermentation Technology

(2 Credits, 1L, 1T, Elective Course II)

Unit 1 **15 L**

1. Bioreactors

Design of a basic fermenter, individual parts, baffles, impellers, foam separators, sparger, culture vessel, cooling and heating devices, probes for online monitoring, computer control of fermentation process, measurement and control of process Reactors for specialized applications: Tube reactors, packed bed reactors, fluidized bed reactors

2. Mass transfer in reactors

Transport phenomena in fermentation: Gas- liquid exchange and mass transfer, oxygen transfer,

Determination of Kla, heat transfer, aeration/agitation, its importance

Sterilization of Bioreactors, nutrients, air supply, products

Fermentation media formulation and modification

Kinetics of growth in batch culture, continuous culture

Unit II **15 L**

1. Fermentation process

Fed-batch fermentation

Preservation of industrially important culture, Inoculum development, Strain improvement, Scale up.

2. Downstream processing

Biomass separation (centrifugation, filtration, flocculation)/*+

Recovery of intracellular components (Physical, chemical and enzymatic methods)

Extraction: (Solvent, two phase liquid extraction, whole broth, aqueous multiphase extraction) Purification of product (chromatography techniques)

Concentration by ultra-filtration, reverse osmosis

Drying and crystallization

Modern trends in microbial fermentation

Probiotics, Biosurfactants, Biopolymers (dextran) Bioplastics (PHB, PHA), Bio-fuels

References

1. Biochemical Engineering Fundamentals by J.E. Bailey and P.F. Ollis, (1986), 2nd edition, McGraw Hill Publication
2. Principles of fermentation technology by Stansbury, P.F., A. Whitaker and S.J. Hall (1997), Pergamon Press, Oxford
3. Patel, A.H. (2005). Industrial Microbiology. Mac Millan India Ltd, New Delhi.
4. Bioprocess Technology: Fundamentals and Applications. Stockholm KTH.
5. Biochemical Reactors by Atkinson B., Pion, Ltd. London.
6. Biotechnology - A Text Book of Industrial Microbiology by Cruger.
7. Industrial Microbiology by L.E. Casida, Wiley Eastern

COURSE MBT 108: Elective Course Lab: Nutrition and diet lab. exercises (2 Credits, 1P, 3.00 Hrs, Elective Course 1 Lab)

1. Food Analysis (preparation of sample, moisture, protein, fat, fibre, ash, carbohydrate) 4P
2. Estimation of total proteins by Kjeldahl'smethod and metabolites 3P
3. Estimation of carbohydrates (Glucose, fibre, glycogen) 3P
4. Extraction of lipids, TLC of lipids and estimation of lipid peroxides 3P
5. Estimations of various food toxins (trypsin inhibitor, aflatoxin) 2P
6. Estimation of vitamins (water soluble, fat soluble) 2P
7. Estimation of minerals 3P

References

1. A manual of laboratory techniques, National Institute of Nutrition, Raghulamulu N, Nair K. M., Kalyanasundarm S
2. Laboratory manual for human nutrition. Dashman T., Blocker D., Backer N. Harwood academic publishers. 2nd edition

COURSE MBT 108: Elective Course Lab: Fermentation Technology Lab
(2 Credits, 1P, 3.00 Hrs, Elective Course 2 Lab)

1. Isolation of industrially important microorganisms for microbial processes (citric / lactic/ amylase) and improvement of strain for increase yield by mutation. 4P
2. Determination of Thermal Death Point (TDP) and Thermal Death Time (TDT) of microorganisms for design of a sterilizer 4P
3. Preservation of industrially important bacteria by lyophilization 3 P
4. Whole cell immobilization 3P
5. Visits 2P

References

1. Harley Prescott, Laboratory Exercises in Microbiology, 5th edition, The McGrawHill Companies (2002).
2. Experiments in Microbiology, Plant Pathology and Biotechnology, 4th Edn., Aneja, K.R., New Age International Publishers, New Delhi (2007)
3. R. Vasanthakumari, (2009), Practical Microbiology, BI publications, New Delhi.Emanuel Goldman and Lorrence H Green (editors), (2008), Practical Handbook of Microbiology, Second Edition, CRC press.
4. Primrose, S.B. and Wardlow, A.C. (1998) Source book for Experiments for Teaching of Microbiology. Acedemic Press, London (ISBN: -12-565680-7)

COURSE MBT109: General Course I

(communication skills and personality development)

(2 Credits)

Objectives: A widely heard theme among employers is that BT professionals must be able to communicate effectively with colleagues and clients. Because of the importance of good communication skills in industry as well as research careers, Biotechnology students must sharpen their oral and writing skills. The students are expected to:

- Communicate ideas effectively
- Make effective oral presentations, both formally and informally
- Understand and offer constructive critiques of the presentations to the others
- Have a pleasant demeanor as they work with people, either in person or by phone
- Write appropriate electronic communications (including email, blogs, instant messages etc.)

The communication skill development program will include formal lectures and demonstrations for improving writing and oral communication in a way that emphasizes both speaking and active listening skills.

COURSE 110: Group Project

(2 Credits)

Few professionals can expect work in isolation. Successful projects are always implemented by group of people working together as a team. Students therefore need to learn about the mechanics and dynamics of effective team participation as part of their education. To ensure that students have the opportunity to acquire these skills, students in groups of 3 or 4 are expected to undertake a project. Students in a group are expected to spends about 50 hours on the project. The guide should simulate a team environment and assess each student's performance.

SEMESTER II

COURSE MBT 201: Molecular Biology

(4 Credits, 3 L + 1T, Core Course)

UNIT1 **15L**

1. DNA – The genetic material

Nucleic acids properties and function

2. Nature of genome

Genome sizes of different organisms, C value, paradox, repetitive sequences, clusters and repeats, satellite DNA, Concept of gene, interrupted and uninterrupted genes,

3. Organization of prokaryotic and eukaryotic genome

Organization of prokaryotic and eukaryotic genomes, chromosome structure and role, chromosome banding, replication of telomeric sequences

UNIT 2 **15L**

1. DNA Replication and DNA Repair

DNA polymerases, Mechanism of DNA replication in prokaryotes and eukaryotes DNA damage, DNA repair and recombination

UNIT 3 **15L**

1. Prokaryotic transcription

RNA polymerase, Mechanism of transcription in prokaryotes

2. Eukaryotic transcription

Eukaryotic RNA polymerase and their promoters, activating transcription, post transcriptional modifications, RNA splicing reactions, catalytic RNA.

UNIT 4 **15L**

1. Translation

Genetic code, Mechanism of protein synthesis in prokaryotes and eukaryotes, post translational modifications, transport of proteins.

2. Regulation of gene expression

Constitutive and inducible enzymes, concept of operon, induction and repression, positive and negative regulation, attenuation, lactose, arabinose and tryptophan operon

Regulation of gene expression during translation

References:

1. Watson J. and Stephen (2004) Molecular Biology of the Gene, Dorling Kindersley(India) pvt ltd,New delhi. Taylor and Francis group, New York.
2. Cooper G.M. and Hausman R.E. (2004) The Cell: A molecular approach, Sinauer Associates, Inc., ASM Press, Washington DC.
3. Lewin (2007) Genes IX: Pearson Prentice Hall, Pearson Education, Inc. Upper Saddle River, NJ 07458

COURSE MBT 202: Genetic Engineering and Applications

(4 Credits, 3 L + 1T, Core Course)

Unit I **15 L**

Scope of genetic engineering

Tools and techniques: hybridization, PCR, electrophoresis

Enzymes: restriction endonucleases, nucleases, methylases, DNA polymerases, ligases, kinases, phosphatases, topoisomearses, labeling of DNA: nick translation and random priming

Cloning vectors for *E. coli* : plasmids and bacteriophages, purification of DNA from living cells

Cloning vectors for eukaryotes: yeast and fungi, higher plants, animals

Unit II **15 L**

Advanced vectors: cosmids, BACs, PACs, special purpose vectors

Introduction of DNA into living cells: vector mediated and direct gene transfer, identification of recombinants

DNA libraries: construction and screening of genomic library and cDNA library

Unit III **15 L**

Cloning in *Saccharomyces cerevisiae* and other fungi

Sequencing and mutagenesis

Restriction mapping

Gene expression and function

Unit IV **15 L**

Recombinant proteins from cloned genes

Reporter genes

Applications of genetic engineering in medicine, agriculture, forensic science etc.

References:

1) Brown T. A., 5th edition(2006), Gene cloning and DNA analysis , Blackwell Publishing, UK
2) Primrose S., Twyumon R. M. And Old R. W., 7th edition (2008), Principles of gene manipulation, Blackwell Publishing, UK

3) Nicholl D. S. T. ,2nd edition (2002), Introduction to genetic engineering, Cambridge University Press, UK
4) Channarayappa (2006), Molecular Biotechnology: Principles and Practices, University Press, New Delhi, India
5) Watson J. and Stephen (2004), Molecular Biology of the gene, Dorling Kindersley Pvt. Ltd., New Delhi, India
6) Benjamin Lewin, (2004) Genes VIII , Pearson Education Inc. Nj.

COURSE MBT 203: Immunology

(4 Credits, 3L + 1T, Core Course)

UNIT 1 **15L**

Introduction to basic immunology

Immunology overview, Innate immunity, Cells of the immune system
Organs of the immune system, Antigens, Antibodies, Antigen presenting cells, antigen processing and presentation

Unit 2 **15L**

Lymphocyte ontology and molecular immunology

B cell maturation, activation and differentiation, Ig gene rearrangement
T cell maturation, activation and differentiation, T cell receptor, Major histocompatibility complex, Complement system, Cytokines, Chemokines and their receptors, Cell signalling and trafficking

Unit 3 **15 L**

Effector functions in humoral and cell mediated immune response

1. Humoral immune response

Antigen-antibody interactions: Preparation of polyclonal antibodies, Immunoglobulin separation techniques, production of monoclonal antibodies and genetically engineered antibodies, assessment of antibodies by: precipitation, agglutination, complement fixation, viral neutralisation, ELISA, RIA, Immunofluorescence, immunoperoxidase, western blotting.

2. Cellular immune response

Separation of immune cells, Identification of lymphocytes, lymphocyte transformation, Mixed lymphocyte reaction, generation of cytotoxic T cells, Measurement of cytotoxicity of T and NK cells, ADCC, Enumeration of cells secreting specific proteins (Elispot)

Unit 4 **15L**

Clinical immunology

Immunology of bacterial diseases with special reference to Tuberculosis, leprosy, Pneumonia, Immunology of viral diseases with special reference to influenza and AIDS, Immunology of parasitic diseases with special reference to malaria, filarial and Leishmaniasis, Immunological diseases: Tolerance and autoimmunity, Hypersensitivity, Immunodeficiency diseases, Transplantation immunology, Tumour immunology, vaccinology

References:

1. Goldsdy A., Thomus J. K., Barbara A. O. and Kuby J. Immunology

2. Peter Patham, The immune system, 3rd Edition, Garland Sc, 2009

3. Janeway C., Traverse, Walport and Shlomchik Immonobiology, 6th Edition, Garland Sc.

4. Gangal S.G. and Sontakke S.D. Basic and clinical immunology, Universities press, 2012, in press

COURSE MBT 204: Molecular Biology Lab (Practical Course)

(3 Credits, 2P, 6.00 Hrs, Core Course)

1.	Isolation and analysis of DNA from bacteria/ cells/blood/plant	6P
2.	Isolation and estimation of mRNA from bacteria/yeast/eukaryotic cells	6P
3.	Determination of Tm and % (G+C) of DNA	2P
4.	Southern blotting	3P
5.	Demonstration of DNA amplification by PCR, Real Time PCR	3P
6.	DNA sequencing (Demonstration)	1D
7.	Problems on chromosome, chromosome structure Preparation of blood chromosome spreads/ chromosome banding	3P
8.	Study of phases of mitosis and meiosis	2P

References:

1. Sambrook J and Russell D. (2001) Molecular cloning A Laboratory Manual, Cold spring harbor laboratory press, New York.
2. Wilson K. and Walker J. (2005) Principles and Techniques of Biochemistry and Molecular Biology, Cambridge University Press, New York.

COURSE MBT 205: Genetic Engineering Lab (Practical Course)
(3 Credits, 2P, 6.00Hrs, Core Course)

1) Competent cell preparation and cloning in *E. coli* 4P
2) Plasmid isolation 3P
3) Restriction digestion 2P
4) Ligation 2P
5) Restriction mapping 2P
6) In vitro transcription 2P
7) Phage DNA isolation 3P
8) Visit 2P

References:

1) Molecular Cloning - Sambrook & Russell 2001 - Vol-1, 2, 3
2) Joseph Sambrook & David W. Russell, Cold Spring Harbor Laboratory, New York

COURSE MBT 206 Immunology Lab (Practical Course)

(2 Credits, 1P, 3.00 Hrs, Core Course)

1. Ouchterlony double diffusion 2P
2. Radial immunodiffusion 2P
3. Immunoelectrophoresis of serum 2P
4. Rocket immunoelectrphoresis 2P
5. Lymphocyte separation from peripheral blood 2P
6. Lymphocyte transformation 2P
7. T and B cell identification by E and EAC rosettes 4P
8. ELISA 2P
9. Immunoperoxidase staining 2P

References:

1. Goldsby A., Thomus J.K., Barbara A. O. and Kuby J. Immunology, 5th eds.
2. Deives P.J., Seamus J.M. and Raoitt E. M. (2006) Essential Immunology, 11th eds. Blackwell Publ.
3. Jaeway C. Travers, Walport and Shlomchik Immunobiology 6th eds. Garland Sc. Publ.

COURSE MBT 207: Elective Course: Virology

(2 Credits, 1L, 1T, Elective Course III)

Unit 1 **15 L**

1. **Classification and Morphology of Viruses** **02 L**

   Virus classification, Morphology and ultra-structure of viruses, Virus related agents, viroids and prions.

2. **Cultivation and assay of viruses**

   08L

   Cultivation of viruses using embryonated eggs, experimental animals and cell cultures (Cell-lines, cell strains and transgenic systems) Purification of viruses, Assay of viruses, Physical and Chemical methods (Electron Microscopy and Protein and Nucleic acids studies)

   Infectivity Assays (Plaque and end-point)

3. **Viral Multiplication**

   05L

   Mechanism of virus adsorption and entry into the host cell including genome replication and mRNA production by animal viruses, mechanism of RNA synthesis, mechanism of DNA synthesis, transcription mechanism and post transcriptional processing, translation of viral proteins, assembly, exit and maturation of progeny virions, multiplication of bacteriophages.

Unit 2 **15 L**

1. **Pathogenesis of Viruses**

   10L

   Pathogenesis of animal viruses Adenovirus, Hepatitis virus, Poxvirus and Orthomyxovirus, pathogenesis of plant [TMV] and insect viruses [NPV]. Host cell transformation by viruses and oncogenesis of DNA and RNA viruses.

2. **Control of Viruses** **05L**

   Control of viral infections through vaccines, interferons and chemotherapeutic agents,

Structure, genomic organization, pathogenesis and control of Human immunodeficiency virus. Emerging viruses

References

1. Medical Virology 10 Th Edition by Morag C and Tim bury M C 1994. Churchil Livingstone, London.
2. Introduction to Modern Virology 4th Edition by Dimmock N J, Primrose S. B. 1994. Blackwell Scientific Publications, Oxford
3. Virology 3 rd Edition by Conrat H.F., Kimball P.C. and Levy J.A. 1994. Prentice Hall, Englewood Cliff, New Jersey
4. Text Book on Principles of Bacteriology, Virology and Immunology Topley and Wilsons
1995.
5. Molecular Biology, Pathogenesis and Control by S.J. Flint and others. ASM Press, Washington, D.C.
6. Applied Virology. 1984. Edited by Edonard Kurstak. Academic Press Inc.
8. Prion diseases by Gaschup, M.H.
9. Clinical virology Manual by Steven, S., Adinka, R.L., Young, S.A.
10. Principles of Virology, 2000 by Edward Arnold.

COURSE MBT 207: Elective Course: Clinical Biochemistry

(2 Credits, 1L, 1T, Elective Course IV)

Unit 1 **15 L**

1. **Clinical significance of biochemical tests**

   Clinical significance of biochemical tests and their role in diagnosis and monitoring of disease, Clinical characteristic of disease. Role of pharmacological testing in clinical management of disease. Role of clinical biochemistry in detection, diagnosis and therapy of genetically inherited diseases and cancer.

2. **Specimen Collection and Processing**

   Collection of blood vein puncture, collection with syringe, collection with evacuated tube, skin puncture, arterial puncture and anticoagulants. Collection of urine:-Timed urine specimens, urine preservatives. Test for urinary compounds. Clinical significance of urinary components with reference to sugars, proteins, ketone bodies, bilirubin and porphyrins. CSF:- Composition and collection ,chemical examination and infections, spinal cord, infections. Amniotic fluid:- Origin, collection, composition and analysis of amniotic fluid.

Unit 2 **15 L**

1. Serology and Hematology

C- reactive protein test, immunological test for pregnancy. Rhumatoid arthritis (RA) test. ESR., Coagulation test, prothrombin test.

Hemoglobin: Normal and abnormal Hb, Seperation of hemoglobin. Thalasemia, Hemoglobinopathies. Erythrocyte metabolic pathways, Disorder of erythrocyte metabolic pathways, erythrocyte enzyme disorders. Porphyrins and porphyrias.

2. Clinical Enzymology Principles of Diagnostic Enzymology

Factors affecting enzyme levels in blood. Principle, assay, and clinical

significance of transaminases, creatine kinase, lactate Dehydrogenase, phosphatases, isocitrate dehydrogenase, 5'nuclotidase, gamma –glutamyl transferase, amylase, lipase, trypsin, chymotrypsin, choline esterase, glutamate dehydrogenase, glucose -6-phosphate dehydrogenase and ceruloplasmin.

3. Enzyme pattern in diseases:- Myocardial infarction, hepatobiliary diseases. Enzymes in inborn errors of metabolism – Phenyl ketonuria, alkaptonuria, throsinosis, albinism, Galactosemia, Taysacch's disease, Lesh Nyham syndrome.

4. Organs Associated with Disease Diagnosis

Liver function test and related disorders:-Jaundice, cirrhosis, hepatitis, fatty liver and gall stones.

Renal function test and related disorder:- Acute renal failiure. Glomerular disease, tubular diseases, urinary tract obstruction, analysis of urinary calculi.

Gastric and pancreatic function test:- Hyper and hypo lipoproteinemias and diagnostic test for lipoprotein disorders.

References

1. Marshall, W J, Clinical Chemistry, 3rd edition, Mosby, 1997.
2. Harper's Biochemistry K. Robert, M.D. Murray, D.K. Granner, P.A. Mayes and V.I. Rodwell, McGraw Hill/ Appleton and Lange
3. Enzymes Biochemistry, Biotechnology, Clinical Chemistry, Trevor Palner
4. Principles of Biochemistry, A.L. Lehninger, D.L. Nelson, M.M. Cox. , Worth Publishing

COURSE MBT 208: Elective Course Lab: Virology Practical

(2 Credits, 1P, 3.00 Hrs, Elective Course III Lab)

1. One step growth curve 4P
2. Phage typing of *E.coli* 4P
3. Specialized transduction 3P
4. Isolation of plant viruses 4P
5. Phage titration 3P
6. Visit 1P

References

1. Medical Virology 10 Th Edition by Morag C and Tim bury M C 1994. Churchil Livingstone, London.

2. Introduction to Modern Virology 4th Edition by Dimmock N J, Primrose S. B. 1994. Blackwell Scientific Publications, Oxford

3. Virology 3 rd Edition by Conrat H.F., Kimball P.C. and Levy J.A. 1994. Prentice Hall, Englewood Cliff, New Jersey

4. Text Book on Principles of Bacteriology, Virology and Immunology Topley and Wilsons1995.

5. Molecular Biology, Pathogenesis and Control by S.J. Flint and others. ASM Press,
Washington, D.C.

6. Applied Virology. 1984. Edited by Edonard Kurstak. Academic Press Inc.

8. Prion diseases by Gaschup, M.H.

9. Clinical virology Manual by Steven, S., Adinka, R.L., Young, S.A.

10. Principles of Virology, 2000 by Edward Arnold.

COURSE MBT 208: Elective Course Lab: Clinical Biochemistry Lab

(2 Credits, 1P, 3.00 Hrs, Elective Course IV Lab)

1. Specimen collection and processing (Collection of blood, urine, CSF, aminotic fluid), ethical sanction, safety and disposal 4P + 2D
2. Hematology 6P
   Enumeration of RBC, Packed cell volume, Hemoglobin, Erythrocyte sedimentation rate, enumeration of WBC, osmotic fragility of RBC
3. Estimation of metabolites 3P
   Bilurubin, Uric acid, oxalic acid, Fibronolytic activity
4. Estimation of marker enzymes 3P
   SGOT, SGPT, LDH, ALP

References

1. A practical clinical biochemistry, methods and interpretations; R. Chawala, Jaypee Brothers Medical Publishers Ltd.

2. A manual of laboratory techniques, National Institute of Nutrition, Raghulamulu N, Nair K. M., Kalyanasundarm S

3. Manipal manual of clinical Biochemistry, Shivananda Nayak, Jaypee Brothers Medical Publishers Ltd. 3rd Edition.

COURSE MBT 209: General Course III – Technical writing
(2 Credits, 1T)

Technical and scientific writing skills

The course will involve formal lectures on developing technical writing and scientific writing skills of students in clear and concise English. Students will select a relevant topic for which they will perform a literature search and write a review.

COURSE MBT 210: General Course IV – Journal Club
(2 Credits)

This course will involve reading, assimilation, understanding and presentation of one published research paper selected from the research journal. Student will present seminar on the research papers selected in each course of Semester II

SEMESTER III

COURSE MBT 301: Environmental Biotechnology

(4 Credits, 3L, 1T, Core Course)

Unit 1: Environment **15 L**

1. Basic concepts, Its ingredients – soil, water, air, biota and non-biota and its significance
2. Environmental issues, Environmental pollution - Types, measurement, effects on health & food, Air pollution and its control through Biotechnology, Water pollution and its control, Soil pollution sources, fertizers, pesticides, heavy metels and agrochemical and its control, Noise pollution: effects and control, Degradation of Xenobiotic compounds in Environment

Unit 2: Water and Waste water treatment technology

15 L

1. Overview of standards of water in relation to public health
2. Detection and control of micro-organisms in environmental fresh water, in source and drinking water; Potable and nonpotable water
3. Methods of water sampling for pollution analysis
4. Biosensors - types and applications in environmental pollution detection and monitoring
5. Biological treatment: stabilization pond, aerated lagoon, activated sludge process, trickling filter anaerobic treatment
6. Water Pollution Monitoring
7. Sewage and waste water treatments systems; Primary, secondary and tertiary treatments; Measurement of treatment efficiencies
8. Biological treatments - aerobic versus anaerobic treatments
9. Biofilms in treatment of waste water; Biofilm development and biofilm Kinetics; Aerobic Biofilms

10. Bioreactors for waste water treatments; Reactors types and design; Reactors in series; Development and optimization of membrane bioreactor process for use in sanitary and industrial sewage treatment

Unit 3: Global Environmental issues 15 L

1. Solid waste Management, physicochemical characters, hazardous and non hazardous wastes, bio-degradable and non-biodegradable wastes, collection and transport of solid waste, composting, vermicomposting and methane production.
2. Global warming: climate change, ozone depletion, UV- B and green house effects, acid rain, its effects
3. Biotechnological approaches for management
4. Carbon credit
5.

Unit 4: Biotechnological approach for improving the Environment 15 L

1. Biotechnological approach for improving the Environment:
2. Characteristics of industrial effluents, Conventional treatments, kinetics of biodegradation of waste, Advances in aerobic and anaerobic treatments, genetically modified organisms for improving the environment, Techno-economic feasibility of conversion of waste into energy.
3. Environmental pollution control- Bioremediation, Bioaugmentation and Biostimulation;
4. Desalination technique: Reverse osmosis, quality of input and output water, cost effectiveness, byproducts of desalination and industrial application

References

1. Rittamann B. E. and Mc Carty P. L. (2001), Environmental Biotechnology: Principles and Applications, International Edition, McGraw-Hill, New York
2. Methods of Air Sampling & Analysis (1977), 2nd Edition –APHA intersociety Committee APHA, Washington D.C
3. Standard Methods for the Examination of Water and Wastewater (1986) 15th Edition APHA-AWWA-WPCF
4. R.K.Trivedy & P.K.Goel, (1986), Chemical & Biological Method For Water Pollution Studies, Enviromedia Karad
5. De A.K., (2008), Environmental Chemistry, Wiley Eastern Ltd
6. Brunner R.C., (1989), Hazardous Waste Incineration, McGraw Hill Inc.

COURSE MBT 302: Plant Biotechnology

(4 Credits, 3L, 1T, Core Course)

Unit 1: Plant Biodiversity 15L

Biodiversity hotspots in India

Characterization of biodiversity through different biochemical and molecular methods (chemical printing of biodiversity)

Conservation stratergies of biodiversity, threatened and extinct species, bioprospecting of biodiversity for product development

Unit 2: Genetics and its role in plant breeding 15L

Somaclonal & Gametoclonal Variation: applications and limitations.(Exploitation for selecting superior phenotypes-disease resistant, stress tolerant, high secondary metabolite production),Screening procedures.

Haploid production (Anther, Ovule, Pollen cultures).Cryopreservation and ex-situ conservation of germplasm. In vitro pollination and fertilization, embryo rescue, embryo culture, endosperm culture and production of seedless plants. Somatics hybridization (Symmetric, Asymmetric, and Cybrids) Commercial production of secondary metabolite –Use of bioreactors, immobilized cells, biotransformations, elicitors. Applications and limitations, Metabolic Engineering for secondary metabolite production, Utilization of micropropagation for commercial crops like banana, strawberry, ginger and ornamental plants.

Unit 3: Plant tissue culture 15L

Approaches for crop improvement Introduction and importance

Somaclonal and gametoclonal Variations (Selection of superior phenotypes-disease resistant, stress tolerant etc.)

Double haploid plant production

In vitro pollination and fertilization

Embryo culture and embryo rescue technology

Endosperm culture and production of seedless plants'

Somatic hybridization (Symmetric, Asymmetric, Cybrids)

Seed industries and micropropagation industries in India and abroad.

Advantages and limitations

Commercial production of secondary metabolites –Use of bioreactors, immobilized cells, biotransformations, elicitors.

Metabolic Engineering for secondary metabolite production.

Utilization of micropropagation for commercial crops like banana, strawberry, ginger and ornamental plants

Bio-fuels, Bio-pesticides and Bio-fertilizers

Cryopreservation and conservation of germplasm

Unit 4: Plant genetic Engineering 15L

Ti and Ri-plasmid based vectors

Selectable markers, Reporter genes, promoters, SARs

Manipulation of gene expression in plants

Production of transgenic plants resistant to herbicides, pathogens, and insect pests and abiotic stresses.

Phase wise applications of plant genetic engineering indicating the initial thrusts and the present status

Exploitation of genetic engineering technology, marker assisted selection and bio - prospecting of biodiversity by industries

References:

1. Poehlmann M. (1959) Breeding of field crops, Henry Holt and Co., New York.
2. Strickberger M.W. (1985) Genetics, Pearson Education Inc. , and Dorling Kindersley Publ., Inc.
3. Reinert J.R. and Bajaj Y.P.S.(1997) Applied and fundamental aspects of plant cell, tissue and organ culture. Springer and Verlag, Berlin.
4. Allard R. D. (1999) Princ'iples of Plant Breeding, John Wiley and Sons, Inc.
5. Purohit S.S. (1999) Agricultural Biotechnology. Agro Botanica. India
6. Levin B. (2000) Genes VII, Oxford Uni. press.
7. Sharma K.V.S. (2002) Statistics made simple: Do it yourself on PC, PHI.
8. Martin J. C. (2003) Plants, Genes, and Crop Biotechnology, Jones & Burlett Publ., Canada.
9. Krishnamurthy K.V. (2003) Textbook of Biodiversity, Daya Publ.
10. Bhojwani S. S. and Razdan M.K.(2004) Plant Tissue Culture - Theory and Practice, Elsevier publ., Amsterdam.

11. Leandro Peña Eds. (2005) Transgenic Plants: Methods and Protocols, (Methods in Molecular Biology), Human Press Inco.
12. George A. (2007) Principles of Plant Genetics and Breeding, Blackwell Publ
13. Mangal S. K. Ed. (2007) Biotechnology for Agricultural Breeding, Daya Publ
14. Adrian S., Nigel W. S. and Mark R. F. (2008) Plant Biotechnology: The Genetic Manipulation of Plants , 2nd ed., Oxford press.
15. Neal Stewart Jr. C. (2008) Plant Biotechnology and Genetics: Principles, Techniques and Applications, John Wiley and Sons.

COURSE MBT 303: Animal Tissue Culture

(2 Credits, 1L, 1T, Core Course)

UNIT 1 **15 L**

1. **Introduction** 5L

Introduction to animal tissue culture technique, principle and significance, brief historical review, important systems of animal tissue culture, advantages and limitations, definitions of important terms

2. **Growth characteristics**

   3L

   Growth characteristics of cells growing in tissue culture, molecular basis of cell adhesion, anchorage dependent and independent cells

3. **Aseptic techniques** and laboratory requirements of animal tissue culture technique 2L

4. **Tissue Culture Media** 5L

   Introduction to balanced salt solutions, physical and metabolic role of constituents of culture medium, role of carbon di oxide, serum and supplements, serum free media, commercially available important media formulations

UNIT 2 **15 L**

1. **Basic technique of mammalian cell culture** 6L

   Disaggregation of tissue and techniques for preparation of primary culture, routine subculture and maintenance of cell line, propagation in suspension

2. **Quantiation of cells and estimation of viability** 2L

3. **Scale up of animal cells in culture**

   Scale up of anchorage independent and dependent cells, bioreactors, microcarriers, perfused monolayer cultures 3L

4. **Applications of animal cell culture** 4L

   Tissue culture as a screening system for drug testing, industrial applications; monoclonal antibodies, vaccines and therapeutics, applications in medicine, introduction to tissue engineering

References:

1. Ian Freshney, Culture of Animal cells (5^{th} edition)2006, Wiley-Liss publication
2. Ed. John, Masters RW, Animal Cell Culture-Practical Approach, Oxford Press

3. Ed. R. Basega, Cell Growth and Division: A Practical Approach, IRL Press
4. Ed Martin Clynes, Animal Cell Culture Techniques, Springer
5. Ed. Jenni, Mather P, Barnes D, Methods in Cell Biology, Vol 57, Animal cell culture methods.

COURSE MBT 304: Human Genetics
(2 Credits, 1L, 1T, Core Course)

Unit I **15 L**

Mendel' laws of inheritance, concepts of alleles, dominance, recessiveness, codominance, epistasis, pleiotrophy and multiple alleles. ABO and Rh blood group systems. Genetic linkage, sex determination in human and role of Y chromosome, dosage compensation, mitochondrial genome-extrachromosomal inheritance.

Molecular basis of mutations, types of mutations, structure of human chromosome, chromosomal anomalies-addition, deletion, translocation, karyotyping, techniques for detection of abnormalities in fetus.

Unit II **15 L**

Population genetics, Hardy-Weinberg law

Genetic disorders in human
Diseases exhibiting Mendelian pattern of inheritance-sickle cell anemia, X-linked diseases-haemophilia, cystic fibrosis, diseases associated with chromosomal aberrations, human aneuploidy-monosomy and trisomy- Down's syndrome, Edward's syndrome, Patau's syndrome, Turner's syndrome, Klinefelter' syndrome, Jacobe syndrome, inborn errors of amino acids, carbohydrate and lipid metabolism, mitochondrial genetic defects.

References:

1. Human molecular genetics 3. T Stranchan and A. Read. Garland Publishing. 2004
2. Genetics: Analysis of genes and genomes. D.L. Hartl and E. W. Jones, Jones and Bartlett. 2001
3. Emery's elements of medical genetics. 2nd Edn. R. Mueller and I. Young. Churchill Livingstone 2001.
4. Human Genetics. A. Gardner, R. T. Howell and T. Davies. Viva Book Publ.

COURSE MBT 305: Environmental Biotechnology Lab (Practical Course)
(3 Credits, 2P, 6.00 Hrs, Core Course)

1. Determination of particulate matter 10μ (PM) concentration from ambient air by high volume sampler
2. Determination of SOx and NOx concentration from ambient air by high volume sampler
3. Determination of equivalent noise level (Leq) of the surrounding air
4. Determination of dissolved oxygen (DO) in given water sample
5. Determination of biochemical oxygen demand (B.O.D) in given water sample
6. Determination of chemical oxygen demand (C.O.D) in given water sample
7. Enumeration of coilform in wastewater by most probable number (MPN) test
8. Determination of organic matter phosphate/ calcium / magnesium from given soil sample
9. Determination of sodium / potassium
10. Determination of sodium absorption ratio (SAR)
11. Determination of cation exchange capacity (CEC)
12. Isolation of symbiotic N2 fixer from a soil sample
13. Standard plate count
14. Total viable count
15. Visit to waste water treatment plant(Industrial visit)

References

1. S. M. Khopkar, Environmental pollution analysis, 1st Edition, Wiley Eastern, 1993.
2. D.S. Ramtake andC. A. Moghe, Manual on water and waste water analysis, NEERI, Nagpur, 1988
3. Gabriel Bitton, Wastewater Microbiology, 2nd Edition. Wiley-Liss; 2nd Edition, 1999.
4. Trivedy,R.K. and Goel,P.K.(1987).Practical Methods in Ecology and Environmental Science,Environmental Publications, Karad.
5. Standard Methods for Waste and Water Analysis APHA 21stEdition

COURSE MBT 306: Plant Biotechnology Lab (Practical Course)

(3 Credits, 2P, 6.00 Hrs, Core Course)

- Nutrient media composition, preparation and sterilization 4P
- Selection of explants, surface sterilization, establishment and maintenance of different types of plant cultures for callus induction and regeneration 3P
- Initiation and establishment of suspension cultures 1P
- Micropropagation of dicot and monocot plants via axillary shoot Proliferation 2P
- Micropropagation via adventitious shoot proliferation 2P
- Micropropagation via somatic embryogenesis 2P
- Preparation of synthetic seeds. 2P
- Anther/microspore culture. 1P
- Embryo/ovule culture. 1P
- Protoplast isolation and culture 1P
- Histological and cytological techniques for plant cultures 2P
- Isolation of DNA from plant tissues. 1P
- *Agrobacterium*- mediated transformation studies 1P
- Extraction and quantification of secondary metabolites from callus 1P
- Visit to commercial Biotechnology industry 1P

References:

1.Gaurd.R.S. Gupta.G.D and Gukhade.S.B.2000. Practical Biotechnology: Nirali park ashan publishers. Pune.

2.Tejovathi.G, Vimala.Y and Rekha Bhadauria, 1996. A practical manual for plant Biotechnology. CBS publishers and distributors. New Delhi.

COURSE MBT 307: Animal Tissue Culture Lab (Practical Course)

(2 Credits, 1P, 3.00 Hrs, Core Course)

1. Understanding of tissue culture laboratory requirements, equipments, and sterilization procedures 2P
2. Preparation of reagents, formulation of tissue culture medium and membrane filtration 2P
3. Subculturing and routine maintenance of cell lines 4P
4. Cell counting and estimate of viability 1P
5. Observation of cells and maintenance of records 1P
6. Fixation and staining of cells 1P

References:

1. Ian Freshney, Culture of Animal cells (5^{th} edition)2006, Wiley-Liss publication
2. Ed. John, Masters RW, Animal Cell Culture-Practical Approach, Oxford Press
3. Ed. R. Basega, Cell Growth and Division: A Practical Approach, IRL Press
4. Ed Martin Clynes, Animal Cell Culture Techniques, Springer
5. Ed. Jenni, Mather P, Barnes D, Methods in Cell Biology, Vol 57, Animal cell culture methods.

COURSE MBT 308: Genetics Lab (Practical Course)

(2 Credits, 1P, 3.00 Hrs, Core Course)

Cytogenetic Analysis Practical Course

1. Planting of blood culture 1P
2. Preparation of chromosome spreads from lymphocyte culture 3P
3. Banding of metaphase slides 2P
4. Karyotyping and analysis 2P
5. Preparation of chromosome spreads from amniotic fluid 3P
6. Primary culture of cells from chorionic villus sample 2P
7. Preparation of chromosome spreads from chorionic villus cells 4P
8. Visit to the cytogenetic laboratory 2P

References:

1. Chromosome analysis protocols (Methods in molecular biology) Ernstjan Speel, A.H.N. Hopman. Humana Press Inc., U.S.; 2nd Edn 2005
2. Human cytogenetics: Malignancy and acquired abnormalities, A practical approach. 3rd Edn. D. E. Rooney, ed., Oxford University Press 2001
3. Human cytogenetics: Constitutional analysis: A practical approach. D. E. Rooney, ed., OUP Oxford; 3rd Edn. 2001

COURSE MBT 309: Elective Course: Floriculture

(2 Credits, 1L, 1T, Elective Course V)

Unit 1 : Fundamentals of Floriculture 15L

1. Introduction and scope; branches of industry (cut flowers, pot plants, seeds and bulbs, essential oil, Landscaping, interiorscaping)
2. Soils and other media, manures and fertilizers, irrigation Environmental factors, ecological physiology, photo periodism, dormancy, growth regulators
3. Cultivation under protection
4. Garden implements and important operations, control of diseases, insects and weeds
5. Methods of propagation''
6. Time of Propagation, Methods of seeds & bulbs collection and storing
7. Post harvest technology of cut flowers, seeds, bulbs
8. Irrigation & Water management

Unit 2: Plant Materials and their Cultivation 15L

1. Importance of identification and classification
2. Description of the categories of ornamental plants, lawns, pot plants, cut flower crops, bulbous plants, annuals and other bedding plants, rock garden plants and aquatic plants.
3. Cultural practices: soil and climate, land preparation and planting, manuring, irrigation and other intercultural operations.
4. Control of insect pests, diseases, and weeds
5. Detailed study (plant height, shape and spread; flower colour, time and blooming duration foliage/fruit/bark beauty, hardiness deciduous/ evergreen) and uses of important species of each category wherever applicable.
6. Landscape plants : Trees, b) Lawn, c) Shrubs, d) Hedges, e) Edges, f) Climbers, g) Pot plants, h) Cut flower crops, i) Annuals and other bedding plants, j) Bulbous plants, k) Flock gardens, l) Aquatic plants etc.
7. Nursery and Seed Production

Reference:

1. Floriculture in India (2007)', G. S. Randhawa, A. Mukhopadhay, Allied Publishers Pvt. Ltd., New Delhi
2. Floriculture: Principles and Species (2004, 2nd Edition) by John M. Dole and Harold F. Wilkins

COURSE MBT 309: Elective Course: Food Biotechnology

(2 Credits, 1L, 1T, Elective Course VI)

Unit 1

Food & milk borne diseases 4L

Food borne infections – bacterial (Salmonella, Clostridium) & viral pathogens

Food intoxications – bacterial (Botulism) & fungal toxins

Unit 2

Food spoilage and its Preservation 7L

Food spoilage, Normal microbial flora of food & milk, Causes of spoilage, Types of spoilage (fermentation, putrefaction, rancidity),

Preservation of food by physical methods (Asepsis, canning, use of heat radiation, gaseous sterilant, Pasteurization)

Chemical methods, combination of methods

Unit 3

Food fermentation process 5L

Fermented milk product (cheese),

Fermented food product (bread),

Fermented vegetables (sauerkraut)

Fermented beverages (wine)

Unit 4

Methods of quality control of food 11L

Physical methods- Microcalorimetry, flow cytometry

Chemical methods – Detection of thermostable nuclease, endotoxins, radiometry, chromogenic substrates

Microbiological & chemical methods of milk analysis - Grading of milk, platform tests – MBRT, RRT, peroxidases & phosphatases, DMC, SPC, LPC, coliform counts

Microbiological standards of food, Sanitary quality of foods – indicator microbes & total microbial load, HACCP/ISO – definitions, principles of HACCP, guidelines for application of HACCP system.

Unit 5

Advances in Food Microbiology **4L**

Genetically modified foods, Biosensors in food, Applications of microbial enzymes in dairy industry [Protease, Lipases], Utilization and disposal of dairy by-product (whey).

References

1. Food Microbiology, Frazier & Westhoff, 4th edition, 2008,Tata McGraw Hill Publications
2. James Monroe Jay, Martin J. Loessner, David Allen Golden, (2005) Modern Food Microbiology, 7th edition, Springer Science + Business Media Inc. USA.
3. Food Microbiology by Adams & Moss, 3rd edition,2008, The Royal Society of Chemistry
4. A textbook on Biotechnology, R. C. Dubey, Illustrative edition,2006, S. Chand Publications.
5. Advances in Biotechnology, S. N. Jogdand,2007, Himalaya Publishing House
6. Banwart George J., (1979) Basic Food Microbiology, AVI Publications.
7. Biotechnology: Food Fermentation Microbiology, Biochemistry and Technology. Volume 2 by Joshi.
8. Essentials of Food Microbiology. Edited by John Garbult. Arnold International Students Edition.
9. Microbiology of Fermented Foods. Volume II and I. By Brian J. Wood. Elsiever Applied Science Publication.
10. Dairy Microbiology by Robinson. Volume II and I.

COURSE MBT 310: Elective Course Lab: Food Microbiology Lab

(2 Credits, 1P, 3.00 Hrs., Elective Course V Lab)

1) Determination of quality of milk sample by SPC, MBRT
   4P
2) Microbiological examination of foods 2P
3) Production of wine from grapes 4P
4) Cheese fermentation
   3P
5) Production of citric acid using *Aspergillus niger* 3P
6) Visit 2P

References

1) Frazier W.C and Westhoff D.C. (2005) Microbiology 4th edn. Tata Mc Graw-Hill, Delhi. (ISBN:0-07-462101-7)
2) Sukumar De (2005) Outlines of Diary Microbiology, Oxford University Press, New Delhi (ISBN: 0-19-56194-2)
3) Harley Prescott, Laboratory Exercises in Microbiology, 5th edition, The McGrawHill Companies (2002).
4) Mu deli, J (2007), Introductory Practical Microbiology, Narosa Publ. House P. Ltd. New Delhi, (ISBN: (978-81-7319-744-4)
5) Cappuccino J.G. and Sherman N. (2004) Microbiology: A Laboratory Manual. 6th edn., Pearson Education, Delhi(ISBN:81-224-1494-X).

COURSE MBT 310: Elective Course Lab: Floriculture Practical
(2 Credits, 1P, 3.00 Hrs, Elective Course VI Lab)

1. Common garden operations using different implements
2. Handling of soils, purpose of nursery bed, potting media, potting etc
3. Propagation by cutting, budding, greating, Audio Visual demonstration
4. Handling of seeds, bulbs, cut flowers, nursery plants, pot plants
5. Audio Visual demonstration
6. Acquaintance with soil types, various manures, fertilizers, Vermicompost, pesticides, growth regulator

Reference

1. Floriculture: fundamentals and practices (1942), Alexander Laurie, Victor Heinrich Ries, McGraw-Hill book company, inc., - Gardening - 496 pages

COURSE MBT 311: General Course V: Special Topics

(2 Credits, 2L)

1. How to write a research paper
2. How to write a research proposal
3. Rules for biosafty in laboratory
4. Ethical issues in biomedical research
5. Ethical and regulatory issues in animal experiments
6. Basics of intellectual property rights and patenting system
7. Opportunities for biotechnologists in industry and academia
8. Opportunities for biotechnologists in business development and administration
9. Common garden operations using different implements
10. Handling of soils, purpose of nursery bed, potting media, potting etc
11. Propagation by cutting, budding, greating, Audio Visual demonstration
12. Handling of seeds, bulbs, cut flowers, nursery plants, pot plants
13. Audio Visual demonstration
14. Acquaintance with soil types, various manures, fertilizers, Vermicompost, pesticides, growth regulator

COURSE MBT 312: General Course VI: Research Methodology

(2 Credits, 1L, 1T)

This course will enhance the students' knowledge of data analysis techniques. The main objectives of this course are to give students practice in the quantitative methods used by researches as well as to expose them to statistical packages. Other objectives includes

1. To read and understand scientific research papers
2. To formulate a research question and translate it into step by step approach for working with data
3. To practice the presentation of statistical data.

To achieve this goals this course will use a combination of lectures and assignments.

The course contents will make the students familiar with

i) Formulation of viable research question
ii) Principles of theory/ model building and case selection
iii) How to distinguish probabilistic from deterministic explanation
iv) The role of comparison in controlling variation
v) The benefits and draw backs of different methodologies
vi) Identification and interpretation of data
vii) Preparation and execution of feasible research project.
viii) Elimination of alternative explanations.

Course Contents

1. Introduction
2. Study design
3. Protocol writing format
4. Data collection and statistical analysis
5. Scientific writing
6. Financial aspects of research and resources

References:

1) Research methodologies, Bulakh PM, Patki PS and Chaudhary AS, 1st Eds. 2010, Expert Trading Corporation, Mumbai.
2) Research Methodologies: Methods and Techniques, Kothari CK, 2004, 2nd Eds. New Age International, New Delhi.
3) Research Methodologies, Panneerselvam R, Prentice Hall of India, New Delhi, 2004.

Semester IV

COURSE MBT401: Specialization Subject I

(4 Credits, 3L, 1T, Elective Course)

Enzymology and its Industrial Applications

Unit 1 **15L**

1. Classification - IUB system, rationale, overview and specific examples. Characteristics of enzymes, enzyme substrate complex. Concept of active centre, binding sites, stereospecificity and ES complex formation. Effect of temperature, pH and substrate concentration on reaction rate. Activation energy. Transition state theory. Enzyme activity, international units, specific activity, turnover number, end point kinetic assay
2. Michaelis - Menten Equation - form and derivation, steady state enzyme kinetics. Significance of Vmax and Km. Bisubstrate reactions. Graphical procedures in enzymology - advantages and disadvantages of alternate plotting. Enzyme inhibition - types of inhibitors - competitive, noncompetitive and uncompetitive, their mode of action and experimental determination.
3. Factors affecting catalytic efficiency, proximity & orientation effects, distortion or strain, acid-base and nucleophilic catalysis. Methods for studying fast reactions, Chemical modification of enzymes, Isoenzymes and multiple forms of enzymes.

Unit 2
15L

1. Structure function relations: Lysozyme, ribonuclease, trypsin, pyruvate dehydrogenase complex
2. Enzyme regulation: product inhibition, feedback, induction, repression, covalent modifications,allosteric.
3. Protein-ligand binding, analysis of binding isotherms, co-operativity, Hill & Scathard plots and kinetics of allosteric enzymes.

Unit 3 **15L**

1. Immobilized enzymes: Advantages, Carriers, Methods of immobilization: covalent coupling, cross-linking and entrapment methods, Microenvironmental effects.
2. Enzyme Reactors: Reactors for batch/continuous enzymatic processing, Choice ot reactor type: idealized enzyme reactor systems
3. Mass Transfer in Enzyme Reactors: Steady state analysis of mass transfer and biochemical reaction in enzyme reactors.
4. Bio-process Design: Physical parameters, reactor operational stability; Immobilized cells.
5. Biomedical Applications of Immobilized Cells

Unit 4
15L

1. Techniques in biochemistry: Sequencing of proteins, Chromatography- gel permeation, adsorption, partition, HPLC, protein purification
2. 2D analysis and MALDI-Tof for proteins
3. Centrifugation techniques
4. Electrophoresis: SDS-PAGE, various blotting techniques
5. Fluroscence Spectroscopy, IR, NMR, CD, crystallization of proteins

References

1. Nelson and Cox (2008), Principles of Biochemistry by A. Lehninger, W.H. Freeman and Company, New York, USA.
2. Berg Jeremy M., Tymoczko J. L. and Stryer L. (2003), Biochemistry, W.H. Freeman and Company, New York, USA.
3. Immobilized Enzymes and Cells (second edition), Methods in Biotechnology, Vol 22, Guisan, Jose M (Ed), 2006, 264 p 217
4. Analytical Techniques

COURSE MBT401: Specialization Subject 2

(4 Credits, 3L + 1T, Elective Course)

Animal Cell Culture Applications

UNIT 1 **15L**

1. Overview of animal tissue culture system. Advantages and limitations
2. Structure and organization of tissues
   Epithelial, connective, vascular, lymph
3. Differentiation of cells – Expression of in vivo phenotype, stages of differentiation, stem cell plasticity, markers of differentiation, induction of differentiation, differentiation and malignancy
4. Cell matrix and cell interactions
5. Methods for quantitation of cells

UNIT 2 **15L**

1. Culture of specialized cell types – Epithelial, cornea, breast, cervix, gastrointestinal tract, liver, pancreas, kidney, oral, prostate, mesenchymal, hematopoietic and stem cells
2. Organ culture – Purpose of organ culture, advantages and limitations, techniques, advances, spheroid cultures
3. Cell based assays for screening of drugs – Viability, survival, metabolic assays, anticancer drug screening, transformation and mutagenesis, testing for carcinogenicity and inflammation
4. Applications of cell cultures in biotechnology industry – Production of monoclonal antibodies, vaccines, interferons and biological

UNIT 3 **15L**

5. Introduction to tissue engineering – Basic definition, current scope of development, use in therapeutics and *in vitro* testing
6. Hormone and growth factor signaling – Growth factor delivery in tissue engineering, applications of growth factors, VEGF/ angiogenesis
7. Scaffolds – Basic properties, different scaffolds used for tissue engineering

8. Stem cells – Introduction, types, embryonic, fetal, adult, plasticity, sources of cells for tissue engineering
9. Technique – Cell surface markers, FACS analysis, repopulation experiments

UNIT 4 **15L**

10. Transplantation of engineered cells and tissues – Basic transplantation immunology
11. Bioconstructs of skin, bone, cartilage, tendon, ligament, liver and applications for treatment of wound, bone, liver and endocrine disorders
12. Other applications of engineered tissues

References

1. Bernhard Palsson, Sangeeta Bhatia , *Tissue Engineering*, Pearson Prentice Hall, 2003

2. Robert. P.Lanza, Robert Langer & William L. Chick, *Principles of tissue engineering*, Academic press,1997

3. Gordana Vunjak-Novakovic, R. Ian Freshney, *Culture of Cells for Tissue Engineering*, WIS, 2006

4. B. Palsson, J.A. Hubbell, R.Plonsey & J.D. Bronzino, *Tissue Engineering*, CRC-Taylor & Francis

5. Joseph D., Bronzino *The Biomedical Engineering –Handbook*, CRC; 3rd edition , 2006

COURSE MBT401: Specialization Subject: Pharmaceutical and Medical Microbiology

(4 Credits, 3L + 1T, Elective Course)

Unit I **15L**

Epidemiology of microbial diseases

Microbiology for public health, Host – parasite relationship

Causative agent, pathogenesis, laboratory diagnosis and control measures of

Bacterial diseases (Typhoid, Cholera, Tuberculosis)

Parasitic diseases (Malaria, Ameobiasis)

Fungal disease (Candidasis)

Unit II **15L**

Identification of disease genes

Functional cloning –eg. haemophilia gene, Positional cloning – eg. DMD and CGD genes, Candidate gene approach – eg. Marfan's syndrome, Alzeimer's disease

Molecular basis of human diseases

Pathogenic mutations, Gain of function mutations: Oncogenes,

Loss of function - Tumour Suppressor Genes

Principle of antimicrobial chemotherapy

Introduction and selection of antimicrobial agents

Concept of Bioassay, therapeutic index, MIC and $LD_{50.}$

Mechanism of action, Antibacterial spectrum, acquisition of drug resistance, and adverse drug effect of β- Lactum, aminoglycosides, Production of antibiotics (Streptomycin), vitamins (vitaminB12)

Unit III **15L**

Production of immunological product

Manufacturing procedure and in-process control of Traditional Bacterial and Viral vaccine, sera

Newer Vaccines (Peptide vaccine, vaccine vectors, development in AIDS vaccine, cancer vaccine)

Quality Assurance and Validation

Regulatory aspects of QC, QA, and QM.

GMP, GLP and CMP in Pharmaceutical Industry (ISO, WHO, USFDA certification)

Microbial limit test of Pharma products, Sterility testing, pyrogen testing.

Unit IV **15L**

New techniques in production of pharmaceutical product

Recombinant products (Recombinant vaccines, recombinant blood products (factor VIII, anticoagulants), Therapeutic hormones (Insulin, gonadotrophin), edible vaccines)

Neutraceuticals, Role of adjuvants

Nucleic acid and cell based therapies

Gene therapy (approach, vectors used, applications)

Antisense technology,Stem cell therapy

References

1. Pharmaceutical Biotechnology Concepts and Applications by Gary Walsh, (2007), Wiley Publication
2. Pharmaceutical Biotechnology by S. P. Vyas & V.K. Dixit (2000) CBS publishers & distributors, New Delhi.
3. Quality control in the Pharmaceutical industry - Edited by Murray S. Cooper Vol. 2, Academic Press New York (1972).

4. Biotechnology- Edited by H.J. Rhem & Reed, vol 4 VCH publications, Federal Republic of Germany.
5. Hugo and Russell's pharmaceutical microbiology, Stephen P. Denyer, Norman A. Hodges, Sean P.Gorman, *S*eventh Edition 2009, Blackwell Scientific Publications

COURSE MBT401: Specialization Subject 4: Herbal Biotechnology
(4 Credits, 3L + 1T, Elective Course)

Unit 1:Herbal studies **15L**

- Introduction to herbals, validation of herbs, Use of plants or plant products for betterment of health and treatment of ailments, Indigenous medical system-bioprospecting, Indigenous knowledge systems
- Identification of herbs: System for identification, important characters of selected herbs
- Medicinal plants, major groups of plants with their medicinal uses
- Storage of herbal drugs
- Need of authentication of plants
- Ayurvedic prospective of medicinal plants
- Ethno botany - definition, brief introduction, Plants in folk religion / Traditional use of plants
- Importance and relevance of herbal drugs in Indian system of medicine

Unit 2: Experimental part **15L**

- Collection of plants and plant parts
- Stages of validation: in vitro assays, in vivo experiments and clinical studies
- Experiment planning and designing: Ethical clearance, Toxicity study, dose design, statistical analysis
- Introduction of types of animal modes including parameters to be studied
- Elucidating the mechanism of action
- Toxicology: Genera toxic effect of herbs, Over dose and their effects
- Importance of secondary metabolites

- Isolation and characterization of secondary metabolites
- Standardization of natural products: GC, GCMS, HPTLC, HPLC etc
- Drug Designing and Quality Control-

Unit 3: Herbal Drug 15L

- Phytochemical & biological screening- Extraction, Purification and isolation of Plant constituents, Study of some herbal formulations, Drug adulteration and its detection
- Herbal formulations - General properties of drug constituents. Extraction of drugs and methods
- Dosage form design: Introduction, pharmaceutical ingredients. Preformulation studies, stability, preservation against microbial contamination, stability against aerial oxidation, taste and aesthetic qualities.
- Quality assurance: authentication of drug samples; standardization methods. Plant drug adulteration- types and methods. WHO guidelines to standardization and assessment of quality, safety and efficacy of herbal products. Detection of heavy metals, pesticide residues, microbial contamination.

Unit 4: Applied part 15L

- Applications of herbal biotechnology
- Recent trends in plant research: Pharmacognosy, Pharmacology of important medicinal plant
- Scope in Parma company
- Recent advances in the field of Pharmacognosy with special reference to anticancer, Antidiabetic, Antiinflammatory, Hepatoprotective, Immunomodulating, Antioxidants drugs of plant origin

COURSE MBT 402: Practical Course in Specialization subject: Enzymology and Industrial Applications

(3 Credits, 2P, 6.00 Hrs, Elective Course)

1. Isolation and partial purification of an enzyme from a given source. Gross filtration, microfiltration and ultrafiltration. Dialysis, gel - filtration, ionexchange chromatography. 3P
2. Enzyme kinetics: optimum pH, temperature, Km, KI (α amylase). 3P
3. Electrophoresis of protein (native & SDS PAGE). 2P
4. Preparation of beads and column packing for ion exchange chromatography 2P
5. To find capacity and nature of ion exchange matrix/resin 2P
6. Separation of proteins on ion exchange column 2P
7. Gel filtration chromatography: Sephadex, Sepharose 4P
8. Immobilization of enzyme (invertase) on calcium algenate 3P
9. Conversion of starch to glucose by yeast invertase 2P

References:

1. Plummer D.T. (2005), An Introduction to Practical Biochemistry, Tata-McGrow Hill Publishing Company, New Delhi.
2. Jayraman J. (2007), Laboratory Manual in Biochemistry, New Age International (P) Ltd., New Delhi.
3. Sawhney S. K. and Singh R. (2000). Introductory Practical Biochemistry , Narosa Publishing House, New Delhi
4. Wilson K. and Walker J. (2005) Principles and Techniques of Biochemistry and Molecular Biology, Cambridge University press, New York.

COURSE MBT 402: Practical Course in Specialization subject 2 : Animal Cell Culture Applications

(3 Credits, 2P, 6.00 Hrs, Elective Course)

1. Formulation of tissue culture medium 1P
2. Primary culture of chick fibroblast/ rat hepatocytes 4P
3. Subculture of cell lines 2P
4. Culture of lymphocytes, lymphocyte transformation assay 3P
5. Determination of growth curve and population doubling time of cell line 4P
6. Preparation of metaphase chromosomes from cultured cells 2P
7. Drug toxicity testing using MTT/ SRB/ cell viability assay 4P
8. Virus titration/ neutralization assay 4P
9. Culture of cells using matrigel and/or collagen basement membrane matrix & evaluation 4P
10. Visit to research laboratories for study of variety of scaffolds, its preparation & characterization of cells

References:

1. Ian Freshney, Culture of Animal Cells (5th Ed)2006, Wiley-Liss publication.
2. Ed. Jenni, Mather P, Barnes D, Methods in Cell Biology, Vol 57, Animal Cell Culture Methods
3. Principles and practice of Animal Tissue Culture 2nd Edn. Sudha Gangal. University Press; India 2011
4. Robert. P.Lanza, Robert Langer & William L. Chick, *Principles of tissue engineering*, Academic press,1997
5. Gordana Vunjak-Novakovic, R. Ian Freshney, *Culture of Cells for Tissue Engineering*, WIS, 2006

COURSE MBT 402: Practical Course in Specialization subject: Medical and Pharmaceutical Biotechnology

(3 Credits, 2P, 6.00 Hrs, Elective Course)

1. Primary isolation of enteric pathogens (*Salmonella, Shigella*) 2P
2. Identification of enteric pathogen by TSI agar medium. 2P
3. Widal test for *Salmonella typhii* 2P
4. Microbial production and Bioassay of Penicillin. 3P
5. Determination of MIC and LD50 of Ampicillin / Streptomycin. 3P
6. Sterility testing by using *B. sterothermophilus/ B. subtilis.* 2P
7. Screening, Production and assay of therapeutic enzymes (Glucose Oxidase, beta lactamase) 4P

References:

1. Basv Raj Nagoba, Parslow, (2009) Clinical Microbiology, BI Publications Pvt Ltd. New Delhi.
2. Patrick Murray, Ellen Jo Baron, James H Jorgensen, Marie Lousie Landry, Michael A Pfaller, (2007), Manual of Clinical Microbiology, 9th edition, ASM press.

COURSE MBT 402: Practical Course in Specialization subject 4: Herbal Biotechnology

(3 Credits, 2P, 6.00 Hrs, Elective Course)

1. Identification of locally available Medicinal Plants
2. Exomorphic features of the following medicinal plants:

   Roots - Asparagus racemosus, Vetiver zizanoides

   Rhizome - *Zinziber officinale, Curcuma domestica*

   Bark - *Chinnamomum, Cinchona, Indigofera tinctoria*

   Twigs - *Solanum trilobatum, Coccinia indica, Melothria maderaspatana*

   Leaves - *Ocimum sanctum, Aegle marmelos, Piper betel, Nicotiana, Neem*

   Flowers - *Hibiscuss rosasinensis*

   Fruits - Fennel, Cumin, Pepper, Poppy

   Seeds - *Syzygium cumini, Trigonella*
3. Endomorphic Characters: Anatomical and cytological features of the plants
4. Preparation of Herbal Formulations used as common home remedies
5. Preparation of Herbarium sheets of Medicinal plants
6. Identification of Adulterants
7. Microtomy -Preparation of permanent microscopic slides.
8. Crude drug identification – Moisture content, pH, ash content, extractive values
9. Use of extraction equipments - Soxhelt apparatus, Clavenger apparatus

10. Use of Separation techniques - Column, TLC, HPLC, Electrophoresis, Centrifugation.
11. Extraction of volatile oils
12. Animal experiments

Reference

1. Trease & Evans, (2008), *Pharmacognosy 15th Ed*, Elsevier Publication (India)
2. N. R. Krishnaswamy, (1999), *Chemistry of Natural Products*, Universities Press (India) Pvt. Ltd.
3. Kavanagh Frederick, (1963), *Analytical Microbiology Volume I and II*, Academic Press, London
4. .Satoskar et al, (2009) *21st Ed*, *Pharmacology and Pharmacotherapeutics*, Popular Prakashan
5. Lorian.V., (2005), *Antibiotics in laboratory medicine, 5th Ed*, Williams & Wilkins Publication
6. Agarwal S. S. and Paridhavi M., (2007), *Herbal Drug Technology*,*1st Ed* Universities Press (India) Pvt. Ltd
7. Silverstein R. M., Bassler G. C., (1968), *Spectrometric Identification of Organic Compounds,2nd Ed*.
8. Matham V., (2011), *Essentials of Toxicology*
9. National Committee for Clinical Laboratory Standards (now Clinical and Laboratory Standards Institute, CLSI). *Methods for dilution antimicrobial susceptibility testing for bacteria that grows aerobically. Approved Standards M7-A4*. Villanova, PA: NCCLS, 1997.

10. National Committee for Clinical Laboratory Standards (now Clinical and Laboratory Standards Institute, CLSI). *Performance standards for antimicrobial susceptibility testing; 12th information supplement (M100-S1)*. Villanova, PA; NCCLS: 2002

COURSE MBT 403: Biostatistics
(2 Credits, 1L, 1T, Core Course)

Unit 1 **15 L**

1. **Understanding Data**

Introduction
Data and Measurement
The Distribution of One Variable
Measuring Center and Spread
Normal, binomial and Poisson distributions

2. **Understanding Relationships**

Comparing Groups
Scatterplots
Correlation
Least-Squares Regression
Association vs. Causation

3. **Generating Data**

Sample Surveys
Designing Experiments

Unit 2 **15 L**

1. **Experience with Random Behavior**

Randomness
Intuitive Probability
Conditional Probability
Random Variables
Sampling Distributions

2. **Statistical Inference**

Estimating With Confidence
Confidence Intervals for a Mean
Testing Hypotheses
Tests for a Mean

3. **Topics in Inference**

Comparing Two Means
Inference for Proportions
Two-Way Tables
Inference for Regression
One-Way Analysis of Variance

References:

1. Biostatistics: A guide to design, Analysis and Discovery, Peter Fritz, Elsevier India.
2. Biostatistics: A foundation for analysis 7th Edition, Ferric Darvas
3. Applied statistical designs for the researcher, Neil Ed Taylor and Francis Groop.

COURSE MBT 404: Bioinformatics

(2 Credits, 1L, 1T, Core Course)

Unit 1: 15 L

Introduction to Bioinformatics 7L

Definitions of Bioinformatics, Scope of bioinformatics, multidisciplinary nature and overview of applications, High throughput technologies in biotechnology generating data for bioinformatics analysis : Microarray, Genome sequencing and protein structure determination methods, Types of hardware facilities required to practice bioinformatics: Internet, desktop machines, web servers, supercomputing facilities and cloud computing, Data storage devices used for storing voluminous biological data.

Biomolecular Databases 8L

Types of databases in molecular biology, Nucleic acid sequence databases, primary and secondary data bases, Protein sequence and structure databases : Uniprot, PDB and other resources., Derived databases like SCATH, SCOP, PFAM and Transfec, Genome databases and genome browsers for microbial, plant and animal genomes

Unit 2 . 15 L

Database search Methods and Tools 5L

Text and literature search tools and techniques. PubMed and Medline search tools . Sequence database search tools like Entrez and SRS, PDB search tools for downloading 3D protein structures., Sequence similarity search using BLAST tool, Enzyme database search tools and techniques

Protein Structure and Function Prediction 5L

Protein structural levels, primary, secondary and teriatry structures of proteins, Protein 3D structure visualization tools like RasMol, VMD and SPDBV, Methods of

validation of protein 3D structures like Ramchandran plot and Procheck, Computational modelling of protein 3D structures like homology and ab initio modeling, Finding structural domains and active site of a protein.

Genome analysis methods and tools **5L**

From sequences to genomes, genome size in relation to number of genes and proteins, Structure of prokaryotic and eukaryotic genes, Genome annotation, and annotation of gene function, Finding mutations, SNPS, indels, inversions,and gene fusions in the genome, Applications of genomics in medicine, agriculture, and environment case studies.

References:

1. Zvelebil, M. & Baum, J.O. Understanding Bioinformatics. (2007) pp. 772
2. Pevzner, J. (2003). Bioinformatics and Functional Genomics. Wiley.
3. All the slides available at: http://www.bioinfbook.org/
4. W. Mount. Bioinformatics: Sequence and Genome Analysis. (2004) pp. 692.
5. http://www.bioinformaticsonline.org/
6. Westhead, D.R., J.H. Parish, and R.M. Twyman. 2002. ***Bioinformatics***. BIOS
7. Scientific Publishers, Oxford.
8. Branden et al. Introduction to Protein Structure. (1998) pp. 410

COURSE MBT 405: Biostatistics & Bioinformatics Lab (Practical Course)
(2 Credits, 1P, 3.00Hrs, Core Course)

1. Systematic tabular summarization of data (before analysis), measures of central tendency, measures of dispersion, measures of skewness.
2. Correlations (product-moment co-efficient, Spearman's rank co-efficient) and regression (linear regression, curve fitting)
3. Data presentation (tables/figures): 1-D and 2 –D bar charts, pie diagrams, graphs (using computer software packages)
4. Statistical distributions: fitting discrete uniform, binomial, Poisson and normal probability distributions to given data.
5. Testing of hypotheses: Tests of significance (mean, standard deviation, correlation co-efficient)
6. Chi-square test for goodness-of-fit, tests for independence of attributes, non parametric tests (run test)
7. Sampling (drawing random samples using random numbers, tables, chits)
8. Computer programs for random number generation, design of experiments, ANOVA
9. A guided tour of NCBI/EBI : Data access – standard search engines: data retrieval Tools – Entrez, DBGET and SRS: software for data building; submission of new revised data
10. Sequence homology, sequence similarity searches, sequence alignment-global, local, end free –space; measurement of sequence similarity and homology
11. Multiple sequence alignment
12. Phylogeny reconstruction, PHYLIP package

References

1. Zvelebil, M. & Baum, J.O. Understanding Bioinformatics. (2007) pp. 772
2. Pevzner, J. (2003). Bioinformatics and Functional Genomics. Wiley.
3. All the slides available at: http://www.bioinfbook.org/

4. W. Mount. Bioinformatics: Sequence and Genome Analysis. (2004) pp. 692.
5. http://www.bioinformaticsonline.org/
6. Westhead, D.R., J.H. Parish, and R.M. Twyman. 2002. ***Bioinformatics***. BIOS
7. Scientific Publishers, Oxford.
8. Branden et al. Introduction to Protein Structure. (1998) pp. 410
4. Biostatistics: A guide to design, Analysis and Discovery, Peter Fritz, Elsevier India.
5. Biostatistics: A foundation for analysis 7th Edition, Ferric Darvas
6. Applied statistical designs for the researcher, Neil Ed Taylor and Francis Groop.

COURSE MBT 406: Project
(10 Credits, Core Course)

The student will undertake a project preferably in the specialization subject. The student will conduct literature review, plan of work and will conduct the project under the guidance of assigned guide. About 10 credits are allotted for the project. The dissertation will be assessed for 100 marks. The distribution of these marks will be as follows;

1. 25 Marks for literature survey and framing of Aims & Objectives of the selected dissertation topic.
2. 25 Marks for progress of work (based on day – to – day work)
3. 25 Marks for fulfillment of objectives
4. 25 Marks for presentation/ Viva (External evaluation)

COURSE MBT 407: Elective Course: Nano-biotechnology
(2 Credits, 1L, 1T, Elective Course VII)

Unit 1 **15 L**

1. Introduction to nanotechnology, History and scope, interdisciplinary nature, Nanostructures : Carbon fullerene, Carbon nanotube, Quantum dots
2. Synthesis of nano materials: Top - down and bottom - up approaches, chemical precipitation, vapour deposition, hydrothermal method, pyrrolysis, Sputtering, laser ablation, electric - arc, sol - gel processing, lithography.

3. Characterization of nanomaterials: SEM, TEM, EDAX, X - ray diffraction atomic force microscopy, confocal microscopy, UV - Visible spectroscopy, photoluminescence spectroscopy, FTIR spectroscopy, UV and X - ray photoelectron spectroscopy, particle size analysis, charge distribution analysis (charge on the surface, estimation)

Unit 2

15 L

1. Nano-scale biological assemblies and their applications: S-layer organization, self organization of bacteriophages, phosopholipids, actin and Microtubules, Kinesisn and Dynein.
2. Nano-bio assemblies
3. Application of nanobiotechnology in (a) medicine: drug delivery, Biological detection, (b) agriculture and (c) environmental: desalination, monitoring water quality, detection of pollutants.

References

1. T. Pradeep, Nano, The Essentials, Understanding Nanoscience and

Nanotechnology, Tata McGraw-Hill Publishing Company Limited, 2007
2. J. W. M. Bulte, M.M.J. Modo, Nanoparticles in Biomedical Imaging: Emerging Technologies and Applications, Springer Science Business Media, LLC, 2008
3. C.A. Mirkin and C.M. Niemeyer, Nanobiotechnology- II, More Concepts and Applications, WILEY-VCH, Verlag Gmb H&Co, 2007
4. V. Renugopalakrishnan and R. V. Lewis Eds. Bionanotechnology - Proteins to Nanodevices, Springer.
5. D. S. Goodsell, Bionanotechnology - Lessons from Nature John Wiley & Sons, Inc
6. Bhushan Ed.,Handbook of nanotechnology, Springer.
7. A C. Yih and I. Talpasanu Eds. Micro and Nano Manipulations for Biomedical Applications
8. Tuan Vo - Dinh. Ed. Nanotechnology in Biology and Medicine: methods, device and applications. CRC Press.

MBT - 407 Plant breeding & Biotechnology

Plant breeding & Biotechnology

2 credits, 1L, 1T, Elective Course VIII

Unit 1 : 15 L

Plant Breeding

1. Introduction , History and scope of plant breeding
2. Plant Genetic resources: Importance and urgency, Sources of germplasm, Systematic evaluation and utilization, Germplasm conservation, Global and National organization for crop improvement and Pattern of evolution in crop plants.
3. Historical perspectives
4. Mating Systems
5. Genetic basis and breeding methods of self pollinated and cross-pollinated crops
6. Mutations and polyploidy breeding
7. Breeding methods for vegetatively propagated crops
8. Role of FAO/CGIAR system for access to genetic resources: Biodiversity prospecting for agriculture and pharmaceuticals.

Unit 2 15

Biotechnology in Crop Improvement

1. Crop biotechnology and its scope
2. Plant organ, tissue and cell culture
3. Theory and applications of molecular techniques
4. Post-transcriptional gene silencing (PTGS)
5. Vectors and gene cloning
6. Libraries and molecular probes
7. Polymerase chain reaction (PCR)

8. Methods of gene transfer in plants and transgenic plants
9. IPRs in plant breeding

Reference

1. Gupta P K (2009). Genetics, 4/e. Rastogi Publications, Meerut.
2. Gupta P K (2007). Genetics:Classical to modern. Rastogi Publications, Meerut.
3. Griffith et *al* (2008). An introduction to Genetic Analysis. Freeman & Co.
4. Hartl DL and Jones EW (1997). Genetics: Principles and Analysis 4th Ed. Jones & Bartlett Publishers, Inc
5. Allard, R.W. (1960). Principles of Plant Breeding. John Wiley, New York
6. Chopra, V.L. (2000). Plant Breeding: Theory and Practice 2nd Ed. Oxford & IBH, New Delhi.
7. Frey, K. J. (1966). Plant Breeding. The Iowa State University Press, Ames.
8. Frey, K. J. (1982). Plant Breeding II. Kalyani Publishers, New Delhi.
9. Welsh, J. R. (1981). Fundamentals of Plant Genetics and Breeding. John Wiley and Sons, New York.
10. Abelson, P. H. (1984). Biotechnology and Biological Frontiers. American Association for the Advancement of Science, Washington, U.S.A.
11. Ammirato, P. V., Evans, P. V., Evans, D. A., Sharp, W. R. and Yamada, Y. (Eds.) (1984). Handbook of Plant Cell Culture. Vols. 1, 2 & 3. MacMillan Publishing Co,New York.
12. Singh, B. D. (2007). Plant Breeding. Kalyani Publishers, New Delhi
13. Chahal, G. S. and Gosal, S. S. (2003). Principles and Procedures of Plant Breeding:
    Biotechnological and Conventional Approaches. Narosa Publishing House, New Delhi
14. W.J.C.Lawrene,(1951). Practical plant Breeding George Allen & Unwin Ltd.London

Course MBT 408: Plant Breeding and methodology Lab

(2 Credits, 1P, 3.00 Hrs, Elective Course 7 Lab)

1.	Seed production in self pollinated and cross pollinated crops	**2D**
2.	Embryo rescue technique	**2P**
3.	Protoplast technique	**2P**
4.	Production of homozygous plants	**2P**
5.	Somaclonal variant selection	**2P**
6.	Indirect method of plant cell transformation	**2P**

References:

1. W. J. C. Lawrene,(1951). Practical plant Breeding George Allen & Unwin Ltd.London
2. Hartman, H.J. et.al., 1990 : Plant propagation . Principles and practices. Prentice Hall, New Delhi.

COURSE MBT 408: Nano-biotechnology Lab

(2 Credits, 1P, 3.00 Hrs, Elective Course 8 Lab)

1. Synthesis of nanoparticles,
   i. Gold by reduction method
   2 P
   ii. Silver by reduction method 2 P
   iii. Magnetic nanopatilces co-precipitation method
   2 P
   iv. Gold by Biological method
   4 P
2. Characterization of nanoparticles using UV-Vis absorption techniques 2 P
3. Study on stabilization of nanoparticles 4 P
   Synthesis of semiconductor/luminescent nanoparticles using chemical/physical method (such as SiO2/CdS/CdSe/ZnS nanoparticles)
   4 P Study of analysis tools such as SEM and TEM pictures
   2 P
4. Designing of bio nanosensor (theoretical) 4 P
   Application silver nanoparticles to inhibit bacteria 4 P
   Nano fibre synthesis (demonstration) 2 P
5. Visit to different laboratories

References:

1. J. W. M. Bulte, M.M.J. Modo, Nanoparticles in Biomedical Imaging: Emerging Technologies and Applications, Springer Science Business Media, LLC, 2008
2. Magnetic nanoparticles: preparation, structure and properties S P Gubin, Yu A Koksharov, G B Khomutov, G Yu Yurkov
3. Antimicrobial effects of silver nanoparticles, Nanomedicine: Nanotechnology, Biology, and Medicine 3 (2007) 95– 101