RASHTRASANT TUKADOJI MAHARAJ NAGPUR UNIVERSITY

DIRECTION NO. 14 0F 2010

DIRECTION RELATING TO THE EXAMINATION LEADING TO THE DEGREE OF MASTER OF SCIENCE IN MOLECULAR BIOLOGY AND GENETIC ENGINEERING (CREDIT BASED SEMESTER PATTERN) (Faculty of Science)

(Issued under Section 14(8) of the Maharashtra Universities Act, 1994)

WHEREAS Maharashtra Universities Act, 1994 (hereinafter referred to as Act) has come into force from 22nd July, 1994 and was amended from time to time.

AND

WHEREAS, the University Grants Commission, New Delhi has granted the Department of Molecular Biology and Genetic Engineering during XI plan to this University through its letter vide No. D.O. No. F. 9-6/2008 (XI Plan dated 11th July, 2009 and F. No. 87-I/2007(SU-I), dated 4th December, 2009, it is expedient to frame and constitute the syllabus, scheme of examination and direction of the course Master of Science (M.Sc.) in Molecular Biology and Genetic Engineering to be implemented from the session 2010-11 and onwards.

AND

WHEREAS, the Academic Council and Management Council of this University has accepted and approved the guidelines along with total grant in aid head and item wise including this proposal as received from UGC under XI Plan same under relevant section of the Maharashtra Universities Act, 1994.

AND

WHEREAS, the Ad-hoc Board/Committee of Studies in Molecular Biology and Genetic Engineering has approved the the syllabus, scheme of examination and direction of the course leading to Master of Science (M.Sc.) in Molecular Biology and Genetic Engineering in its meeting held on 10/6/2010 and the same is approved by the Faculty of Science in its meeting held on 15/6/2010. Further approval to this course as granted by Hon'ble Vice-Chancellor under Section 14(7) on behalf of Academic Council and Management Council vide dated 6/7/2010.

AND

WHEREAS, academic session 2010-2011 has commenced from 16th June, 2010, it is felt expedient in the interest of the students to give effect to the decision of Academic Council and Management Council to start the Master of Science in Molecular Biology and Genetic Engineering course from the session 2010-2011.

AND

WHEREAS, Ordinance making is a time consuming process, therefore, I, Dr. V. S .Sapkal, Vice-Chancellor Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur in exercise of the powers vested under Section 14(8) of the Act do hereby issue the following Direction.

1. This Direction may be called "Direction relating to examination leading to the degree of Master of Science in Molecular Biology and Genetic Engineering in the faculty of Science. (Credit Based Semester Pattern).

2. The Direction shall come in to force with effect from the date of its issue by Hon'ble Vice Chancellor .

3. The duration of course shall be of two academic years consisting of four semester with University examinations at the end of each semester namely:

a) M.Sc. (Molecular Biology and Genetic Engineering) **Semester I Exam.**

b) M.Sc. (Molecular Biology and Genetic Engineering) **Semester II Exam**.

c) M.Sc. (Molecular Biology and Genetic Engineering) **Semester III Exam.**

d) M.Sc.(Molecular Biology and Genetic Engineering) **Semester IV Exam.**

4. The examinations shall be held at such places and dates which are notified by the University.

ELIGIBILITY TO THE COURSE

5. Subject to the compliance with the provisions of this direction and of other ordinances in force from time to time, the following applicant candidates/students shall be eligible for the admission to this course and examination their of

A. The candidates who have passed the B.Sc. Examination in at least second division with any one or more subjects of life sciences or biological sciences candidates who have passed B.Sc. Biotechnology in second division.

Or

The candidates who have passed the B.Pharm. Examination in at least second division.

Or

The candidates who have passed the graduation degree in agriculture or fisheries or veterinary sciences Examination in at least second division.

B. Candidates shall have passed any one of the above examinations from the RTM Nagpur University or any other statutory University of India or abroad, recognized by the UGC or any other concerned apex regulatory authority/body of India.

a) M.Sc.(Molecular Biology and Genetic Engineering) **Semester I Exam.**

Students who have fulfilled the eligibility criteria as mentioned in Section 5 (A) & (B) and have been admitted to this course in semester I.

b) M.Sc.(Molecular Biology and Genetic Engineering) **Semester II Exam**.

Students who have been admitted to this course in semester one and have passed the semester I examinations.

c) M.Sc.(Molecular Biology and Genetic Engineering) **Semester III Exam.**

Students who have been admitted to this course in semester two and have passed the semester II examinations

d) M.Sc.(Molecular Biology and Genetic Engineering) **Semester IV Exam.**

Students who have been admitted to this course in semester three and have passed the semester III examinations

(Note:- Subject to the Rules of ATKT as mentioned in para 6 of this Direction.)

2. Every candidate shall submit three copies of the project report for the fourth semester (in Lieu of the practical) to the university at least one month before the commencement of the practical examination through the Head of the Department/principal of the college concerned along with the certificate signed by the supervisor and declaration by the candidate towards original work which is not submitted to any university or organization for award of the degree. The guidelines for the students and supervisors regarding project report are given in Appendix

6. The ATKT rules for admission for the M.Sc. Molecular Biology and Genetic Engineering course (Theory and Practical as separate passing head) shall be as given in the following table.

Admission to Semester	Candidates should have passed in all the subjects of the following examination of Nagpur University	Candidates should have passed at least two third of the passing heads of the following examinations
Semester I	As provided in the Para 5 of the direction	---
Semester II	--	Semester I
Semester III	Semester I	Semester II
Semester IV	Semester II	Semester III

7. Without prejudice to other provisions of this Ordinance no. 6 relating to the examination in general, provisions of Para 5,8,9,10,26,31 and 32 of the said ordinance shall apply to every student , admitted to this course.

8. The fees for the examination, tuition, laboratory and other fees shall be as prescribed by the university from time to time.

9. a) The scope of the subjects shall be as prescribed in the syllabus.

b) The medium of instruction and examination shall be English.

10. The number of papers and the maximum marks assigned to each paper and minimum marks/grade an examinee must obtain in order to pass the examination shall be as prescribed in **appendix**

11. The examinee at each of the examination shall have option of not being declared successful at the examination in case he/she does not secure a minimum of grade equivalent to 55% marks at the examination. This option will have to be exercised every time the application is submitted to any of the examinations. Once this option is exercised, the option shall be binding on the examinee and it shall not be revoked in under any circumstances.

12. The classification of the examinee successful at the semester end examinations and at the end of final semester examination shall be as per the rules and regulations of credit and semester system as prescribed in **appendix**

13. The provisions of direction no3 of 2007 for the award of grace marks for passing an examination, securing higher grade in subject(s) as updated from time to time shall apply to the examination under this direction.

14. The names of the successful examinee passing the examination as a whole in the minimum prescribed period and obtaining prescribed number of places securing the

grades equivalent to first and second division shall be arranged in order of merit as provided in ordinance 6 relating to examination in general.

15. No candidate shall be admitted to an examination under this direction, if he/she has already passed the same examination of this university or of any other university.

16. Examinees successful at the final examination shall on payment of the prescribed fees, will be entitled for the award of the degree in the prescribed form signed by the vice chancellor.

17. This course is based on credit based semester system and therefore, it will be also regulated by guidelines and regulation given in **appendix which** is a part of this direction

APPENDIX-1

Scheme of teaching under credit based semester system for M.Sc. Program in **MOLECULAR BIOLOGY AND GENETIC ENGINEERING**

Sr. No.	Semester	Course Code	Course/paper	Title of course/paper	Teaching scheme		
					Theory (hrs/week.)	Practical (hrs/week.)	No. of credits
1	One	MBGE-T-I	I	Cell Biology (Prokaryotic & Eukaryotic)	4	6	4
2	One	MBGE- TII	II	Basic Biochemistry	4	6	4
3	One	MBGE-TIII	III	Practical Biochemistry and Analytical techniques	4	6	4
4	One	MBGE-T IV	IV	Molecular Biology I	4	6	4
5	One	MBGE-T V	V	Molecular Biology II	4	6	4
6	One	MBGE-PI	Practical I	Practical based on course 1,2,3	--	18	5
7	One	MBGE-PII	Practical II	Practical based on course 4,5	--	12	5
8	Two	MBGE-T VI	VI	Enzyme technology	4	6	4
9	Two	MBGE-T VII	VII	Recombinant DNA technology I	4	6	4
10	Two	MBGE-T VIII	VIII	Recombinant DNA technology II	4	6	4

11	Two	MBGE -T IX	IX	IPR,Biosafety, Bioethics, and Entrepreneurship	4	6	4
12	Two	MBGE -T X	X	Immunology	4	6	4
13	Two	MBGE -PIII	Practical III	Practicals based on course no. 6,10	--	12	5
14	Two	MBGE -PIV	Practical IV	Practicals based on course no. 7,8,9	--	18	5
15	Three	MBGE -T XI	XI	Bioinformatics and Data Mining	4	6	4
16	Three	MBGE -T XII	XII	Biostatistics, laboratory management & safety	4	6	4
17	Three	MBGE -T XIII	XIII	Plant genetic engineering	4	6	4
18	Three	MBGE -T XIV	IVX	Animal genetic engineering	4	6	4
19	Three	MBGE -T V	XV	Industrial applications of genetic engineering	4	6	4
20	Three	MBGE -PV	Practical V	Practicals based on course no.11,12	--	12	5
21	Three	MBGE -PVI	Practical VI	Practicals 13,14 15	--	18	5
22	Four	MBGE -PVII	VI	Seminar *	--	--	2

23	Four	MBGE -PVIII	VII	Project work and report writing*	--	Entire semes ter	8

*1.In the fourth semester student will have to give seminar on any topic relevant to the syllabus encompassing the recent trends and development in that field. The topic of the seminar will be decided at the beginning of fourth semester in consultation with the supervising teachers. The student has to deliver the seminar for one hour duration which will be followed by discussion. The seminar will be open to all the teachers of the department, invitees, and students

2. The student will have to carry out the research based project work in lieu of practical in the fourth semester in the department or depending on the availability of placement; he/she will be attached to any of the national/regional/private research institute/organization for the duration of the fourth semester. The student will be randomly allotted the priority number for the selection of the supervisor at the end of third semester. The student in consultation with supervisor will finalize the topic of the project work at the end of the third semester.

3. These courses can be taught by person having post graduate qualifications in relevant/equivalent subject/s or having teaching/research experience in that particular area.

APPENDIX-2

Scheme of the examination under credit based semester system for M.Sc. Program in MOLECULAR BIOLOGY AND GENETIC ENGINEERING

Sr.No.	semester	Course/cpaper	Title of course/paper	Examination scheme								
					Theory				Practicals			
				Dur. Of paper (hrs)	Maximum marks (external)	Maximum internal marks	Total	Minimum passing grade points	Maximum marks External	Max. marks Int. Ass.	Total	Min. passing grade points

				T	P								
1	One	I	Cell Biology (Prokaryotic & Eukaryotic) MBGE-I (T)	3		50	50	100	01				
2	One	II	Basic Biochemistry MBGE-II (T)	3		50	50	100	01				
3	One	III	Practical Biochemistry and Analytical techniques MBGE-III (T)	3		50	50	100	01				
4	One	IV	Molecular Biology I MBGE-IV (T)	3		50	50	100	01				
5	One	V	Molecular Biology II MBGE-V (T)	3		50	50	100	01	--	--	--	--
6	One	Practical I	Practical based on course 1,2,3 MBGE-I (P)	--	12					80	20	100	01
7	One	Practical II	Practical based on course 4,5 MBGE-II (P)	--	12					80	20	100	01
8	Two	VI	Enzyme Technology MBGE-VI (T)	3		50	50	100	01				

9	Two	VII	Recombinant DNA Technology I MBGE- VII	3		50	50	100	01				
10	Two	VIII	Recombinant DNA technology II MBGE-VIII(T)	3		50	50	100	01				
11	Two	IX	IPR, Biosafety, Bioethics, and Entrepreneurship MBGE-IX(T)	3		50	50	100	01				
12	Two	X	Immunology MBGE-X(T)	3		50	50	100	01				
13	Two	Practical III	Practicals based on course no. 6,10 MBGE- PIII	--	12					80	20	100	01
14	Two	Practical IV	Practicals based on course no. 7,8,9 MBGE- PIV	--	12					80	80	100	01
15	Three	XI	Bioinformatics and Data Mining MBGXI(T)	3		50	50	100	01				
16	Three	XII	Biostatistics, Laboratory management and safety MBGE-XII(T)	3		50	50	100	01				

17	Three	XIII	Plant genetic Engineering MBGE-XIII(T)	3		50	50	100	01				
18	Three	XIV	Animal genetic Engineering MBGE-XIV(T)	3		50	50	100	01				
19	Three	XV	Industrial applications of genetic engineering MBGE- XV(T)	3		50	50	100	01				
20	Three	Practical V	Practicals based on course no.11,12 MBGE-PV	--	12					80	20	100	01
21	Three	Practical VI	Practicals based on 13,14,15 MBGE- PVI	--	12					80	20	100	01
22	Four	xVI	Seminar * MBGE-PVII	--	--						20	20	01
23	Four	xVII	Project work and report writing* MBGE-PVIII	--	--					80	--	80	01

*1.In the fourth semester student will have to give seminar on any topic relevant to the syllabus encompassing the recent trends and developments in that field. The topic of the seminar will be decided at the beginning of fourth semester in consultation with the supervising teachers. The student has to deliver the seminar for one hour duration which will be followed by discussion. The seminar will be open to all the teachers of the department, invitees, and students.

2. The student will have to carry out the research based project work in lieu of practical in the fourth semester in the department or depending on the availability of placement he/she will be attached to any of the national/regional/private research institute/organization for the duration of the fourth semester. The student will be

randomly allotted the priority number for the selection of the supervisor at the end of third semester. The student in consultation with supervisor will finalize the topic of the project work at the end of the third semester.

3. The regular full time teacher of the department/ contributory teacher approved by university/scientist of govt. / private research laboratory appointed by university as contributory teacher and having M. Phil. or Ph.D. degree can supervise the project work of the student.

APPENDIX-3

Rules and Regulations for Credit and Semester System in Post-Graduate Departments of Molecular Biology and Genetic Engineering of the university.

I. General Administration of the Credit & Semester System

1. There shall be a Coordination committee for Credit & Semester system, with Head of the department as its chairperson, consisting of not less than three teachers of the department. The committee will be nominated by Vice Chancellor. This committee will, from time to time take appropriate decisions regarding the functioning of the Credit & semester system. All matters regarding the conduct of Credit & Semester system shall be referred to this Coordination Committee for decision. This committee will forward these recommendations to appropriate authority, in case such approvals are essential.

2. Any issue not covered by this set of Rules and Regulations, but covered by the Rules previously existing, shall be governed by the rules existing before the commencement of these Rules.

3. Any issue arising out of the implementation of the Credit and Semester system which are of a specific nature, which does not need the approval of any authority and Vice Chancellor shall be resolved by the departmental coordination committee.

4. The Coordination committee shall from time to time consider suggestions received from Faculty, Students and the Examination Section and wherever the matter pertains to the overall functioning of the credit and semester system, shall recommend new rules, modifications in the existing rules or clarifications thereof.

II. Admission and Conduct of the Credit System

1. The M.Sc. degree in Molecular Biology and Genetic Engineering will be awarded to students who complete a total of 100 credits (Sciences) in a minimum of two years.

2. Each credit (module) will be equivalent to 15 lectures (i.e., 15 hours).

3. The department can announce seminar courses to introduce students to research done by the faculty. Seminar credits are to be conducted through discussion and presentation by the student and the personal guidance of the teacher. Seminars shall

not exceed a maximum of 2 credits. These credits will be evaluated as internal assessment

4. The Departmental Coordination Committee

a. will nominate the faculty for each course to be taught in the department;

b. will approve the plan for the evaluation prepared by the faculty for the credits concerned as internal continuous assessment of 50 percent from among the12 given in the III below. Ordinarily the teacher may opt for an internal assessment procedure other than written exams;

c. will evolve the norms for evaluating oral examinations whenever necessary in relation to term paper/assignments;

d. will take appropriate decisions in the cases of readmissions of students during transition from Old to Revised syllabus by deciding which credits from the Revised syllabus are equivalent to credits from the Old syllabus;

e. will revise the syllabus at least every five years;

5. There will be no mid-way change over from credit system to non-credit or external examination or vice versa.

III. EXAMINATION RULES

1. Each course will have:

a. 50% of marks as semester-end examination of three hours.

b. 50% marks for internal (i.e. in-semester) assessment.

2. The student has to obtain forty percent marks in the combined examination of in-Semester assessment and semester-End assessment with a minimum passing of thirty percent in both these separately.

3. To pass, a student shall have to get minimum aggregate 40% marks (E and above on grade point scale) in each course.

4. If a student misses an internal assessment examination he/she will have a second chance with the permission of the teacher concerned. Such a second chance shall not be the right of the student; it will be the discretion of the teacher concerned to give or not to give second chance to a student to appear for internal assessment.

5. Students who have failed semester-end exam may reappear for the semester end exam only twice in subsequent period. The student will be finally declared as failed if s\he does not pass in all credits within a total period of four years. After that, such students will have to seek fresh admission as per the admission rules prevailing at that time.

6. A student cannot register for the third semester, if s/he fails to complete all the credits of the total credits expected to be ordinarily completed within two semesters.

7. Internal marks will not change. A student cannot repeat Internal Assessment.

8. There shall be revaluation of the answer scripts of Semester-End theory examination only as per the existing ordinance in force. There shall not be revaluation of internal assessment papers and practical examination.

9. While marks will be given for all examinations, they will be converted into grades. The semester end and final grade sheets and transcripts will have only grades and grade points average.

10. The Project will consist of not more than ten percent of the total credits for the Degree course.

11. Each credit will have an internal (continuous) assessment of 50% of marks and a teacher must select a variety of procedures for examination such as:

i. Written Test and / or Mid Term Test (not more than one for each course);
ii. Term Paper;
iii. Journal/Lecture/Library notes;
iv. Seminar presentation;
v. Short Quizzes;
vi. Assignments;
vii. Extension Work;
viii. Research Project by individual students or group of students; or
ix. An Open Book Test (with the concerned teacher deciding what books are to be allowed for this purpose.)

12. The system of evaluation will be as follows: Each assignment/test will be evaluated in terms of grades. The grades for separate assignments and the final (semester-end) examination will be added together and then converted into a grade and later a grade point average. Results will be declared for each semester and the final examination will give total grades and grade point average.

Marks(Out of 100)	**Grade**	**Grade Point**
100 to 75	O: Outstanding	06
74 to 65	A: Very Good	05
64 to 55	B: Good	04
54 to 50	C: Average	03
49 to 45	D: Satisfactory	02
44 to 40	E: Pass	01
39 to 00	F: Fail	00

13. Final Grade Points

Grade Points	**Final grades**
5.0 to 6.0	**O**
4.50 to 4.99	**A**

3.50 to 4.49	**B**
2.50 to 3.49	**C**
1.50 to 2.49	**D**
0.50 to 1.49	**E**
0.00 to 0.49	**F**

14. Calculation of Average Grade Points & Cumulative Grade Point Average (CGPA):

Grade Point Average = Total Grade Points Earned X Credits hrs for each course
Total Credit Hours

Cumulative Grade Point Average

Illustration

Course Code	Course title	Credits Earned	Marks Secured (max 100)	Grade point	Grade	Result
Semester I						
MBGE-I (T)	Cell Biology(Prokaryotic &Eukaryotic)	4	70	05	A	Pass
MBGE-II (T)	Basic Biochemistry	4	60	04	B	Pass
MBGE-III (T)	Practical Biochemistry and Analytical techniques	4	80	06	O	Pass
MBGE-IV (T)	Molecular Biology I	4	70	05	A	Pass
MBGE-V (T)	Molecular Biology II	4	60	04	B	Pass
MBGE-I (P)	Practical based on course 1,2,3	5	65	05	A	Pass
MBGE-II (P)	Practical based on course 4,5	5	75	06	O	Pass
	Total	30	480	35		
	Average Marks Average Grade Points		68.57	05	A	Pass
Likewise Semester II						
	Average Marks Average Grade Points		53.57	04	B	Pass
Likewise Semester III						
	Average Marks Average Grade Points		65.50	05	A	Pass
Likewise Semester IV						
	Average Marks Average Grade Points		70.21	05	A	Pass

Ave rage Marks **Cumulative Grade Point Ave rage (CGPA)**			64.46	4.75	A	

15. 'B' Grade is equivalent to at least 55% of the marks as per circular No.UGC-1298/[4619]UNI-4 dated December 11, 1999.

16. The formula for GPA will be based on Weighted Average. The final GPA will not be printed unless a student passes courses equivalent to minimum 100 Credits.

17. If the GPA is higher than the indicated upper limit in the three decimal digit, then the student be awarded higher final grade (e.g. a student getting GPA of 4.492 may be awarded 'A').

18. While declaring the result, the existing relevant ordinances are applicable. For verification and revaluation existing rules will be applicable..

19. The in-semester and end-semester examinations will be of 50% marks each. This will ensure that the students work regularly through the semester.

20. The description for each of the grades will be as follows*:*

Grade Proposed Norms

O: Outstanding: Excellent analysis of the topic, (75% and above)
Accurate knowledge of the primary material, wide range of reading, logical development of ideas,
Originality in approaching the subject, Neat and systematic organization of content, elegant and lucid
style;

A: Very Good: Excellent analysis of the topic (65 to 74%)
Accurate knowledge of the primary material, acquaintance with seminal publications, logical
development of ideas, Neat and systematic organization of content, effective and clear expression;

B: Good: Good analysis and treatment of the topic (55 to 64%)
Basic knowledge of the primary material, logical development of ideas, Neat and systematic
organization of content, effective and clear expression;

C: Average: Some important points covered (50 to 54%)
Basic knowledge of the primary material, logical development of ideas, Neat and systematic
organization of content, good language or expression;

D: Satisfactory: Some points discussed (45 to 49%)
Basic knowledge of the primary material, some organization, acceptable language or expression;

E: Pass: Any two of the above (40 to 44%)

F: Fail: None of the above (0 to 39%)

IV Guidelines for students and supervisor for the project work.

Every student is required to carry out project work (this is in lieu of practical paper)on a related topic of course - Molecular Biology and Genetic engineering . It must be an original work and must indicate some degree of experimental work. On the basis of this work, student must submit the project report along with declaration of the candidate, certificate by the supervisor and forwarded through head of the department/principal of the college. The project report should comprise of Introduction, Material and Methods, Results, Discussion, Summary, Conclusions and, References.

The topic for the project work will be assigned to the student by supervisor at the end of third semester. The topic will be forwarded to the controller of examination by the head of the department for appointment of examiner.

Sd/-
(Dr. V. S. Sapkal)
VICE-CHANCELL

NAGPUR:
DATED: 5 /1/2011

Course structure of M.Sc. syllabus to be implemented from 2010-11

Course code No.	Title o the course	Credits allotted
Semester I		**30 Credits**
MBGE I (T)	CELL BIOLOGY (PROKARYOTES AND EUKARYOTES)	4
MBGE II (T)	BASIC BIOCHEMISTRY	4
MBGE III (T)	PRACTICAL BIOCHEMISTRY AND ANALYTICAL TECHNIQUES	4
MBGE IV(T)	MOLECULAR BIOLOGY I	4
MBGE V(T)	MOLECULAR BIOLOGY II	4
MBGE I (P)	PRACTICAL I : BASED ON COURSE : I, II & III	5
MBGE II (P)	PRACTICAL II : BASED ON COURSE : IV & V	5
Semester II		**30 Credits**
MBGE VI (T)	ENZYME TECHNOLOGY	4
MBGE VII (T)	RECOMBINANT DNA TECHNOLOGY I	4
MBGE VIII (T)	RECOMBINANT DNA TECHNOLOGY II	4
MBGE IX (T)	IPR, BIOSAFETY, BIOETHICS AND ENTERPRENEURSHIP	4
MBGE X (T)	IMMUNOLOGY	4
MBGE III (P)	PRACTICAL III – 6 & 10	5
MBGR IV (P)	PRACTICAL IV – 7,8, & 9	5
Semester III		**30 Credits**
MBGE XI (T)	BIOINFORMATICS AND DATA MINING	4
MBGE XII (T)	BIOSTATISTICS, LABORATORY MANAGEMENT & SAFETY	4
MBGE XIII (T)	PLANT GENETIC ENGINEERING	4
MBGE XIV (T)	Animal Genetic Engineering	4
MBGE XV (T)	Industrial Applications of Genetic Engineering	4
MBGE V (P)	Practical V: course XI – XII	5
MBGE VI (P)	Practical VI : course XIII-XV	5
Semester IV		**10 Credits**
Seminar (internal assessment)		2
Project (External assessment)		8

Note: The internal assessmen and Semester end examination will be according to the norms of credit system

M.Sc. Genetic Engineering

Semester I

Course code/name:

MBGE I (T) : CELL BIOLOGY (PROKARYOTES AND EUKARYOTES)
(Total CREDITS 4, 1 CREDIT FOR EACH MODULE)

Module 1:

Ultra-structure of prokaryotic and eukaryotic (plant & animal) cells	**1L**
Plasma membrane, cell wall their structural organization	**3L**
Cellular organelles –: Mitochondria, chloroplast; Nucleus, Golgi apparatus. and other organelles and their organization,	**8L**
Transport of nutrients, ions and macromolecules across membranes	**3L**

Module 2:

Cell cycle- Different phases of cell cycle, Controls and Check points, cyclins and cdks – types and their role. Molecular, events and model systems, Apoptosis	**5L**
Cytoskeleton and Cell motility	**3L**
Cell communication: General principles of signaling – endocrine, exocrine & synaptic signaling, surface and intracellular receptors, G proteins and generation of secondary messenger, mode of action of cAMP and ca^{++} calmodulin, Target cell adaptation, cellular responses to environmental signals in plants and animals - mechanisms of signal transduction	**7L**

Module 3:

General characters of microorganisms: Historical developments in Microbial Biotechnology, The concept of Microbial origin of Fermentation, Microscopy and microscopic observation of Microorganisms, Structure and general characters of Bacteria, Archaea, Fungi and Algae, Classification of Bacteria, Fungi and Algae	**15L**

Module 4:

Viruses and their characters: General characters of viruses, Structure and replication of Bacteriophage (T2), Lambda, Retroviruses, TMV, HIV, SV40, Prions – Kuru, Classification of viruses and important characters of each group, Methods of cultivation of viruses, Importance of viruses in biotechnology.	**15L**

Practicals:

1. Morphological study of mitotic & meiotic chromosomes
2. Cell fractionation
3. Sterilization methods (Autoclaving, Hot air oven, radiation and filtration)
4. Preparation of routine microbiological media
5. Microscopic observation, Staining and identification of bacteria, fungi and algae
6. Culturing & preservation of microorganisms: Tube culture (slant/broth), plate culture, flask culture & preservation
7. Isolation of bacteria, fungi, algae and bacteriophages
8. Measurement of microbial growth (Viable count and turbidometry)
9. Study for bacterial growth curve

Books Recommended:

1. Cell & Molecular Biology . E.D.D De Robertis & E.M.F De Robertis, waverly publication.
2. Molecular Biology of the cell. Alberts, B; Bray, D, Lews, J., Raff, M., Roberts, K and Watson, J.D. 1991 3rd edn. Garland publishers, Oxford
3. Microbiology - M. J. Pelzar, E. S. N. Cfan and N.R. Kreig, McGraw Hill Publ.
4. Introductory Microbiology - J. Heritage, E.G.V. Erans, R.A. Killington, Cambridge Univ. Press.
5. General Microbiology - H.G. Schlegel Cambridge University Press.
6. Microbiology – concepts and Application. John Wiley and Sons, New York, 1988.
7. Microbiology- L. M. Prescott, J. P. Harley, D. A. Klein; McGraw Hills 5thedn. (2005)
8. General Microbiology – R. Y. Stanier, J. L. Ingraham, M. L. Wheelis, Page R Painter;
9. MacMillan Press ltd; 5th edn (1986)
10. Microbiology, Tortora, Funke and Chase, Benzamin & Cummings
11. Manual of microbiology: Tools and Techniques 2nd Edn., Kanika Sharma, Ane Books Ltd.

code/name: MBGE II (T): BASIC BIOCHEMISTRY (Total CREDITS 4, 1 CREDIT FOR EACH MODULE)

Module 1:

Carbohydrates – Structure & classification of simple sugars and polysaccharides **15L**

Carbohydrate Metabolism : Regulation of Embden, Meyerhoff and Parnass EMP) Pathway & its regulation, Krebs cycle and its regulation, Krebs Kornberg Cycle, Pentose Phosphate pathway and its regulation, Glucuronate-Xylulose pathway, Oxidative phosphorylation.

Module 2:

Amino acids and Proteins – classification, chemical reactions and physical properties, criteria of homogeneity, end group analysis, 3 D structure of proteins, hierarchy in structure, Structure of the Peptide bond, Ramachandran plot **15L**

Biosynthesis and degradation of individual amino acids, Urea Cycle.

Module 3:

Lipids–classification, structure and functions **5L**

Lipid Metabolism: Beta Oxidation of Fatty acids, fatty acid biosynthesis **10L**

Biosynthesis of simple fat, phospholipids, cholesterol , sulfolipids and their possible regulation.

Module 4:

Heterocyclic compounds and secondary metabolites in living systems – nucleotides, pigments, isoprenoids **5L**

Hormones: Types (peptide & steroid hormones), chemistry , physiological role, regulation, endocrinopathies **5L**

Vitamins – Types (water and fat soluble), chemistry, sources, RDA, physiological role, deficiency manifestations. **5L**

Practicals:

1. Quantitative determination of proteins by Biuret and Lowry's methods or Ninhydrin test
2. Quantitative Estimation of lipids & / Fatty acids profiling in various plant materials by GC
3. Determination of acid number, iodine value in fats.
4. Study of activity of decarboxylase enzyme
5. Determination of sugars by anthrone method
6. Isolation of plant pigements

Books Recommended:

1. Biochemistry-Stryer, Berg, 6th Edition, W. H. Freeman and Co.,2007.
2. Lehninger' Principles of biochemistry-Nelson, Cox, 4th Edn., W.H.Freeman and Co.,2005.
3. Biochemistry –Voet, D.; Voet, J.; 3rd Edn. John Wiley and sonsInc., 2004.
4. Harper's Principles of Biochemistry-Murray, Gardener, Mayes, Rodwell, 27th Edn.
5. Biochemistry-Rawn, D., Pamina publications, 2004
6. Textbook of biochemistry-West, Todd, Mason, VanBrergen, 4th edn. Oxford & IBH, 1966.
7. Biochemistry- Champe, P., 3rd Edn., Lippincott Willams & Wilkins, 2005.
8. Biochemistry-Zubay, G., 3rd Edn., Pearson Education P.Ltd, 2003
9. Enzymes- Palmer, T. , Affiliated East West Press Pvt. Ltd., 2004
10. Cell and Molecular biology, Gerald Karp, John Wiley and sons Inc.
11. Introductory Practical Biochemistry by Sawhney and Randhir Singh., Narora Pub. House.
12. Biochemical method. 2nd Edition, Sadasivam *et al*. New Age International.
13. Practical Biochemistry 3rd Edition, David Plummer. Tata McGraw Hill.
14. Short Protocals in cell Biology. Borifacino ehale, Jon Wiley Plublishing House.
15. Das, H. K. Text book of Biotechnology, wiley dream tech India pvt ltd. 2005.

Course code/name:

MBGE III (T): PRACTICAL BIOCHEMISTRY AND ANALYTICAL TECHNIQUES

(Total CREDITS 4, 1 CREDIT FOR EACH MODULE)

Module I:

Molecular organization, of proteins -primary, secondary, tertiary and quaternary structure	**5L**
Conformational analysis: Nucleic acids and their organization in living cells interactions of nucleic acids.	**5L**
Methods in biophysical analysis : CD, ORD and fluorescence spectroscopy, Raman spectroscopy.	**5L**

Module II:

Separation of bio-molecules: Various types of Chromatography TLC, HPTLC and Column chromatography (partition chromatography, Adsorption, Chromatography, Ion-exchange chromatography, Gel filtration chromatography, affinity chromatography, reverse phase chromatography, HPLC, chromato focussing.	**9L**
Electrophoresis: Principles, Kohlrausch's regulating function, Agarose, Starch, PAGE including SDS-PAGE, Pulsed Field Gel Electrophoresis, Isoelectrofocussing, Isotachophoresis, gel -documentation	**6L**

Module III:

Centrifugation: Differential centrifugation, Density gradient centrifugation, Ultracentrifugation.	**3L**
Absorption and emission spectroscopy-theory, instrumentation & application of visible, UV, IR, AAS, NMR, ESR and Mass spectroscopy.	**10L**
Characterization of macromolecules using X-ray diffraction analysis.	**2L**

Module IV:

Microscopy, phase contrast, fluorescence, Electron, confocal, scanning tunneling and polarization microscopy; Cell sorter and its applications	**8L**
Radio isotope technique : Radioactive decay constant, half life of an isotope, Detection and measurement of radio activity, Geiger Muller counters, scintillation counting, auto radiography and RIA , Application of isotopes in biological studies.	**7L**

Practicals:

1. Study of Laboratory Instruments :
   Electrophoresis unit, Autoclave, Water bath, Hot air oven, Laminar air flow, Light microscope, Haemocytometer and cell number determination, pH meter, Centrifuge, Spectrophotometer, HPCL / GC , balance, Pipettes
2. Preparation of various Buffers and to check its pH, preparation of solution of given Morality, Normality and its Standardization by titration methods.
3. Separation and Identification of Biomolecules by TLC,/ gel filtration/ iox exchange/affinity chromatography
4. Separation and identification of biochemical compounds by HPLC
5. Separation of biomolecules by centrifugation
6. Study of cell viability by fluorescence microscope
7. Separation of DNA and Proteins by Electrophoresis
8. Quantification of biocompounds by spectrophotometer
9. Gel documentation of DNA, RNA and proteins

RECOMMENDED BOOKS:

1) A textbook of biophysics, R. N. Roy, New Central Publication, 1st edition.
2) Elementary biophysics. P. K. Srivastava Narosa Publication, 1st edition.
3) Biophysical Chemistry. Upadhyay & Nath, Himalaya publications 3rd edition.
4) Biological thermodynamics. Donald T. Haynie, Cambridge University Press, 1st edition.
5) Principles of Physical Biochemistry. Kensl E.van Holde, W. Curtis Johnson, P. Shing Ho, Pearson Prentice Hall, 2nd edition.
6) Biophysical chemistry Part I: The conformation of biological macromolecules. Cantor and Schimmel, W. H. Freeman and Company, 10th edition
7) Biophysical chemistry Part III: The behavior of biological macromolecules. Cantor and Schimmel, W. H. Freeman and Company, 10th edition
8) Biochemistry of nucleic acids. 1992. Adams *et. al*. Chapman and Hall.
9) Crystallography made crystal clear. 1993. G. Rhodes. Academic Press.
10) Principles of physical biochemistry. 1998. Van Holde et. Al. Prentice Hall.
11) Principles and Techniques of Biochemistry and Molecular Biology, 6th Ed. Wilson Keith and Walker John (2005) Cambridge University Press, NewYork.

Course code/name: MBGE IV (T): MOLECULAR BIOLOGY I (Total CREDITS 4, 1 CREDIT FOR EACH MODULE)

Module 1:

Mendel's Laws of inheritance and modifications **15L**
Chromosome theory of inheritance**,** Extra-chromosomal inheritance
Chromosomes and heredity: Genes and gene families (immunoglobulin gene clusters, globin gene family),
Linkage, crossing over and recombinations
Gene: gene concept, unit of function, replication, recombination and mutation – Fine structure of gene: bar locus, complex loci, rII locus and complementation analysis – Gene function: one gene/one enzyme hypothesis, pathways of gene action

Module 2:

Genome organization: Genome organization in prokaryotes and eukaryotes - special features of eukaryotic gene structure and organization, genome organization in mitochondria and chloroplast, **8L**
DNA content and C-value paradox . **2L**
Methods to measure DNA content variation - Various types of DNA sequences (simple sequences, repetitive sequences, nonsense sequences, tandem gene clusters, satellites) **5L**

Module 3:

DNA Damage and repair: Spontaneous and Induced mutations **–** Physical and Chemical mutagenesis, Molecular mechanisms of mutagenesis – Transition, Transversion, Frame Shifts, mis-sense and non-sense mutations, Photo-reactivation, Excision Repair, Mismatch Repair, Post-replication Repair, SOS Repair **5L**
Recombination in bacteria and viruses :Transformation: Competence factors, mechanism of transformation, mapping genes by transformation, Conjugation: Structure of F plasmid, Mechanism of transfer of F plasmid, Hfr, mechanism of integration of F plasmid into bacterial chromosome circularization of chromosome, Conjugation mapping – different methods, Transduction & Gene mapping. **5L**
Genome Rearrangements and Recombination: Complete and Segmental Duplication of Genomes, Insertion, Deletion and Translocation of Sequences, Process of Rearrangements, Homologous Recombination – rec Pathways, Site specific Recombination, Non-homologous End Joining, Transposon and Repeats mediated Rearrangements, Molecular mechanisms of Gene Conversion. **5L**

Module 4:

Genetics of Drosophila, Yeast, and Human: **5L**
Drosophila molecular genetics: genome - developmental genetics – mutants and genetic screens – P element biology – directed expression in drosophila – construction and use of genetic mosaics.

Yeast molecular genetics: genome - mutants and genetic screens – genetic redundancy – cell type determination – cell cycle regulation of mitotic events – genetic interaction: two hybrid systems – gal pathway, gene regulation **5L**

Human Genetics: inborn errors of metabolism, x and Y-linked genes, Viral and cellular oncogenes, tumor suppressor genes from humans, structure, function and mechanism of action of pRB and p53 tumor suppressor proteins Biosynthesis of glycogen in animals and its regulation. **5L**

Practicals :

1. Isolation, and study of polytene chromosome in *Drosophila*
2. Study of structure chromosomal rearrangements
3. Effect of mutagenes on physiology and genetic material of suitable organism
4. Bacterial conjugation
5. Bacterial transduction
6. Bacterial transposons

Recommended books:

1. Molecular Cell Biology, 3rd edn. (1995) W.H.H. Lodish, A. Berk, and C. A. Kaiser, Freeman & Co Ltd.
2. Molecular Biology of the Gene, 5th edn. (2004) J. D. Watson, T. A. Baker, S. P. Bell, A. Gann, M. Levine, R. Losick, Pearson Education Inc.
3. Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K. and Watson, J.D. 1999. Molecular Biology of Cell, Garland Publishing, Inc., New York
4. Buchanan, B. B., Gruissem, W. and Jones, R. L. 2000 Biochemistry and Molecular Biology of Plants. American Soc. Of Plant Physiologists, Maryland, USA
5. Karp, G. 1999 Cells and Molecular Biology; Concepts and Experiments. John Wiley & Sons, Inc., USA.
6. Kleinsmith, L. J. and Kish, V. M. 1995 Principles of Cell and Molecular Biology (2nd Edn.) Harper Collins Coll. Publisher, New York, USA.
7. Malacinski, G. M. and Freifelder, D. 1998 Essentials of Molecular Biology (3rd Edi.) Jones and Bartiet Pub. Inc., London
8. Wolf, S. L. 1993. Molecular and Cellular Biology, Wadsworth Publishing Co., California, USA

Course code/name: MBGE V (T) : MOLECULAR BIOLOGY II (Total CREDITS 4, 1 CREDIT FOR EACH MODULE)

Module 1:

Biosynthesis of purines and pyramidine nucleotides from ribose including regulation, salvage pathways **3L**

Structure, types and function of nucleic acids (DNA & RNA) **6L**

DNA Replication: Prokaryotic and eukaryotic DNA replication, Mechanism of DNA replication, enzymes and accessory proteins involved in DNA replication. **6L**

Module 2:

Protein Synthesis: Prokaryotic transcription, eukaryotic transcription, RNA polymerases, General and specific transcription factors, Regulatory elements and mechanisms of transcription regulation, 5' Cap formation, Transcription termination, 3'end processing and polyadenylation, nuclear export of mRNA, mRNA stability **8L**

RNA splicing: Nuclear splicing, spliceosome and small nuclear RNAs, group and group II introns, *Cis*- and *Trans*- splicing reactions, tRNA splicing, alternate splicing. **2L**

Genetic Code , Prokaryotic and eukaryotic translation; Synthesis of aminoacyl tRNA, aminoacyl synthetases, Mechanism of initiation, elongation and termination, Regulation of translation, co-and post-translational modifications of proteins, mobility shift assay, Dipeptide assay, Tripeptide assay, *In vitro* translation. **5L**

Module 3

Regulation of gene expression: Induction and repression, operon theory, lac operon, trp operon, ara operon, attenuation, positive and negative control, catabolite repression, regulation of transcription by cAMP and CRP, and guanosine tetraphosphate, *Run off* transcription. Britten-Davidson and Mated models of gene regulation, regulation of gene expression in eukaryotes. **15L**

Module 4:

RNA interference: Molecular mechanism of antisense molecules, inhibition of splicing, polyadenylation and translation, disruption of RNA structure and capping, Biochemistry of ribozyme; hammer – head, hairpin and other ribozymes, strategies for designing ribozymes, applications of antisense and ribozyme technologies. **8L**

Protein Localization: synthesis of secretory and membrane proteins, Import into nucleus, mitochondria, chloroplast and peroxisomes, Receptor mediated endocytosis, Protein targeting and protein localization signals, role of golgi **7L**

Practicals:

1. Study of expression of inducible genes
2. Regulation of gene expression
3. Isolation of total cellular RNA from suitable organisms (yeast, plant, animal cells)
4. Isolation of total m RNA from suitable organisms

Recommended books:

1. Molecular Biology of the Gene - J. D. Watson, N. H. Hopkins, J. W, Robertis , A. Steitz & A.M. Weiner, Benjamin cummings Publ. California - 1988
2. Genes VII. - Benjamin Lewin, Oxford Univ. Press, Oxford (2000)
3. Molecular Biology – Freifelder, D, Narosa Publishing house New York, Delhi, 1987.
4. Molecular Cell Biology - Lodish, H., Baltimore, D; fesk, A., Zipursky S.L., Matsudaride, P. and Darnel 4th edn. American Scientific Books. W.H. Freeman, New York (2000).
5. Advance Molecular Biology Twyman, R.M., Bios Scientific publishers Oxford 1998.
6. Molecular Biology - Brown, 3rd edition.
7. Essentials of Molecular Biology. D. Freifelder, Panima publishing corporation.

Practicals (10 Credits):

MBGE I (P) : Practical I: (5 credits) Based on Course : I, II & III

MBGE II (P): Practical II: (5 credits) Based on Course : IV & V

SEMESTER II

Course code/name: MBGE VI (T) : Enzyme technology

(Total CREDITS 4, 1 CREDIT FOR EACH MODULE)

Module 1:

Discovery, classifications and nomenclature of enzymes, Techniques of enzyme isolation and enzyme assay, Intracellular localization of enzymes, Techniques used in the purification of enzymes, Criteria of enzyme homogeneity Techniques used for determination of native and sub-unit molecular weight of enzymes , Isoenzymes, Multienzyme complexes and multifunctional enzymes **15L**

Module 2:

Physico-chemical characterization of enzymes, Enzyme kinetics : Enzyme catalysis in solution -kinetics and thermodynamic analysis, effects of organic solvents on enzyme catalysis and structural consequences. Kinetics of enzyme inhibition, Allosterism including half of the site activity phenomena Enzyme memory and pnemonical enzymes **15L**

Module 3:

Structure and activity of the enzymes, Mechanism of action of chymotrypsin, glyceraldehyde 3 Phosphate dehydrogenase, lysoenzyme, carboxy peptidase, ribonuclease, aldolase etc. **15L**

Module 4:

Various techniques used for the immobilization of enzymes, Applications of immobilized enzyme in Biotechnology, Riboenzyme and catalytic antibodies-Functional proteins-structure and drug targets (enzymes and receptors). **15L**

Practicals:

1. Study of activity of various enzymes ( )
2. To Study the factors influencing the kinetics of enzymes (Enzyme and substrate concentration), pH and temperature.
3. Study of Isocitrate dehydrogenase in yeast
4. Determination of molecular weight and purity of enzyme
5. Separation of isoenzymes by native PAGE.
6. Electrophoresis of proteins
7. Isolation of total proteins and precipitation by Ammonium sulphate.
8. Methods for immobilization of enzymes

Recommended Books:

1. Balasubramanian, D., Bryce, C., Dharmalingam, K., Green, J. and Jayaraman, K. (1999) Concepts in Biotechnology, University Press, India.
2. Colin Ratledge and Bjorn Kristiansen (2001) Basic Biotechnology, Cambridge University Press, UK.
3. Joshi, V. K., Ashok Pandey. (1999) Biotechnology, Food fermentation (Microbiology, Biochemistry and Technology) Vol. I & II Basic, Educational Publishers and Distributors, Ernakulam.
4. Whitaker Stanbury (1998) The principles of fermentation technology, Butterworth Heineman, U.K.
5. Vedpal, S. Malik, Padma Sridhar, Sharma, M. C. and Polasa, H. (1992) Industrial Biotechnology, Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi.

Course code/name: MBGE VII (T): RECOMBINANT DNA TECHNOLOGY I

(Total CREDITS 4, 1 CREDIT FOR EACH MODULE)

Module 1 :

Scope of Recombinant DNA Technology, Milestones in Genetic Engineering **15L**
Isolation, purification, and quantification of DNA and RNA
Preparation of total cellular DNA from animal & plant, preparation of plasmid DNA, bacteriophage DNA, separation and quantization of DNA by Gel electrophoresis.
Total cellular RNA, cytoplasmic and nuclear RNA, poly (A+) RNA, detection & quantitation and gel electrophoresis.
Methods of gene transfer techniques in plants and animals (*Agrobacterium* mediated, electrophoration and particle gun, liposome, PEG).

Module 2:

Cutting, joining and modifying and amplifying DNA , Restriction endonucleases, **15L**
Ligases, Alkaline phosphatase, polymerases. Double digest modification of restriction fragment ends. Other ways of joining DNA.
Amplification of DNA-PCR and cell based DNA cloning, importance of cloning, PCR : Basic features, optimization of PCR parameters, variations in PCR and applications, principles of cell based DNA cloning, cloning system for producing single stranded and mutagenized DNA.

Module 3:

Gene Cloning Vectors Plasmids, bacteriophages, phagemids, cosmids, Artificial **4L**
chromosomes.
Alternative Strategies of Gene Cloning, Cloning interacting genes-Two-and **5L**
three hybrid systems, cloning differentially expressed genes, Nucleic acid microarray arrays.
cDNA Synthesis and Cloning mRNA enrichment, reverse transcription, DNA **6L**
primers, Linkers, adaptors and their chemical synthesis, Library construction and screening, construction and screening of genomic libraries.

Module 4:

Nucleic acid hybridization: Principles and applications, preparation of **15L**
probes, principles of nucleic acid hybridization, nucleic acid hybridization assays and microassays.
Tools for analyzing gene expression: Reporter genes , Analysis of gene regulation, purification & detection tags, analysis at the level of gene transncription – Northern blot, in situ hybridisation, RNAse protection assay, RT-PCR analysis at the level of translation – Western blot, in situ analysis, ELISA, protein gel electrophoresis, antibody production.

Practicals:

1. Isolation of DNA from suitable microorganism/ higher organism
2. DNA amplification by PCR
3. Restriction digestion of genomic or lambda DNA and size determination of the fragments
4. Determination of insert size by R.E analysis
5. Preparation of competent cells, transformation of *E.coli* and screening of transformants
6. (Blue / white screening)
7. Analysis of recombinant clone
8. Ligation of vector and insect DNA, and checking of LM
9. Western Blotting

Recommended Books:

1) RNA methodologies-A laboratory guide for isolation & characterization, 3rd Edn., Farell, R. Elsevier 2005
2) Molecular Cell Biology-Lodish , Berk, 5th Edn. Freeman 2003
3) Molecular Biology of the Cell, 5th edn, Alberts 2008, Grandland science
4) Cells-Levin, 1st Ed. Jones & Bartlett Publisher 2006
5) The cell – A molecular Approach 4th Edu. Geoffrey M. Cooper, Rober E. Hausman
6) Genes IX - Lewin B. 2004, Prentice Hall
7) Biochemistry – Voet D. Voet J. G. 3rd Edn., Johnwiley & Sons inc. 2004
8) Cell & Molecular & William & Wilkins 2006
9) DNA repair mutagenesis: Friedberg E. C. ASM press 1995.
10) Enzymology primer for Recombinant DNA technology Eun HM, Elservier, 1996.
11) Glick, B.R. and Pasternak, J.J. (1994) Molecular Biotechnology, ASM Press.
12) John G. Webster. (2004) Bioinstrumentation. Univ. of Wisconsin, John Wiley & Sons, Inc.
13) Sambrrok, J. and Ruseell, D.W. (2001) Molecular Cloning – A Laboratory Manual (3rd edn., Vol. 1,2,3) Cold Spring Laboratory Press, New York.
14) Savile Pradbury (1991) Basic measurement techniques for light microscopy, Oxford Univ. Press, Royal Microscopical Society.
15) Surzeki, S. (2000). Basic Techniques in Molecular Biology, Springer.
16) Westermeier, R (1993) Electroporesis in practice – VCH – Federal Republic of Germany.
17) Willett, J.E. (1991) Gas Chromatography, John Wiley & Sons.
18) Wilson, K. and Walker (1995) Practical Biochemistry Principles and Techniques, Cambridge Univ. Press.

Course code/name:

MBGE VIII (T): RECOMBINANT DNA TECHNOLOGY II

(Total CREDITS 4, 1 CREDIT FOR EACH MODULE)

Module 1:

DNA synthesis, sequencing, mutation; detection, separation, cloning, gene expression. **7L**

Molecular Tools and Their Applications Restriction enzymes, modification enzymes, DNA, and RNA markers, Restriction Mapping of DNA Fragments and Map Construction. Nucleic Acid Sequencing **8L**

Module 2:

Molecular Mapping of genome: Genetic and physical maps, physical mapping and map-based cloning, choice of mapping population, simple sequence repeat loci, Southern and fluorescence in situ hybridization for genome analysis, chromosome micro-dissection and micro-cloning, molecular markers in genome analysis, RFLP, RAPD and AFLP analysis, molecular markers PCR based , molecular markers linked to disease resistance genes. **15L**

Module 3:

Site-directed Mutagenesis and Protein Engineering **2L**

How to Study Gene Regulation? DNA transfection, Northern blot, Primer extension, S1 mapping, RNase protection assay, Reporter assays. **3L**

Expression Strategies for Heterologous Genes Vector engineering and codon optimization, host engineering, *In vitro* transcription and translation, expression in bacteria, expression in Yeast, expression in insects and insect cells, expression in mammalian cells, expression in plants. **7L**

Processing of Recombinant Proteins Purification and refolding, characterization of recombinant proteins, stabilization of proteins. **3L**

Module 4:

Phage Display , T-DNA and Transposon Tagging: Role of gene tagging in gene analysis, T-DNA and transposon tagging, Identification and isolation of genes through T-DNA or transposon. **5L**

Transgenic and Gene Knockout Technologies, Targeted gene replacement, Chromosome engineering. **5L**

Gene Therapy: Vector engineering. Strategies of gene delivery, gene replacement/augmentation, gene correction, gene editing, gene regulation and silencing. **5L**

Practicals:

1. Isolation of DNA and its quantification (plant, animal, bacterial)
2. Isolation, purification, quantification and separation of plasmid DNA
3. RAPD, RFLP analysis from microbe genome.
4. DNA sequencing
5. Gel electrophoresis of DNA
6. Extraction of DNA from Gel
7. Detection of transposon through bacterial conjugation

Recommended Books:

1. Molecular Biology of the gene - J. Watson
2. Genes VI, VII and VIII - Benjamin Lewin
3. Molecular Biotechnology Principles and application of recombinant DNA
4. Molecular Biology - Robert F. Weaver
5. Recombinant DNA: A short course - J. Watson, Tooze and Kurtz
6. Molecular Biology - J. Watson
7. Plant Molecular Biology: A practical approach. - C.H. Shaw (2006), Panima Pub. Corp.
8. Methods in plants Molecular biology - Schuler, Raymond. E Zielinski (2005), Acad. Press.
9. Current protocols in molecular biology - Ausbel *et. al.,* 2000.
10. Molecular cloning Vol. 1-3. Sambrook and Russel. 2001. CSH press.
11. Principles of gene manipulation. 1994. Old and Primrose, Blackwell Scientific Publ.
12. Genome analysis. Four volumes. 2000. CSH Press.
13. Principles and techniques of biochemistry and molecular biology, 6th Ed. Wilson Keith and Walker John (2005) Cambridge University Press, New York.
14. DNA Cloning : A practical approach D.M. Glover and D.B. Hames, R.L. Press, Oxford, 1995
15. Methods in Enzymology Guide to Molecular Cloning Techniques, Vol. 152 S.L. Berger and A. R. Kimmel, Academic Press Inc, San Diego, 1996
16. Methods in Enzymology Gene Expression Technology, Vol. 185D. V. Goedel, Academic Press Inc, San Diego, 1990
17. DNA Science: A First Course in Recombinant Technology, D. A. Mickloss and G. A Freyer, Cold Spring Harbor Laboratory Press, New York, 1990
18. Molecular Biotechnology, 2nd Ed. S. B. Primrose, Blackwell Scientific publishers, Oxford, 1994
19. Milestones in Biotechnology, Classic Papers on Genetic Engineering, J. A. Davis and W. S. Reznikoff, Butterworth-Heinemann Boston 1992
20. Route Maps in Gene Technology, M. R. Walker, and R. Rapley, Blakwell Science, Oxford, 1997
21. Genetic Engineering : An Introduction to Gene Analysis and Exploitation in Eukaryotes, S. M. Kingsman, Blackwell Scientific Publications, Oxford, 1998

Course code/name:

MBGE IX (T) : IPR, BIOSAFETY, BIOETHICS AND ENTERPRENEURSHIP

(Total CREDITS 4, 1 CREDIT FOR EACH MODULE)

Module 1:

Intellectual property rights (IPR), sovereignty rights, CBD, bioethics and patenting **15L**
General agreement on trade and tariffs Indian sui-generis system for animal variety and farmer's rights protection act, PVFRA , WTO with reference to biotechnological affairs, TRIPs.
General Introduction: Patent claims, the legal decision – making process, ownership of tangible and intellectual property, Patent litigation.
Basic Requirements of Patentability: Patentable subject matter, novelty and the public domain, non obviousness .
Special issues in Biotechnology Patents: Disclosure requirements, Collaborative research, Competitive research.
Plant biotechnology Indian patents and Foreign patents, Plant variety protection act, The strategy of protecting plants.
Recent Developments in Patent System and Patentability of biotechnological inventions.
IPR issues in Indian Context Role of patent in pharmaceutical industry, computer related innovations. Case studies Rice, Turmeric, Margo, etc. and challenges ahead.

Module 2:

Entrepreneurship **15L**
Concept, definition, structure and theories of entrepreneurship
Types of start-ups
Types of entrepreneurship, environment, process of entrepreneurial development,
Entrepreneurial culture, entrepreneurial leadership,
Product planning and development
Project management
Search for business idea
Concept of projects
Project identification, formulation
Design and network analysis
Project report and project appraisal

Module 3:

Ethical Issues: Introduction – causes of unethical acts, ignorance of laws, **15L**
codes, policies and Procedures, recognition, friendship, personal gains
Professional ethics – professional conduct
Ethical decision making, ethical dilemmas
Teaching ethical vaues to scientists, good laboratory practices, good manufacturing practices, laboratory acModuleation
Bioethics & Society (Indian context): Ethical issues on New Genetics – Human Genome Project – Gene therapy – Genetic screening – Experimentation with human subjects -National Practice of health care – Public & Private medical practice – National resource allocations.

Module4:

Biosafety in the laboratory institution: Laboratory associated infections and other hazards, assessment of biological hazards and levels of biosafety, prudent biosafety practices in the laboratory/ institution **15L**

Biosafety regulations in the handling of recombinant DNA processes and products in institutions and industries, biosafety assessment procedures in India and abroad

Biotechnology and food safety: The GM-food debate and biosafety assessment procedures for biotech foods & related products, including transgenic food crops, case studies of relevance.

Ecological safety assessment of recombinant organisms and transgenic crops, case studies of relevance (Eg. Bt cotton).

Biosafety assessment of biotech pharmaceutical products such as drugs/vaccines etc.

International dimensions in biosafety: Catagena protocol on biosafety, bioterrorism and convention on biological weapons

Practicals:

Report submission on Biosafety assessments, transgenic crop , Bioethics & Society, Preparation of patent application, Seeking permission to work on GM crops, IGMORIS, application for strip trails, application for BRL I and II (case studies),

Recommended Books :

Intellectual Property Rights - Brigitte Anderson, Edward Elgar Publishing

Intellectual Property Rights and the Life Sciences Industries - Graham Dutfield, Ashgate Pub.

WIPO Intellectual Property Handbook

Intellectual Property Rights - William Rodelph Cornish, David Clewelyn

Entrepreneurship: New Venture Creation - David H. Holt

Biotechnology-The science and the business Mosses V, Cape RE,2nd edn., CRC press 2000.

Patterns of Entrepreneurship - Jack M. Kaplan

Entrepreneurship and Small Business Management: C. B. Gupta, S. S. Khanka, Sultan Chand

Indian Patents Law, Mittal, D.P. (1999) Taxmann, Allied Services (p) Ltd.

Handbook of Indian Patent Law and Practice - Subbaram , N. R. , S. Viswanathan (Printers and Publishers) Pvt. Ltd., 1998.

Websites:1) Intellectual Property Today : Volume 8, No. 5, May 2001, www.iptoday.com

2) Using the Internet for non-patent prior art searches, Derwent IP Matters, July 2000. www.ipmatters.net/features/000707_gibbs.html

Course code/name:

MBGE X (T): Immunology

(Total CREDITS 4, 1 CREDIT FOR EACH MODULE)

Module 1:

Introduction, Phylogeny of Immune System , Innate and acquired immunity, Clonal nature of immune response, Organization and structure of lymphoid organs, Nature and Biology of antigens and super antigens, Antibody structure and function, Antigen-antibody interactions. **15L**

Module 2:

Major histo-compatibility complex, BCR & TCR, generation of diversity, Complement system, Cells of the immune system: Hematopoietic and differentiation, Lymphocyte trafficking, B-lymphocytes, T-lymphocytes, Macrophages, Dendritic cells, Natural killer and Lymphokine activated killer cells, Eosinophils, Neutrophils and Mast-Cells. **15L**

Module 3:

Regulation of immune response, Antigen processing and presentation, generation of humoral and cell mediated immune responses -Activation of B- and T-lymphocytes -Cytokines and their role in immune regulation -T-cell regulation, MHC restriction -Immunological tolerance. **15L**

Module 4:

Cell -mediated cytotoxicity: Mechanism of T cell and NK cell mediated lysis, Antibody dependent cell mediated cytotoxicity, macrophage mediated cytotoxicity, Hypersensitivity, Autoimmunity, Transplantation, Immunity to infectious agents (intracellular parasites, helminthes & Viruses), Tumor Immunology, AIDS and other Immunodeficiences, Hybridoma Technology and Monoclonal antibodies. **15L**

Practicals:

1. Micro-hemagglutination Test
2. Sandwitch Enzyme-Linked Immuno-sorbent Assay (ELISA) to test antigen concentration
3. Cell-viability Test by Trypan Blue
4. Collection of human blood, separation of mononuclear cells and counting of viable cells.
5. Identification of Ag – Ab complex by Gel diffusion assay (gel precipitation, Ouchterlony technique) -
6. Immunoprecipitation test,
7. Slide agglutination test (Blood grouping),
8. Latex agglutation test for detection of antigen and antibody
9. Separation of Serum proteins by electrophoresis.
10. Study of Immuno-diffusion electrophoresis.
11. Immuno electrophoresis of complex antigen mixture
12. Study of Immuno-histochemistry test for localizing antigen

Recommended Books:

1. Immunology – R. A. Goldsby, T. J. Kindt, B. A. Osborne, Janis Kuby; W.H. Freeman & Company, 5th edn. (2003)
2. Essential Immunology - Ivan M. Roitt, Peter J. Delves Blackwell Science Ltd., 10th Edn. (2001)
3. An Introduction to Immunology - C.V. Rao; Narosa Publishing House,1st Edi.(2004)
4. Instant Notes in Immunology - P.M. Lydyard, A. Whelan, M.W. Fanger BIOS Scientific Publ. Ltd, 1st Edn. (2003)
5. Immunology: Introductory textbook; Nandini Shetty, New Age International pvt. Ltd. 1st Edn. (2003).
6. A Handbook of Practical and clinical Immunology - Short protocols in Immunology Vol 1. Talwar and S. K. Gupte, 2nd Edn. (2003) , Coliganetal John Wiley.
7. Immunology II Edn., Kuby, J. W. H., Freeman and Company, New York.
8. Immunology - Klaus D. Elgert , Wiley-Liss. NY.
9. Text Book on Principles of Bacteriology, Virology and Immunology, IX Edn. (5 volumes)
10. Topley and Wilson's, Edward Arnold, London.
11. The Experimental Foundations of Modern Immunology - Clark, V.R., John Willey and Sons, Incl.
12. Fundamental Immunology – W. E. Paul, Raven Press, New York.
13. Fundamentals of Immunology - R. M. Coleman, M. F. Lombord and R. E. Sicard 2nd edn.
14. C. Brown publishers.
15. Immunology - D. M. Weir and J. Steward 7th Edn.

Practicals (10 credits)

MBGE III (P) Practical III – 6 & 10 (5 credits)

MBGR IV (P) Practical IV – 7,8, & 9 (5 Credits)

SEMESTER III

Course code/name:

MBGE XI (T) : BIOINFORMATICS AND DATA MINING

(Total CREDITS 4, 1 CREDIT FOR EACH MODULE)

Module 1: **15L**

Foundations to bioinformatics – Evolution, similar macromolecular components, constancy of gene number and core proteome in closely related organisms
Bioinformatics data – nucleic acid sequence, protein sequence, protein structure, genomic, proteomic and metabolomic information
Bioinformatics databases – types (Nucleic acid sequence databases: GenBank, EMBL, DDBJ; Protein sequence databases: SWISS-PROT, TrEMBL, PIR_PSD ; Genome Databases (NCBI, EBI, TIGR, SANGER), design, file formats (genbank, fasta, gcg, msf, nbrfpir etc.), access tools with examples
Bioinformatics tools and Resources – free online tools, downloadable free tools, software packages, internet, Bioinformatics books and Journals, Bioinformatics web- portals

Module 2:

Comparison methods in bioinformatics **15L**
Dot-matrix comparison (Scoring matrices: basic concept of a scoring matrix, Matrices for nucleic acid and proteins sequences, PAM and BLOSUM series)
Basics of sequence alignment - match, mismatch, gaps, scoring alignments, gap penalty, protein vs DNA alignment
Pairwise alignment algorithms – Needleman and Wunch algorithm, Smith Watermann algorithm Multiple sequence alignment algorithms – progressive alignment algorithms, Iterative alignment algorithms Pair wise alignment based heuristic algorithms - Blast algorithm, FASTA algorithm.
Multiple sequence alignment based databases searching: Consensus sequence, patterns, profiles, PAM and BLOSUM matrices, Basic concepts of sequence, similarity, identity and homology, definitions of homologues, orthologues, paralogues.

Module 3:

Genomic and Proteomic Application of Bioinformatics **15L**
Bioinformatics for genome sequencing
EST Clustering and analyses
Finding genes in prokaryotic and eukaryotic genomes: open reading frames, contents, signals
Regulatory sequence analysis: core and distal promoter sequences, transcription factor binding sites

Bioinformatics for Genome maps and markers
Bioinformatics for understanding Genome variation
Protein structure prediction and classification
Bioinformatics in support of Proteomic research .

Module IV: **15L**

Applications of Bioinformatics
Medical application of Bioinformatics – disease genes, drug targets, pharmacogenomics, drug designing
Structural biology - Homology modeling
Bioinformatics for micro array designing and transcriptional profiling
Bioinformatics for metabolic reconstruction
Bioinformatics for Taxonomy and phylogenetic analysis (Basic concepts in systematics, taxonomy and phylogeny; molecular evolution; nature of data used in Taxonomy and Phylogeny, Definition and description of phylogenetic trees and various types of trees, Prediction of protein structure)

Practicals:

1. Training on usage of various bioinformatics tools (online), software packages, web portals
2. Online searching of various databases (nucleic acids, proteins, organisms) using diff. Bioinformatics tools (FASTA, BLAST)
3. To find the sequences of a given protein in SWISS-Prot, Uni-Prot
4. To search biochemical pathway involved for a given trait.
5. To work out the sequence from given autoradiogram and to identify it from Gene Bank by BLAST method.
6. To generate Pair-wise and multiple sequence alignment of a given organisms
7. To generate phylogenetic tree using given sequences.
8. Identify protein, its location on chromosome and generate various models (Ribbon etc.) from the given amino acid sequences.
9. To predict a protein from given sequence by using online tools from NCBI.
10. To design PCR primers for isolation of given gene and to clone it in the given vector.
11. To generate the map of given plasmid and find the Reporter gene.
12. To predict N-Glycosylation site in the given protein sequence.
13. Translate the given gene sequence.
14. To find out ORF in the given gene sequence.
15. To find out the promoter in the given sequence.
16. Compositional analysis of DNA – GC/AT content - codon usage - codon bias
17. Understanding ORF and gene prediction
18. Protein structure visualization
19. Secondary structure prediction online
20. Understanding the bioinformatics behind human, rice, yeast and E.coli genome projects

Recommended Books:

1. Mount W. 2004 Bioinformatics and sequence genome analysis 2nd Edi. CBS Pub. New Delhi
2. Alberts, Bruce; Johnson, Alexander; Lewis, Julian; Raff, Martin; Roberts, Keith; Walter,
3. Peter c2002 Molecular Biology of the Cell New York and London: Garland Science.
4. McEntyre, J.; Ostell, J., editors Bethesda (MD) The NCBI Handbook: National Library of Medicine (US), NCBI; 2002-2005
5. Bergman, N.H Comparative Genomics Humana Press Inc., Part of Springer Science+Business Media; 2007
6. Baxevanis, A. D. and Ouellate, B. F. F. 2009 Bioinformatics: A Practical Guide to the analysis of genes and proteins. John-Wiley and Sons Publications, New York.
7. Baxevanis, A. D., Davison, D. B.; Page, R. D. M.; Petsko, G. A.; Stein, L. D. and Stormo, G. D. 2008 Current Protocols in Bioinformatics
8. Brown T. A., Genomes, 3rd Edition. Garland Science 2006
9. Campbell A. M. & Heyer, L. J., Discovering Genomics, Proteomics and Bioinformatics, 2nd Edition. Benjamin Cummings 2007.
10. Primrose, S. & Twyman, R., Principles of Gene Manipulation and Genomics, 7th Edition, Blackwell, 2006.
11. Cynthia Gibas & Per Jambeck (2001) Developing Bioinformatics Computer Skills: -Shroff Publishers & Distributors Pvt. Ltd (O'Reilly), Mumbai
12. Des Higgins & Willie Taylor (2000) Bioinformatics: Sequence, structure and databanks. Oxford University Press
13. H. H. Rashidi & L. K. Buehler (2002) Bioinformatics Basics: Applications in Biological Science and Medicine, CRC Press, London
14. Misener, S. and Krawetz, S.A. (2000). Bioinformatics Methods and Protocols.Human Press, Totowa, New Jersey.
15. Biological Sequence Analysis : Probabilistic Models of Proteins and Nucleic Acids by Richard Durbin, Sean R. Eddy, Anders Krogh, Graeme Mitchison, Cambridge University Press.
16. Bioinformatics tools and Resources – free online tools, downloadable free tools, software packages, internet, Bioinformatics books and Journals, Bioinformatics web-portals

www.wormbook.org
www.ceolas.org/VL/mo/
www.nih.gov/science/models/arabidopsis/index.html

Course code/name:

MBGE XII (T) : BIOSTATISTICS, LABORATORY MANAGEMENT & SAFETY

(Total CREDITS 4, 1 CREDIT FOR EACH MODULE)

Module 1:

Sampling - Sampling procedure, homogenization of samples, samples size, Selection of random sample, Limitation of analytical methods, classification of errors, measurement of averages and variation, minimization of errors. **15L**

Types of data, Frequency distribution, Measure of central values - Mean, median and mode, Measures of dispersion - range , mean deviation , standard deviation, coefficient of variation, moment, Skewness and kurtosis,

Graphical representation of Data, Histogram, Frequency polygon, Pie Chart

Probability ,Concept of Probability Theory, Events ,Trials , Mutually exclusive events, favorable events, exhaustive events, Bayesian theorem of Probability, Addition theorem, Multiplication theorem

Binomial distribution, Normal distribution, Poisson distribution & their applications.

Discriminating power, Derivation, Evaluation of evidence by discriminating powers.

Combination of independent systems, Correlated attributes, transfer of evidence, Likelihood ratio

Module 2:

Statistical Inference of Qualitative & Quantitative Variables **15L**

Concept of Test of hypothesis, Null & Alternative hypothesis, level of significance

Chi square test & its applications,

Large Sample Tests- Z-test of Means & Proportions

Small sample test - T-test for Means, Paired T-test,

Analysis of variance and Co-variance

One-Way ANOVA, Two way ANOVA, F-test

Simple regression and correlation

Test of regression coefficient and correlation Coefficient

Module 3:

Standards for analysis & Quality management **15L**

Basic standards, Need of standards in analytical sciences

Analytical standards- Reference materials/controls (positive & negative), High purity substances, certified reference material

Working or secondary standards, matrix effect in standards

Biological standards , Biochemical standards , Microbial cell lines and standards

Quality Management - Quality system, Inspection and testing, Handling, Storage, Packaging, Preservation of the material, Internal quality audits, Quality assurance.

Laboratory AcModuleation, AcModuleation Boards, NABL guidelines for AcModuleation in India

Proficiency testing system, Internal quality control, Inter and intra laboratory testing programmes , Advantages of AcModuleation.

Module 4:

Laboratory Management & Safety : **15L**

Administration of Laboratories, Laboratory design, Security measures, Laboratory Information management system (LIMS)
Laboratory safety – Safety policies
Operation Hazardous compound - chemicals, solvents, poisons, isotopes, explosives and Biological strains (Bacterial, fungal etc)
Storage of hazardous material and disposal of biological and radioisotope wastes

Practicals:
Mean, median and mode,
Measures of dispersion - range , mean deviation ,
standard error & deviation,
coefficient of variation,
Frequency Analysis
Chisqure & t test
Anova one way and two way test
f-test
Simple regression and correlation
Graphical representation of Data,
Histogram preparation,
Frequency polygon,
Pie Chart
Probability tests

Recommended Books:

1. Daniel, W.W. (2004), Biostatistics. 8th Edn. Wiley
2. Arora, P. N. & Malhon, P. K., (1996) Biostatistics. Himalaya Publishing House, Mumbai.
3. Sokal & Rohif, (1973) Introduction to Biostatistics - Toppan Co. Japan.
4. Stanton, A. & Clantz, Primer of Biostatistics — The McGraw Hill Inc., New York.
5. Bliss, C. I. K. (1967) Statistics in Biology. Vol. 1 Mc Graw Hill, New York.
6. Campbell, R. C. (1974) Statistics for Biologists. Cambridge University Press, Cambridge.
7. Wardlaw, A. C. (1985) Practical Statistics for Experimental Biologists. John Wiley and Sons., Inc., New York.
8. Cochran, W. G. Sampling Techniques, Wiley estern Ltd, New Delhi.
9. Fellller, W. Introduction to probability theory and its applications, Asia Publ. House, Mumbai.
10. Glover, T. and Mitchell, K. 2002, An introduction to Biostatistics. McGraw-Hill , N.Y.
11. Goon, Gupta and Dasgupta, Fundamentals of statistics. World Press, Kolkota.
12. Irfan Ali Khan and Atiya Khanum, Fundamentals of Biostatistics. 2nd Ed. Ukaaz Publ., Hyderabad.
13. Montgomery, D. C., Design and analysis of experiments. John Wiley and Sons.
14. Murthy, M. N., Sampling methods. Indian Statistical Institute, Kolkota.
15. Wayne Daniel 2007 Biostatistics, a foundation for analysis in the health Sciences, Edn.7, Wiley-Indian Edn.
16. Panse & Sukhatme Agricultural Biostatistics

Course code/name:

MBGE XIII (T) : PLANT GENETIC ENGINEERING
(Total CREDITS 4, 1 CREDIT FOR EACH MODULE)

Module 1:

Introduction to Conventional Plant Breeding	**2L**
Introduction to cell and Tissue Culture, tissue culture as a technique to produce novel plants and hybrids.	**2L**
Tissue culture media (composition and preparation).	**3L**
Initiation and maintenance of callus and suspension culture; single cell clones.	**3L**
Organogenesis: somatic embryogenesis: transfer and establishment of whole plants in soil.	**5L**

Module 2:

Shoot-tip culture: rapid clonal propagatio n and production of virus-free plants.	**2L**
Embryo culture and embryo rescue	**2L**
Protoplast isolation, culture and fusion; selection of hybrid cells and regeneration of hybrid plants; symmetric and asymmetric hybrids, cybrids.	**5L**
Anther, pollen and ovary culture for production of haploid plants and homozygous lines.	**4L**
Cryopreservation, slow growth and DNA banking for germ plasm conservation.	**2L**

Module 3:

Plant Transformation technology: basis of tumor formation, hairy rootfeatures of TI and RI , plasmids, mechanisms of DNA transfer, role of virulence genes, use of TI and RI as vectors, binary vectors, use of 35S and other promoters, genetic markers, use of reporter genes, reporter gene with introns, use of scaffold attachment regions, methods of nuclear transformation, viral vectors and their applications, multiple gene transfers, Vectors-less or direct DNA transfer, particle bombardment, (electroporation, microinjection, transformation of monocots. Transgene stability and gene silencing.	**8L**
Application of Plant Transformation for productivity and performance: herbicide, resistance phosphoinothricin, glyphosate, sufonyl urea, atrazine, insect resistance, Bt genes, Non-Bt like protease inhibitors, alpha amylase inhibitor, virus resistance, coat protein mediated, nucleocapsid gene, disease resistance, chitinase, 1-3 beta glucanase, RIP, antifungal proteins, thionins, PR proteins, nematode resistance, abiotic stress, postharvest losses, long shelf life of fruits and flowers, use of ACC	**7L**

synthase, polygalacturanase, ACC oxidase, male sterile lines, bar and barnase systems, carbohydrate composition and storage, ADP glucose pyrophosphatase.

Module 4:

Chloroplast Transformation: advantages, vectors. success with tobacco and potato. **3L**

Metabolic Engineering and Industrial Products: plant secondary metabolities, control mechanisms and manipulation of phenylpropanoid pathway, shikimate pathway; alkaloids, industrial enzymes, biodegradable plastics, polyhydroxybutyrate. therapeutic proteins, lysosomal enzymes, antibodies, edible vaccines, purification strategies, oleosin partitioning technology. **5L**

Molecular Marker-aided Breeding: RFLP maps, linkage analysis, RAPD markers, STS, microsatellites, SCAR (sequence characterized amplified regions), SSCP (single strand conformational polymorphism), AFLP, QTL, map based cloning, molecular marker assisted selection. **5L**

Arid and semi-arid plant biotechnology**.** **1L**

Green House and Green-Home technology. **1L**

Practicals:

1. Clonal propagation of elite ornamentals, trees and agricultural plants
2. Introduction of somatic embryos and preparation of synthetic seeds
3. Induction of hairy root cultures for the production of secondary metabolites
4. Permeabilization or immobilization of cells and measurement of secondary plant products
5. Screening of libraries by colony hybridization
6. Confirmation of transgenics by Southern blotting technique and by PCR
7. Genetic transformation of plants using *Agrobacterium tumefaciens*
8. Isolation of protoplast and their fusion by PEG
9. Anther culture
10. Organogenesis
11. DNA finger printing techniques (RAPD, RFLP etc) for molecular markers

Books Recommended:

1. Plant Tissue Culture and its Biotechnological Applications - W. Barz, E. Reinhard, M.H. Zenk
2. Plant Tissue Culture - Akio Fujiwara
3. Frontiers of Plant Tissue Culture - Trevor A. Thorpe
4. In Vitro Haploid Production of Higher Plants - S. Mohan Jain, S.K. Sopory, R.E. Veilleux
5. Plant Tissue Culture : Theory and Practice - S.S. Bhojwani and A. Razdan
6. Plant Cell, Tissue and Organ Culture - Applied AND Fundamental Aspects - Y.P.S. Bajaj and A. Reinhard

Course code/name:

MBGE XIV (T): Animal Genetic Engineering
(Total CREDITS 4, 1 CREDIT FOR EACH MODULE)

Module 1 :
Animal Tissue Culture **15L**
Media for cultured cells & tissues – natural & defined media
Preparation of various tissue culture media, sterilization
Fibroblast culture from neonatal rat skin
Development & maintenance of cell lines
Cell hybridization, hybridoma & monoclonal antibodies production
In vitro culture of Oocyte / embryo
Cryopreservation of cell, embryo, ovum, semen
Stem cell – isolation & culture

Module 2:
Animal improvement **15L**
Conventional methods of animal Improvement – Selective Breeding, Cross Breeding Embryo Biotechniques for augmentation of replication efficiency and faster Multiplication of superior germplasm Super ovulation, Oestrus Synchronization, embryo collection and transfer
In vitro maturation of oocytes, in vitro fertilization, embryo culture, preservation
Micromanipulation and cloning, Somatic cell cloning, Embryo sexing
Identification and isolation of gene of economic importance
Transgenesis for animal improvement and production of animals as bioreactors for proteins of pharmaceutical value, Gene mapping in farm animals
Marker assisted selection and genetic improvement of live stocks

Module 3:
Development and Use of Transgenic Animals **15L**
Transgenic mice - methodology
Retroviral Vector method
DNA microinjection method
Engineered embryonic stem cell method
Knocking in and knocking out of genes
Applications

Module 4:
Vaccines and Therapeutic Agents **15L**
Sub-unit Vaccines
Live recombinant vaccines
Attenuated Vaccines
Anti-idiotipic vaccines
Monoclonal antibodies as therapeutic agents (transplant rejection)
Genetically engineered Immunotherapeutic agents

Practicals:

1. Preparation of Tissue culture medium & membrane filtration
2. Preparation of single cell suspension
3. Cell counting and cell viability
4. Cryopreservation and thawing
5. Trpsinization of monolayer and subculturing
6. Measurement of doubling time
7. Role of serum in cell culture
8. preparation of Metaphase chromosomes from culture
9. Isolation of DNA from cell culture
10. Cell fusion with PEG

Recommended Books:

1. C. Helgasson; Basic cell culture protocols, 3rd edition, Human press
2. E. D. Rang, H.P. Dale, M.M. Ritter; Pharmacology, 5th edition
3. J. Mather and d. Barnes; Animal cell culture methods, Elsevier, vol 57
4. J. R. W. Masters; Animal Cell Culture-A practical approach, Oxford university press
5. J. Paul Basic Protocols in cell and tissue culture
6. M. Butler; Animal cell technology-Principles and products, Open University press
7. M. Butler and M. Dawson, Cell culture lab. fax, Bios scientific Pvt. Ltd.
8. M. Cylnes; Animal cell culture techniques, Springer Verlag
9. M. M. Young; Animal Biotechnology, Pergamon press, Oxford
10. N. Jenkins; Animal cell biotechnology-Methods and protocols, Human Press
11. R. I. Freshney; Culture of animal cells:A manual of basic techniques, John Wiley & sons, 4th edn.
12. H. K. Das, Text book of Biotechnology, Wiley dream tech India pvt.ltd.,2005

Course code/name:

MBGE XV (T): Industrial Applications of Genetic Engineering

(Total CREDITS 4, 1 CREDIT FOR EACH MODULE)

Module 1:

Introduction to Bioprocess Engineering, Bioreactors. Types of fermentation processes: Analysis of batch, Fed-batch and continuous bioreactions, stability of microbial reactors, analysis of mixed microbial populations, specialized bioreactors (pulsed, fluidized, photobioreactors etc.) Measurement and control of bioprocess parameters. Downstream Processing: Introduction, Removal of microbial cells and solid matter, foam reparation, precipitation, filtration, centrifugation, cell disruptions, liquid-liquid extraction, chromatography, Membrane process, Drying and Crystallization, Effluent treatment: D.O.C. and C.O.D. treatment and disposal of effluents. **15L**

Module 2:

Industrial Production of Chemicals: Alcohol (ethanol), Acids (citric, acetic and gluconic), solvents (glycerol, acetone, butanol), Antibiotics (penicillin, streptomycin, tetracycline), Aminoacids (lysine, glutamic acid), Single Cell Protein. **15L**
Whole cell Immobilization and their Industrial Applications.
Use of microbes in mineral beneficiation and oil recovery.

Module 3: **15L**

Environment: Basic concepts and issues.
Environmental Pollution: types of pollution, Methods for the measurement of pollution; Air pollution and its control through Biotechnology genetic engineering. sources of water pollution, Waste water treatment -physical, chemical and biological treatment processes. Treatment schemes for waste waters of dairy, distillery, tannery, Sugar.

Module 4:

Bioremediation of contaminated soils and waste land. **15L**
Biopesticides in integrated pest management.
Solid wastes: sources and management (composting, wormiculture and). methane production
Global Environmental Problems: Ozone depletion, UV-B, green -house effect and acid rain, their impact and biotechnological approaches for management.

Practicals:

1. Isolation of Industrially important microorganisms from microbial processes
2. Development of laboratory scale bioreactors: know how
3. Recovery of product from fermentation broth and optimization of parameters
4. Extraction of protein from a crude bioprocess homogenate using Aqueous Two Phase System (ATPS)
5. Comparative studies of ethanol production using different substrates
6. Production of microbial biofertilizers and biopesticides
7. Determination of Biology Oxygen demand (BOD) of sewage sample
8. Determination of Chemical Oxygen demand (COD) of sewage sample
9. Testing for microbiological quality of potable water (Coli form test)
10. Microbial degradation of organic matter
11. Testing for microbial biodegradation of pesticides

Recommended Books:

1. P. T. Kalaichelvan and I. Arul Pandi 2007 Bioprocess Technology, MJP Pub. , Chennai.
2. Alexander, M. 1994 Biodegradation and Bioremediation, Acad. Press, San Diego, CA
3. Bailey, J. E. and Ollis, D. F. 1987 Biochemical Engineering Fundamentals 2nd Edn. Mc Graw Hill, New Delhi.
4. Malik, V. S. and Sridhar, P. 1992 Industrial Biotechnoogy, Oxford & IBH Pub. Co. Pvt. Ltd., New Delhi.
5. Yoshida, T. and Tanner, R. D. 1993 Bioproducts and Bioprocess Vol. 2 Springer-Verlag, Berlin
6. Casida, L. E. 1994 Industrial Microbiology, Wiley Eastern Ltd., New Delhi
7. Gadd, G. M. 2001 Fungi in Bioremediation, Cambridge Univ. Press, U.K.
8. Demain, A.L. and Davies, J.E. (1999). Manual of Industrial Microbiology and Biotechnology. ASM Press.
9. Tortora, G. J., Fernke, B. R. and Case, C. L. (2001) Microbiology – An Introduction, Benjamin Cummings.
10. Standbary P. F. A. Whitaker and Hall. 1995, Principles of Fermentation Technology. Pergaman. McNeul and Harvey. 1990.
11. Michael Shiler and Kargi, Bioprocess Engineering.
12. Mukhopadhaya S.N. (2001) Process Biotechnology Fundamentals. Viva Books Pvt. Ltd. New Delhi.
13. E.M.T. EL` Mansi & C.F.A. Bryce Fermentation Technology and Biotechnolgy
14. Comprehensive Biotechnology (All volumes) Ed. Young, M.Y. Pub: Pergmon Press
15. Environmental Microbiology. Grant, WD and Long PE. Publ: Blakie, Glasgow
16. Biotreatment systems Vol. 22. Ed. Wise, DL.
17. Microbial Ecology: Principles, Methods and Applications by Lavin, Seidler, Rogul
18. Laboratory Experiments in Microbiology by Gopal Reddy et al
19. Das, H. K. Text book of Biotechnology, Wiley dream tech India pvt.ltd.,2005
20. Air Pollution Vol I by A.C. Stern
21. Environmental management by Biswarup Muhkerjee V. Publication House
22. Pollution Biology: Hynes

23. Environmetal Biology by Biswarup Muhkerjee Tata Mcgraw Hill
24. Modern Concepts of Ecology by H.D.Kumar
25. Cunning, P. (1995). Official Methods of Analysis, Vol. I and II, 16th Edn, Arlington,Virginia,
26. USA, AOAL.
27. Burus, R. G. and Howard Slater (1982). Experimental Microbial Ecology, Blackwell Sci. Publ.
28. Clescri, L.S., Greenberg, A.E. and Eaton, A.D. (1998). Standard Methods for Examination of
29. Water and Waste Water, 20th Edition, American Public Health Association.
30. Ec Eldowney S, Hardman D. J., Waite D.J., Waite, S. (1993) Pollution: Ecology and Bio-treatment – Longman Scientific Technical.

Practicals: (Total 10 Credits)

MBGE V (P): Practical V (5 Credits): course XI - XII

MBGE VI (P): Practical VI (5 credits) : course XIII-XV

Semester IV

Seminar: 2 credit

Project report submission: 08 credits

SEMESTER I

M.Sc. EXAMINATION IN MOLECLAR BIOLOGY AND GENETIC ENGINEERING

PRACTICAL I

TIME : 12 HOURS	FULL MARKS : 80 (Ex. Ass.)
Q.1 Practical from course I	15
Q.2. . Practical from course I I	15
Q.3. Practical from course III	15
Q.4. Comment on the spots from course I , II, III	15
Q. 5. Viva- Voce	10
Q. 6. Practical record	10

SEMESTER I

M.Sc. EXAMINATION IN MOLECLAR BIOLOGY AND GENETIC ENGINEERING

PRACTICAL I I

TIME : 12 HOURS	FULL MARKS : 80 (Ex. Ass.)
Q.1 One minor practical from course I V	10
Q.2. . One minor practical from course V	10
Q.3. One major practical from course I V or V	25
Q.4. Comment on the 3 spots from course IV, V	15
Q. 5. Viva- Voce	10
Q. 6. Practical record	10

SEMESTER II

M.Sc. EXAMINATION IN MOLECLAR BIOLOGY AND GENETIC ENGINEERING

PRACTICAL III

TIME : 12 HOURS	FULL MARKS : 80 (Ex. Ass.)
Q.1 One minor practical from course VI	10
Q.2. . One minor practical from course X	10
Q.3. One major practical from course VI or X	25
Q.4. Comment on the 3 spots from course VI, X	15
Q. 5. Viva- Voce	10
Q. 6. Practical record	10

SEMESTER II

M.Sc. EXAMINATION IN MOLECLAR BIOLOGY AND GENETIC ENGINEERING

PRACTICAL IV

TIME : 12 HOURS	FULL MARKS : 80 (Ex. Ass.)
Q.1 Practical from course VII	20
Q.2. . Practical from course VIII	20
Q.3. Practical from course IX	10
Q.4. Comment on the spots from courseVII , VIII	10
Q. 5. Viva- Voce	10
Q. 6. Practical record	10

SEMESTER III

M.Sc. EXAMINATION IN MOLECLAR BIOLOGY AND GENETIC ENGINEERING

PRACTICAL V

TIME : 12 HOURS	FULL MARKS : 80 (Ex. Ass.)
Q.1 Two practicals from course XI	30 (15 each)
Q.2. . Two minor practicals from course XII	30 (15 each)
Q.3. Viva- Voce	10
Q.4. Practical record	10

SEMESTER III

M.Sc. EXAMINATION IN MOLECLAR BIOLOGY AND GENETIC ENGINEERING

PRACTICAL V

TIME : 12 HOURS	FULL MARKS : 80 (Ex. Ass.)
Q.1 Practical from course XIII	15
Q.2. . Practical from course XIV	15
Q.3. Practical from course XV	15
Q.4. Comment on the spots from course XIII , XIV, XV	15
Q. 5. Viva- Voce	10
Q. 6. Practical record	10