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Department of Biotechnology
Mohanlal Sukhadia University
Syllabus of M.Sc. Biotechnology CBCS Scheme

Type of course	Course code	Title of the Course	L-T-P/Week	No. of credits	University exam	Internal assessment	Total
Semester I							
Core course 1	M1BT01CT01	Instrumentation and Analytical Techniques	3-1-0	4	80	20	100
Core course 2	M1BT02CT02	Cell Biology and Molecular Genetics	3-1-0	4	80	20	100
Core course 3	M1BT03CT03	Fundamentals of Microbiology	3-1-0	4	80	20	100
Core course 4	M1BT04CT04	Biomolecules and Metabolism	3-1-0	4	80	20	100
Core course practical 1	M1BT05CP01	Instrumentation and Analytical Techniques + Cell Biology and Molecular Genetics	0-0-8	4	80	20	100
Core course practical 2	M1BT06CP02	Fundamentals of Microbiology + Biomolecules and Metabolism	0-0-8	4	80	20	100
				24	**480**	**120**	**600**
Semester II							
Core course 5	M2BT01CT05	Molecular Biology	3-1-0	4	80	20	100
Core course 6	M2BT02CT06	Immunology and Enzymology	3-1-0	4	80	20	100
Core course 7	M2BT03CT07	Bioinformatics and Biostatistics	3-1-0	4	80	20	100
Core course 8	M2BT04CT08	Genetic Engineering	3-1-0	4	80	20	100
Core course practical 3	M2BT05CP03	Molecular Biology + Immunology and Enzymology	0-0-8	4	80	20	100
Core course practical 4	M2BT06CP04	Bioinformatics and Biostatistics + Genetic Engineering	0-0-8	4	80	20	100
Skill course 1	M2BT07SEC01	Any one from the given list	1-0-2	2	80	20	100
				26	**560**	**140**	**700**
Semester III							
Core course 9	M3BT01CT09	Biosafety, Bioethics and IPR	3-1-0	4	80	20	100
Core course 10	M3BT02CT10	Animal Biotechnology	3-1-0	4	80	20	100
Core course 11	M3BT03CT11	Plant Biotechnology	3-1-0	4	80	20	100
Core course 12	M3BT04CT12	Advanced Biotechnology	3-1-0	4	80	20	100
Core course practical 5	M3BT05CP05	Biosafety, Bioethics and IPR + Animal Biotechnology	0-0-8	4	80	20	100
Core course practical 6	M3BT06CP06	Plant Biotechnology + Advanced Biotechnology	0-0-8	4	80	20	100
Skill course 2	M3BT07SEC02	Any one from the given list	1-0-2	2	80	20	100
				26	**560**	**140**	**700**

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Semester IV : Choice of A or B							
A.	**Industrial Training**	Major Research Project (at research laboratory or institute of repute (5 months)	0-0-8	**24**	**480***	**120**	**600**
B.	**DSE**						
Discipline Specific Elective 1	M4BT01ET01	Minor Research Project	3-1-0	4	80	20	100
Discipline Specific Elective 2	M4BT02ET02 (a/b)	Choose any one from the given list	3-1-0	4	80	20	100
Discipline Specific Elective 3	M4BT03ET03 (a/b)	Choose any one from the given list	3-1-0	4	80	20	100
Discipline Specific Elective 4	M4BT04ET04 (a/b)	Choose any one from the given list	3-1-0	4	80	20	100
Discipline Specific Elective practical	M4BT05EP01	Practical 1 DSE	0-0-8	4	80	20	100
Discipline Specific Elective practical	M4BT06EP02	Practical 2 DSE	0-0-8	4	80	20	100
				24	**480**	**120**	**600**
GRAND TOTAL				**100**	**2080**	**520**	**2600**

*480 : (Project dissertation 200 + Presentation 150 + Viva- Voce100, Scientific paper: 30)

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Core Course

S.No.	Type of course	Semester	Course code	Title of the Course
1.	Core course 1	I	M1BT01CT01	Instrumentation and Analytical Techniques
2.	Core course 2	I	M1BT02CT02	Cell Biology and Genetics
3.	Core course 3	I	M1BT03CT03	Fundamentals of Microbiology
4.	Core course 4	I	M1BT04CT04	Biomolecules and Metabolism
5.	Core course 5	II	M2BT01CT05	Molecular Biology
6.	Core course 6	II	M2BT02CT06	Immunology and Enzymology
7.	Core course 7	II	M2BT03CT07	Bioinformatics and Biostatistics
8.	Core course 8	II	M2BT04CT08	Genetic Engineering
9.	Core course 9	III	M3BT01CT09	Biosafety, Bioethics and IPR
10.	Core course 10	III	M3BT02CT10	Animal Biotechnology
11.	Core course 11	III	M3BT01CT11	Plant Biotechnology
12.	Core course 12	III	M3BT01CT12	Advanced Biotechnology

Core Course Practical

S.No.	Type of course	Semester	Course code	Title of the Course
1.	Core course practical 1	I	M1BT05CP01	Instrumentation and Analytical Techniques + Cell Biology and Genetics
2.	Core course practical 2	I	M1BT06CP02	Fundamentals of Microbiology + Biomolecules and Metabolism
3.	Core course practical 3	II	M2BT05CP03	Molecular Biology + Immunology and Enzymology
4.	Core course practical 4	II	M2BT06CP04	Bioinformatics and Biostatistics + Genetic Engineering
5.	Core course practical 5	III	M3BT05CP05	Biosafety, Bioethics and IPR + Animal Biotechnology
6.	Core course practical 6	III	M3BT06CP06	Plant Biotechnology + Advanced Biotechnology

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Skill Enhancement Course Elective

S.No.	Type of course	Semester	Course code	Title of the Course
1.	Skill course 1	II	M2BT07SEC01	Skill course elective 1 (Techniques of Molecular Biology) **(any one)**
2.	Skill course 2	III	M3BT08SEC02	Skill course elective 2 (Techniques of Plant Biotechnology) (**any one)**

Discipline Specific Elective

S.No.	Type of course	Semester	Course code	Title of the Course
1.	**A. Industrial Training**	IV		Major Research Project (at research laboratory or institute of repute (5 months)
2.	**B.**			
3.	Discipline Specific Elective 1	IV	M4BT01ET01	Minor Research Project (Compulsory)
4.	Discipline Specific Elective 2(a)	IV	M4BT02ET02	Agriculture Biotechnology
5.	Discipline Specific Elective 2(b)	IV	M4BT03ET02	Environmental Biotechnology
6.	Discipline Specific Elective 3(a)	IV	M4BT04ET03	Food and Dairy Biotechnology
7.	Discipline Specific Elective 3(b)	IV	M4BT05ET03	Fermentation Technology
8.	Discipline Specific Elective 4(a)	IV	M4BT05ET04	Medical and Pharmaceutical Biotechnology
9.	Discipline Specific Elective 4(b)	IV	M4BT05ET04	Host-Parasite Interactions

Discipline Specific Elective Practical

S.No.	Type of course	Semester	Course code	Title of the Course
1.	Discipline Specific Elective practical 1,	IV	M4BT06EP01	Based on Choice of DSE
2.	Discipline Specific Elective practical 2	IV	M4BT07EP02	Based on Choice of DSE

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NOTE:

1. In 4th semester the students have an option of either doing Major research project (MRP) for 5 months in a government institution other than parent university or take any four DSE electives.
2. Students opting for MRP in 4th semester will have to complete SEC 2 in 3rd semester.
3. The students opting for MRP will have to take prior permission from the HOD at least 3 months in advance and submit their acceptance letter from the institute where he/she is going to do the training one month in advance. Failing this the student will not be permitted to go for training.
4. The student who opts for MRP will have submit a duly signed and sealed certificate from the mentor and competent authority in the prescribed format (Annexure 1)
5. Student will be required to submit a hard copy of the continuous assessment report prepared by the mentor as per the prescribed format filled in a sealed envelope. The mentor will also have to send a soft copy of the same to the HOD. (Annexure 2)
6. Such students will also have to submit a dissertation report as per the prescribed format for the training. (Annexure 3)
7. Such students will also have to submit a research paper based on the research work done which may or may not have been published in any journal.
8. The total credits for the MRP will be 24 and the student will maintain a log book showing the presence for 32 hrs./week in the institution and submit the same along with the dissertation. Evaluation of the MRP will be done as per the prescribed scheme. (Annexure 4)
9. In the 4th semester students who opt to take four DSEs also have an alternative option of taking one in-house minor research project within the department or in sister departments of this University in lieu of one DSE. Such students will also have to submit a dissertation report as per the prescribed format for the training. (Annexure 3)
10. The total credits and marks for minor research project will be the same as for any other DSE and Evaluation of the minor research project will be done as per the prescribed scheme. (Annexure 5)

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11. The total contact hrs. for minor research project will be 8 hrs./week. The student who opts for industrial training will have submit a duly signed and sealed certificate from the mentor and competent authority in the prescribed format (Annexure 6)
12. Students can choose skill courses from the list provided in the syllabi of B. Sc. CBCS Biotechnology, M.Sc. Biotechnology, M. Sc. Botany, M. Sc. Microbiology or any other subject from the faculty of Science. The student also has the choice of choosing any general skill courses offered by College of Science
13. Students can also earn extra credits by taking addition skill courses during entire program period.

ANNEXURE 1

INSTITUTE NAME AND LOGO

Ref no.-…….. Date……

CERTIFICATE

This is to certify that the dissertation/project report entitled "**……**" submitted towards the partial fulfillment for the award of the degree of Master of Science in Biotechnology, from Mohanlal Sukhadia University, Udaipur (Rajasthan) India is the result of bonafide work compiled by **Mr./Ms. …….** carried outunder the guidanceof **Dr. ……..** at **……..** under my supervision in the academic year of …….. It has no part the dissertation has been submitted for the award of any degree, diploma, fellowship or other similar titles or prizes and that the work has not been published in part or full in any scientific or popular journals or magazines.

Date

Name & Signature of the supervisor

Seal of the supervisor

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ANNEXURE 2

M. Sc. Biotechnology Semester IV

CONTINUOUS ASSESSMENT SHEET

Major Research Project

Name of Student:

A) Technical Competence	**Maximum Marks**	**Marks Obtained**
1. Experimental Design	7	
2. Handling of Equipments	7	
3. Experimental Skills	7	
4. Data Interpretation/ Result Analysis	**7**	
5. Technical Writing Skills	7	
TOTAL	**35**	
B) Professional Qualities		
1. Sincerity and Reliability	5	
2. Drive and Initiative	5	
3. Motivation to exceed minimum expectation	5	
4. Attendance	30	
TOTAL	**45**	
C) Ability to		
1. Work Independently	4	
2. Understand technical (Research Publication)	4	
3. Adjust in new working environment	4	
4. Plan and work Methodically	4	
5. Work in team	4	
TOTAL	**20**	
D) Communication Skills		
1. Written	10	
2. Oral	10	
TOTAL	**20**	
Grand Total	**120**	

Remark on professional competence (or deficiency) of the trainee and overall performance.

Name of the Mentor :

Designation : E-mail…….

Ph. No.

Organization:

Date: Signature with seal

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ANNEXURE 3

General Guidelines for Preparation of Project Report

(For specific details the students are advised to consult their respective supervisors)

1. Strictly follow the format given to write the manuscript of the project.
2. On the front page include title of the project (font size 21, centered). The title should not contain abbreviation and scientific names of organisms should be in *italics.* This page should not be numbered.
3. Starting from second page, the pages must be numbered consecutively, including figures and table.
4. Text should be 1.5 point spaced type written using Times New Roman Font, Font Size 12, on one side of A 4 Size paper, with 1.5 inch margins throughout. Scientific names of the organisms should be in *italics.* Main headings (Summary, Introduction, Chapter details, Conclusions and References) should be bold type, justified and separated from the text.
5. The full text of project should not exceed 20-25 one side typed pages.
6. Literature citation in the text should be cited in alphabetic order. The form and style of references should be as indicated below.

(a) Journal article

Carvalho, L.C., Goulao, L., Oliveira, C., Goncalves, C.J. and Amancio, S. 2004. Rapid assessment for identification of clonal identity and genetic stability of *in vitro* propagated chestnut hybrids. Plant Cell Tiss. Org. Cult. 77:23-27.

Chae, W.B., Choi, G.W. and Chung, I.S. 2004. Plant regeneration depending on explant type in *Chrysanthemum coronarium* L. J. Plant Biotech. 6:253-258.

(b) Book reference

Salisbury, F. B., Ross, C. W. 1992. Plant Physiology. 4th edn. Wadsworth Publishing Company. Belmount.

(c) Edited books

Constantine, D.R. 1986. Micropropagation in the commercial environment. In : "Plant Tissue Culture and its Agricultural Applications". L.A. Withers and P.G. Alderson (Eds.) pp. 175-186. Butterworths, London, UK.

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(d) Paper presented at a conference

Chaturvedi, H.C. 1992. Hardening of *in vitro* raised plants for transplant success. A state of art report. Paper presented in DBT Project Monitoring Committee Meeting held on 6th-7th July, 1992 in DBT, New Delhi, India.

(e) Proceeding of a symposium

Rajsekharan, P. E., Ganeshan, S. 2005. Designing *exsitu* conservation strategies for threatened medicinal plant species of South India. In: " Proc. Natl. Symp. and 27th Annual Meeting of PTCA(I)." A.K. Kukreja *et al* (Eds). Pp.159-164. CIMAP, Lucknow, India.

(f) Thesis/ Dissertation

Dave, N. 2004. Factors influencing micropropagation of two varieties of *Achras sapota* and their rootstock *Mimusops hexandra*. Ph.D. Thesis, Mohanlal Sukhadia University, Udaipur, India.

(g) Patent

Trepaginer, J.H. 2000. New surface finishings and coatings. US Pat 1276323 (to DuPont Inc, USA). 27 June, 2000. Chem Abstr, 49 (2000) 27689.

(h) Reports

Anonymous, 1976. The Wealth of India. Raw Meterials. Vo. X. pp. 44-48. CSIR, New Delhi, India.

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TITLE MUST BE IN CAPITAL LETTERS, SIZE 21 AND CENTERED, WITH *Scientific names* IN ITALICS

A Project Report submitted

for the partial fulfillment of the Degree of Master of Science

By

(**Name of student**)

[M.Sc. (Biotechnology/Microbiology), IV Semester]

DEPARTMENT OF BIOTECHNOLOGY

Vigyan Bhawan- Block 'B': New Campus

MOHANLAL SUKHADIA UNIVERSITY

UDAIPUR

2015-16

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INSTITUTE NAME AND LOGO

Ref no.-…….. Date……

CERTIFICATE

This is to certify that the dissertation/project report entitled "**……**" submitted towards the partial fulfillment for the award of the degree of Master of Science in Biotechnology, from Mohanlal Sukhadia University, Udaipur (Rajasthan) India is the result of bonafide work compiled by **Mr./Ms. …….** carried outunder the guidance of **Dr. ……** at **……..** under my supervision in the academic year of ……..

It has no part the dissertation has been submitted for the award of any degree, diploma, fellowship or other similar titles or prizes and that the work has not been published in part or full in any scientific or popular journals or magazines.

Date

Name & Signature of the supervisor

Seal of the supervisor

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Declaration

I, **……..** Roll No. _____student of M. Sc. IV Semester Biotechnology (Session 2010-11) hereby declare that the project entitled "……." is my own compilation. I have strictly adhered to the guidelines provided by the department for the preparation of the project report.

Dated: Signature of the Student

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ANNEXURE 4

MARKING SCHEME FOR MAJOR RESEARCH PROJECT

M. Sc. Biotechnology semester IV

S. No.		Maximum Marks	Marks Obtained
1	**Dissertation Report** a. Review of Literature b. Methodology c. Outcome d. Discussion	 100 50 30 20	
2	Presentation	150	
3	Viva – voce	100	
4	Research Paper	30	
5	Continuous Assessment	120	
	TOTAL MARKS	**600**	

ANNEXURE 5

MARKING SCHEME FOR MINOR RESEARCH PROJECT

M. Sc. Biotechnology semester IV

S. No.		Maximum Marks	Marks Obtained
1	**Dissertation Report** a. Review of Literature b. Methodology c. Outcome	 15 10 15	
2	Seminar	25	
3	Viva – voce	15	
4	Continuous Assessment	20	
	TOTAL MARKS	**100**	

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ANNEXURE 6

CONTINUOUS ASSESSMENT SHEET

M. Sc. Biotechnology: Minor Research Project

Name of Student's :

Technical Competence	Maximum Marks	Minimum Marks
• Review of Literature	5	
• Experimental Design & Skills	5	
• Data Interpretation/ Result Analysis	5	
• Attendance	5	
GRAND TOTAL	**20**	

Remark on professional competence (or deficiency) of the trainee and overall performance.

Name :

Designation : E-mail…….

Ph. No.

Organization:

Date: Signature with seal

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SYLLABUS
for
M. Sc. Biotechnology
Structure of M. Sc. Biotechnology under CBCS Scheme

Core Course

Semester I

CC1(M1BT01CT01): Instrumentation and Analytical Techniques
CC2(M1BT02CT02): Cell Biology and Molecular Genetics
CC3(M1BT03CT03): Fundamentals of Microbiology
CC4(M1BT04CT04): Biomolecules and Metabolism
(Practical) CC1,2 (M1BT05CP01): Instrumentation and Analytical Techniques + Cell Biology and Molecular Genetics
(Practical) CC3,4 (M1BT06CT02): Fundamentals of Microbiology + Biomolecules and Metabolism

Semester II

CC5 (M2BT01CT05): Molecular Biology
CC6 (M2BT02CT06): Immunology and Enzymology
CC7 (M2BT03CT07): Bioinformatics and Biostatistics
CC8(M2BT04CT08): Genetic Engineering
(Practical) CC5, 6 (M2BT05CP03): Molecular Biology + Immunology and Enzymology
(Practical) CC7, 8 (M2BT06CP04): Bioinformatics and Biostatistics + Genetic Engineering
SEC1(M2BT07SEC01): Techniques of Molecular Biology

Semester III

CC9 (M3BT01CT09): Biosafety, Bioethics and IPR
CC10 (M3BT02CT10): Animal Biotechnology
CC11(M3BT03CT11): Plant Biotechnology
CC12 (M3BT04CT12): Advanced Biotechnology
(Practical) CC9,10 (M3BT05CP05): Biosafety, Bioethics and IPR + Animal Biotechnology
(Practical) CC11, 12 (M3BT06CP06): Plant Biotechnology + Advanced Biotechnology
SEC2 (M3BT07SEC02): Techniques of Plant Biotechnology

Semester IV : Choice of A or B

A : Industrial Training : Major Research Based Project including Practical work at research laboratory or institute of repute other than parent university (5 Months)

B : Discipline Specific Electives

DSE1(M4BT01ET01): Minor Research Project (Compulsory for all students)

(Any 3 out of the given list)

DSE 2 (M4BT02ET02) (a/b): a. Agriculture Biotechnology
b. Environmental Biotechnology
DSE3(M4BT03ET03)(a/b): a. Food and Dairy Biotechnology
b. Fermentation Technology
DSE4(M4BT04ET04)(a/b): a. Medical and Pharmaceutical Biotechnology
b. Host- Parasite Interactions

(Practical) DSE1
(Practical) DSE 2

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SEMESTER –I

M. Sc. BIOTECHNOLOGY (CBCS STRUCTURE)

CC1(M1BT01CT01): INSTRUMENTATION AND ANALYTICAL TECHNIQUES (THEORY)

TOTAL HOURS: 60 **CREDITS: 4**

Unit I: **Credit hours: 10**

Laboratory instrumentation: principle, components, assembly, working and applications of: Laminar clean air flow bench, autoclave, incubators, weighing balances, pH meter, water bath, hot air oven, colony counter and microtome. Laboratory safety measures.

Unit II: **Credit hours: 10**

Aseptic techniques: Principles of sterilization, Brief idea of various methods of sterilization, Physical, chemical, disinfectants, membrane filtration, pasteurization, tyndallization. Definition and classification of compounds used for sterilization, antibiotics and antimicrobials. Evaluation of effectiveness of antimicrobial/antiseptic compounds.

Unit III: **Credit hours: 15**

Microscopy: Types, principle, components, working, specimen, preparation and applications of Light, Bright field, Dark field, Phase contrast, Electron (SEM, TEM). Scanning tunneling. Fluorescence, Nomarsky differential interference contrast, Confocal, Atomic force microscopes.

Unit IV: **Credit hours: 15**

Chromatography: General Principles, process and applications of Paper and Thin Layer Chromatography. GLC, HPLC, Absorption, Ion Exchange, Gel filtration, Affinity chromatography, Radioactive tracer technique, autoradiography, Gamma and Scintillation counters, Brief idea of NMR, IR, GC-MS.

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UNIT V: **Credit hours: 10**

Centrifugation and spectrophotometry: Types of centrifuges. Principles, working and applications of preparative, Analytical, Microcentrifuge. Refrigerated ultracentrifuge. Colorimeter and types of spectrophotometer: principle, working and application.

Suggested Readings

1. Pattabhai, V. and Gautham (2002), N. Biophysics. 2nd edition Narosa pub.
2. Narayan, P. Essentials of Biophysics. New Age International.
3. Roy, R.N. A Text Book of Biophysics. New Central Book Agency.
4. Daniel, M. Basic Biophysics. Agrobios.
5. Rodney Cottegril (2003), Biophysics: an introduction 2nd edition, John wiley & sons publication.

CC2(M1BT02CT02): CELL BIOLOGY AND MOLECULAR GENETICS

TOTAL HOURS: 60 **CREDITS: 4**

Unit I **Credit hours: 10**

Structure and organization of cell. Intra-cellular compartmentalization. Structure, function and significance of cell wall, plasma membrane, Membrane proteins and transport across biomembrane. Structure, function and significance of Cell organelles, flagella, cilia, cytoskeleton. Genetic organization of Mitochondria and chloroplast.

Unit II **Credit hours: 15**

Nucleus: nuclear membrane, nucleolous and nuclear pore complex. Chromatin; structure, types organization and chemistry of the chromosome. C-value paradox, Nuclear dyes and their application in staining of chromosomes. Karyotyping, Polytene, lambrush and B-chromosomes. Chromosome banding and its staining.

Cell cycle events, regulation of cell division: cyclins, cyclin-dependent kinases, inhibitors, control of cell division in multicellular organisms.

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Unit III **Credit hours: 15**

Brief idea of model organisms of genetic studies: *Drosophila, Neurospora, C. elegans*, *Acetabularia*. Gene interaction: modification of mendalian ratios. Linkage and crossing over, linkage map, linked gene inheritances. Genetic recombination at molecular level (Holliday model). Role of RecA protein in recombination. Numerical and structural changes in chromosomes.

Unit IV **Credit hours: 10**

Mutation – molecular basis of spontaneous and induced mutations. Adaptive mutations in bacteria. Detection of mutations: Ames test, Luria-delbruck fluctuation test. Molecular mechanism of radiation and chemical mutagenesis: use of base analogs, ionizing radiations and alkylating agents for mutagenesis.

Unit V **Credit hours: 10**

Transposons: Types, structure, properties and their significance. Mechanism of transposition, transposon mutagenesis. Integrons, Insertion sequences (IS), Composite transposons. Replicative and non replicative transpositions. Role of transposase and resolvase. Examples of Transposable elements, Retrotransposon.

Suggested Readings

1. Alberts, B., Bray, D. Lewis, J., Raff, M., Roberts, K. and Watson, J.D. 1999. Molecular Biology of Cell. Garland Publishing Co. New York, USA.
2. Snustad, D.P. and Simmons, M.J. 2000. Principles of genetics. John Wiley and Sons.
3. Russel, P.J. 1998. Genetics. The Benjamin/Cumming Publishing Co.
4. Gasque, E. Manual of Laboratory experiments in cell Biology. W.C. Wilson Public.
5. Robertis, E.D.P., Robertis, E.M.F. Cell and Molelcular Biology. Sauder College Publication.
6. Beeker, W.M. The world of the cell. Pearson Education.
7. Karp, G. Cell and Molecular Biology. John Willey and sons.
8. Lodish and Baltimore. Molecular Cell Biology. W.H. Freeman and Co.

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CC3 (M1BT03CT03): FUNDAMENTALS OF MICROBIOLOGY

TOTAL HOURS: 60 **CREDITS: 4**

Unit-I **Credit hours: 10**

Historical events and contributions of important microbiologists. Kingdom and domain system of classification. Bacterial nomenclature and taxonomy. Numerical taxonomy, Chemotaxonomy, Bergey's manual of systematic bacteriology. Problems and paradoxes associated with bacterial taxonomy. Evolutionary relationships and phylogeny. Analysis of dendrograms and cladograms.

Unit-II **Credit hours: 15**

Archaea, Cyanobacteria, Actinobacteria: Discovery, General characters, classification, morphology, structural organization, reproduction, economic and ecological significance: differences and similarities with bacteria. L forms, Rickettsia, Chlamydia, Spirochaetes, viroids, prions, virusoids: Brief idea of general characteristics, structural organization and significance.

Unit-III **Credit hours: 10**

Bacteria: Morphological types. Structure, arrangement and function of flagella and pili. Cell membrane, Cell wall: types, structural organization, significance, Gram staining, Significance of LPS and role in pathogenicity. Nucleoid: organization and significance. Plasmids: properties and types. Important diseases caused by bacteria.

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Unit-IV **Credit hours: 10**

Virus: Structural organization, classification, multiplication, transmission and significance. Mycoplasma, Spiroplasma and Phytoplasma: General characters, reproduction, transmission and significance. Important diseases caused by viruses, mycoplasma, spiroplasma and phytoplasma.

Unit V **Credit hours: 15**

Techniques of microbial culture, Anaerobic culture. Culture media; types, composition, preparation. Selective culture methods, Enrichment culture. Isolation and development of pure culture. Maintaining and preservation of cultures, Enumeration of microbes. Principles of

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Staining, Nature of dyes and types of staining; Characterization and identification of microbes based on morphology, cultural physiological and biochemical characteristics, serology and molecular methods of identification.

Suggested Readings

1. Tortora GJ, Funke BR, and Case C.L. (2004). *Microbiology*: *An Introduction.* 4th edition. Pearson Education.
2. Atlas RM. (1997). *Principles of Microbiology*. 2nd edition. WM.T.Brown Publishers.
3. Cappucino J and Sherman N. (2010). *Microbiology: A Laboratory Manual*. 9th edition. Pearson Education limited.
4. Madigan MT, Martinko JM and Parker J. (2009). *Brock Biology of Microorganisms*. 12th edition. Pearson/Benjamin Cummings.
5. Pelczar MJ, Chan ECS and Krieg NR. (1993). *Microbiology*. 5th edition. McGraw Hill Book Company.
6. Dubey, R.C. and Maheshwari, D.K. A Text Book of Microbiology. S. Chand and Company.
7. Prescott, H. and Klein. 2000. Microbiology. McGraw Hill.

CC4(M1BT04CT04): BIOMOLECULES AND METABOLISM (THEORY)

TOTAL HOURS: 60 **CREDITS: 4**

Unit I **Credit hours: 10**

Bioenergetics: entropy, enthalpy, Gibbs free energy concept, Laws of thermodynamics. Acids and Bases, redox potential, pH and Buffers, Henderson and Hasselbach equation, pKa, pKb. Preparation of buffers. Electron transport mechanism (chemi-osmotic theroy), Energy rich molecules. Mechanism of ATP synthesis.

Unit II **Credit hours: 10**

Carbohydrates: classification, structure, properties and functions. Role of carbohydrates in signaling,glycosylation of other biomolecules. Carbohydrate derivatives: muriens, glycoproteins,

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glycolipids, peptidoglycan. Carbon fixation, Glycolysis (aerobic and anaerobic), TCA, HMP, PPP and other pathways, Gluconeogenesis, Glycogenesis, Glycogenolysis.

Unit III **Credit hours: 10**

Lipids: classification, structure, properties and functions of fatty acids, triacylglycerols, phospholipids, sterols and terpenes, Conjugated lipids - lipoproteins. ketone bodies, Lipids with specific biological functions, micelles and liposomes. Biosynthesis of saturated and unsaturated fatty acids, β-oxidation.

Unit IV **Credit hours: 15**

Amino acids: general properties and biosynthesis, Transamination, Deamination, Decarboxylation; glutamine and glutamic acid pathway, urea cycle, uric acid biosynthesis. Protein structure (primary, secondary, tertiary and quaternary). Ramachandran plot. Protein sequencing, Vitamins and Co-enzyme (biological and biochemical functions).

Unit V **Credit hours: 15**

Electrophoresis: Types, Principles and applications: Gel electrophoresis, SDS PAGE, Affinity electrophoresis, Capillary electrophoresis, Dielectrophoresis, DNA electrophoresis, Electroblotting, Electrofocusing, Immunoelectrophoresis, Isotachophoresis, Pulsed field gel electrophoresis. Methods of studying metabolism: Use of biochemical mutants, Isotopic labeling, Metabolome and its applications.

Suggested Readings

1. Voet and Voet. 2000. Biochemistry. John Wiley.
2. Lehninger. 2000. Principles of Biochemistry. CBS Publishers.
3. Stryer, L. 2002. Biochemistry. W.H. Freeman.
4. Harper. 2003. Biochemistry. McGraw-Hill.
5. Zubay. 1995. Biochemistry. Brown Publishers.
6. Trehan, K. Biochemistry. Wiley Eastern Publications.
7. Jain, J.L. Fundamentals of Biochemistry. S. Chand and Company.
8. Deb, A.C. Fundamental of Biochemistry.
9. Methew, C.K. Biochemistry. Pearson Education.
10. Horton and Moran. Principles & Biochemistry. Prentice Hall.

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SEMESTER –II

CC5(M2BT01CT05): MOLECULAR BIOLOGY (THEORY)

TOTAL HOURS: 60 **CREDITS: 4**

Unit I **Credit hours: 10**

Eukaryotic and Prokaryotic genetic materials: Structure, chemical composition, organization, mechanism of replication. Discontinuous synthesis of DNA, RNA primer for DNA synthesis, Enzymes and proteins associated with DNA replication, repetitive DNA. DNA repair: photo-reactivation, excision repair, post replication repair, SOS repair.

Unit II **Credit hours: 15**

RNA: types, primary, secondary, tertiary and quaternary structure and synthesis.

Transcription: Prokaryotic transcription and RNA polymerase. Eukaryotic transcription and RNA polymerases. Transcription factors and their role. Modification in RNA: 5'-CAP formation, 3'-end processing, Polyadenylation, Splicing, Editing, Nuclear export of mRNA and mRNA stability. Processing of other RNAs, Ribosome formation. Reverse transcription. Inhibitors of RNA synthesis.

Unit III **Credit hours: 10**

Translation: Prokaryotic and Eukaryotic translation, mechanism of initiation, elongation & termination, Amino acid activation, Inhibitors, Regulation of translation, Co-& post translation modification of proteins. Protein sorting: synthesis of secretory and membrane proteins, import into nucleus, mitochondria, chloroplast and peroxisomes, Receptor mediated endocytosis.

Unit IV **Credit hours: 15**

Regulation of gene expression in prokaryotes and eukaryotes: Transcriptional control; enzyme induction and repression, constitutive synthesis of enzymes. The operon hypothesis: genes involved in regulation- regulatory gene, promoter gene, operator gene and structural gene, role of cAMP and cAMP receptor protein (CRP) in the expression of e.g. Lac operon, Tryptophan operon. Catabolite repression. *Cis* control elements, promoters, enhancers, Transacting factors, DNA binding motifs of transcription factors, post transcriptional control.

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Unit- V **Credit hours: 10**

Principles and applications of blotting techniques: Southern, Northern, Western and Eastern blotting. Polymerase chain reaction: Types and applications. Radioactive and non radioactive probes. Autoradiography. DNA fingerprinting, DNA Foot printing and DNA sequencing , Antisense and siRNA technology. Chromosome walking.

Suggested Readings

1. Watson, J.D. Molecular Biology of Gene. Pearson Education.
2. Friefelder, D. Molecular Biology. Narosa Publishing House, New Delhi.
3. Weaver, R. Molecular Biology. McGraw Hill.
4. Lewin, B. Gene VIII. Pearson Education.
5. Lodish and Baltimore. Molecular Cell Biology. W.H. Freeman and Co.
6. Cooper, M. The Cell – A molecular approach. Sinauer.
7. Daniel. Molecular Cell Biology. Scientific American Books.
8. Smith. Molecular Biology. Faber and Faber Publications.
9. Dabre, P.D. Introduction to (Practical) Molecular Biology. John Wiley and Sons, Ltd.Meyers, R.A. (Ed). Molecular Biology and Biotechnology : A comprehensive desk reference. VCH Publishers, New York

CC6(M2BT02CT06): IMMUNOLOGY AND ENZYMOLOGY (THEORY)

TOTAL HOURS: 60 **CREDITS: 4**

Unit I **Credit hours: 10**

Innate and acquired immunity, clonal nature of the immune response. Immune system: primary lymphoid organs, secondary lymphoid organs. Cells of the immune system: B-lymphocytes, T-lymphocytes, Macrophages, Natural killer, Lymphokine activated killer cells. Haptens and adjuants. Nature of antigens, Antibody: types structure and function, Abzymes, Antigen-antibody reactions, serological techniques.

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UNIT II **Credit hours: 10**

Major histocompatibility Complex, complement system. Regulation of the immune response, activation of B and T-lymphocytes, cytokines, T-cell regulation, MHC restriction, Immunological tolerance. Hybridoma technology and monoclonal and polyclonal antibodies. Autoimmunity.

UNIT III **Credit hours: 15**

Classification of Enzymes, Mechanism of Enzyme Action; Concept of active site and energetics of enzyme substrate complex formation; Specifically of enzyme action; Kinetics of single substrate reactions; turnover number; estimation of Michaelis-Menten parameters, multi - substrate reactions- mechanism and kinetics; Types of inhibition-kinetic models; Substrate and Product Inhibition; Allosteric regulation of enzyme; Deactivation kinetics.

UNIT IV **Credit hours: 15**

Extraction and purification of enzymes, Physical and Chemical methods used for cell disintegration. Enzyme fractionation by precipitation (using Temperature, Salt, solvent, pH, chemicals), Liquid-liquid extraction, ionic exchange, Gel Chromatography, Affinity chromatograhy and other special purification methods. Enzymes for analytical and diagnostic applications. Multi enzyme complex, isozymes,Coenzymes, Ribozymes.

UNIT V **Credit hours: 10**

Physical and Chemical techniques for enzyme immobilization-adsorption, matrix entrapment, encapsulation, cross linking, covalent binding. Advantages and disadvantages of different immobilization techniques, overview of application of immobilized enzyme systems. Enzyme crystallization techniques. Commercial applications of enzymes in food, pharmaceutical and other industries.

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Suggested Readings

1. Harvey W. Blanch, Douglas S. Clark, "Biochemical Engineering", marcel Dekker, Inc.
2. James M. Lee, "Biochemical Engineering", PHI, USA.
3. James, E. Bailey & David F. Ollis, "Biochemical Engineering fundamentals", McGraw-Hill.
4. Wiseman, "Enzyme Biotechnology"' Ellis Horwood Pub.
5. Kuby, J. "Immunology". W. H. Freeman and Company.
6. Roitt, Brostoff, Male and Mosby, Immunology.
7. Palmer, T. Understanding Enzymes.
8. Coleman, R.M. Fundamental Immunology. McGraw Hill.

CC7 (M2BT03CT07): BIOINFORMATICS AND BIOSTATISTICS (THEORY)

TOTAL HOURS: 60 **CREDITS: 4**

Unit I **Credit hours: 10**

Computer Architecture, Internal and External devices, computer software, operating system windows, Unix, Application software like word processor, spread sheet, Database, RDBMS. Computer Network- Advantages of network, types of network (LAN, WAN & MAN), Network protocols, Internet protocol (TCP, IP), and File transfer protocol (FTP), WWW, HTTP, HTML, VRL.

Unit II **Credit hours: 15**

Computer words coding (ASCII and EBCDIC), Numeric data. Introduction to programming languages, C^{++} Perl. Databases: Introduction to databases- Relational databases- Oracle, SQL, Database generation, Sequence databases- Resources-Human Genome project (HGP), Microbial genomes, Structural databases- protein data bank (PDB).

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Unit III **Credit hours: 15**

Principles behind computational analysis, Sequence analysis, sequence alignment, scoring matrices for sequence alignment, Similarity searching (FASTA and BLAST), Pair wise comparison of sequences, multiple alignment of sequences.

Unit IV **Credit hours: 10**

Brief description of tabulation of data and their graphical representation, measures of central tendency and dispersion: Mean, median, mode, range, standard deviation, variance. Simple linear regression and correlation. Brief idea of statistical softwares and their applications.

Unit V **Credit hours: 10**

Elementary idea of probability, definition and properties of binomial, poison and normal distributions. Elementary idea of random sampling, selection of simple random samples from a finite population, definition of sampling distribution, Randomized block design, sampling variance and standard error. Analysis of Variance (ANOVA), Idea of two types of errors and level of significance, test of significance, chi-square test of independence and homogeneity test based on Z and T statistics.

Suggested Readings

1. Zar, J.H. Biostatical Analysis. Pearson Edu.
2. Gupta, S.C. and Kapoor, V.K. Fundamentals of applied statistics. S. Chand and Company.
3. Dutta, N.K. Funadamentals of Biostatistics. Kanika Pub. New Delhi.
4. Arora, P.N. and Malhan, P.K. Biostatistics. Himalya Publishers.
5. Daniel, M. 1999. Biostatistics (3rd Edition). Panima Publishing Corporation.
6. Campbell, R.C. Statistics for Biologist. Cambridge University Press.
7. Bliss, C.J.K. Statistics in Biology. McGraw Hill.
8. Swardlaw, A.C. (Practical) statistics for experimental Biology. John Wiley and Sons.

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CC8 (M2BT04CT08): GENETIC ENGINEERING (THEORY)

TOTAL HOURS: 60 **CREDITS: 4**

Unit I **Credit hours: 10**

Recombinant DNA Technology: History and Milestones In Genetic Engineering, Application of enzymes in recombinant DNA technology- exo and endonucleases, restriction enzymes, DNA ligases, polymerases, DNA modifying enzymes etc. General concept and principle of cloning: Cloning vectors, classification, plasmids: pBR 322, pBR327, pUC8. Phage vectors: M13 and λ. Phagemids and cosmids.

Unit II **Credit hours: 10**

Purification of DNA from living cells- Extraction of bacterial DNA, Plasmid DNA. Isolation of DNA, molecular probes, insertion of DNA into living cell- microinjection, electroporation, shot gun method, ultrasonication, microlaser, uptake of DNA by bacterial cell and introduction of phage DNA in to bacterial cell. Nucleic acid purification, yield analysis.

Unit III **Credit hours: 15**

Methods for Constructing rDNA and cloning: Inserts; vector insert ligation; Use of linkers, adaptors and homo-polymer tailing. Methods for screening and selection of recombinant clones. Nucleic Acid sequencing: Sanger's, Maxam Gillbert's method and pyrosequencing. Site-directed mutagenesis. Protein engineering and its applications.

Unit-IV **Credit hours: 15**

Shuttle and expression vectors: Design and characteristics of expression vectors for cloning in prokaryotes and factors that affects expression. Yeast cloning vectors: 2μm plasmid, Yep, Yip and YAC. Animal virus derived vectors: SV40 and retroviral vectors. Applications of cloning in gene analysis: Obtaining clone of specific gene, Study of gene location, expression and regulation of gene expression, Study of translated product of a cloned gene. DNA Libraries: types, construction and screening of Genomic and C- DNA libraries.

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Unit V **Credit hours: 10**

Principle and applications of gel mobility shift assay, Ribozyme, Antisense and siRNA technology. Gene Therapy: Vector engineering, gene replacement/augmentation, gene correction, gene editing, gene regulation and silencing. Restriction Mapping of DNA Fragments and Map Construction.

Suggested Readings

1. Watson, J.D. Molecular Biology of Gene. Pearson Education.
2. Friefelder, D. Molecular Biology. Narosa Publishing House, New Delhi.
3. Weaver, R. Molecular Biology. McGraw Hill.
4. Lewin, B. Gene VIII. Pearson Education.
5. Lodish and Baltimore. Molecular Cell Biology. W.H. Freeman and Co.
6. Cooper, M. The Cell – A molecular approach. Sinauer.
7. Daniel. Molecular Cell Biology. Scientific American Books.
8. Smith. Molecular Biology. Faber and Faber Publications.
9. Dabre, P.D. Introduction to (Practical) Molecular Biology. John Wiley and Sons, Ltd

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SEMESTER –III

CC9(M3BT01CT09): BIOSAFETY, BIOETHICS AND IPR (THEORY)

TOTAL HOURS: 60 **CREDITS: 4**

UNIT I **Credit hours: 12**

Introduction to ethics and bioethics : Personal ethics: profession and professionalism – Moral Reasoning – Ethical theories – person as an experimenter – Moral leadership (integrity and ingenuinity) - framework for ethical decision making.

UNIT II **Credit hours: 12**

Biotechnology and ethics: Biotechnology in agriculture and environment: benefits and risks – benefits and risks of genetic engineering – ethical aspects of genetic testing – ethical aspects relating to use of genetic information – genetic engineering and biowarfare.

UNIT III **Credit hours: 12**

Ethical implications of cloning: Reproductive cloning , therapeutic cloning ; Ethical, legal and socio-economic aspects of gene therapy, germ line, somatic, embryonic and adult stem cell research- GM crops and GMO's – biotechnology and biopiracy – ELSI of human genome project.

UNIT IV **Credit hours: 12**

Introduction to biosafety: Biosafety issues in biotechnology – risk assessment and risk management – safety protocols: risk groups – biosafety levels – biosafety guidelines and regulations (National and International), types of biosafety containment. Ethical issues for animal cell culture.

UNIT V **Credit hours: 12**

Introduction to intellectual property and intellectual property rights: Types, patents, copy rights, trade secrets and trade marks, design rights, geographical indications – importance of IPR – patentable and non patentables – patenting life – legal protection of biotechnological inventions – world intellectual property rights organization (WIPO)

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Suggested Readings

1. Principles of cloning, Jose Cibelli, Robert P. lanza, Keith H. S . Campbell, Michael D.West, Academic Press,2002Glimpses of Biodiversity – B.Bltosetti
2. Ethics in engineering, Martin. M.W. and Schinzinger.R. III Edition, Tata McGraw-Hill, New Delhi. 2003.

CC10(M3BT02CT10): ANIMAL BIOTECHNOLOGY (THEORY)

TOTAL HOURS: 60 **CREDITS: 4**

Unit I **Credit hours: 10**

Animal Cell Culture: Historical events, equipments, Materials & Techniques of animal cell culture. Types of animal cell culture. Culture Media: Natural & Artificial media, balanced salt solutions, Serum and protein free defined Media & their applications. Physiochemical properties of different constituents of culture Medium. Control, testing and storage of media. Maintenance of cell culture.

Unit II **Credit hours: 15**

Biology of cultured cells : Cell adhesion & proliferation, Differentiation , origin of cultured cells. Characterization of the cultured cell, cell transformation, cell synchronization. Culture procedure for tumor cells & specialized cell *viz:* Epithelial cells, Neuronal cells & Hematopoietic cells.

Unit III **Credit hours: 10**

Primary culture: Types, Isolation of tissue, Disaggregation of tissue. Cell lines: Nonenclature, Designation, Selection & Maintenance of cell lines. Cell cloning & cell separation. Animal cell culture, scale up: Scale up in suspension & Scale up in Monolayer culture.

Unit IV **Credit hours: 15**

Contamination: Sources of contamination, routes & monitoring for contamination, cross contamination. Cryopreservation: Need for cryopreservation, Stages of Cryopreservation,.

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Quantitation: Cell counting, Measurement of Growth, Measurement of cell death & Cytotoxicity Assays.

Unit V **Credit hours: 10**

Molecular techniques in cell culture: In situ molecular hybridization, Somatic cell fusion & hybridomes, DNA transfer or tranfection methods & transgenic animals. Production from cell culture.

Suggested Readings

1. Masters, J. Animal Cell Culture. Panima.
2. Freshney, I. Culture of Animal Cell. John Wiley.
3. Martin, C. (Ed). Animal Cell Culture Techniques. Springer.
4. Mather and Barnes. (Ed). Methods in Cell Biology. Vol. 5-7, Animal Cell Culture Method. Academic Press.
5. Paul, J. Animal Tissue Culture.
6. Butler, M. and Dawson, M. Lab Fax : Cell Culture. Bios Scientific Publications.
7. Jenkins, N. Animal Cell Biotechnology. Panima Books Distributors.

CC11 (M3BT03CT11): PLANT BIOTECHNOLOGY (THEORY)

TOTAL HOURS: 60 **CREDITS: 4**

Unit I **Credit hours: 10**

Development of Plant Biotechnology. Principles of Plant Tissue Culture: totipotency, differentiation. Design of laboratory and commercial tissue culture facility. Procedures in tissue culture: fumigation, wet and dry sterilization, ultraviolet sterilization, ultrafilteration and surface sterilization. Culture media: types, composition and preparation. Role of Plant growth regulators/retardants in plant tissue culture media. Explants for tissue culture: shoot tip, axillary buds, leaf discs, cotyledons, inflorescence and floral organs.

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Unit II **Credit hours: 15**

Initiation and maintenance of callus and suspension culture, single cell clones, somaclonal variations and their detection. Micropropagation: direct and indirect morphogenesis, organogenesis, somatic embryogenesis, and clonal propagation, caulogenesis, rhizogenesis, acclimatization, transfer and establishment of whole plants in soil.

Unit III **Credit hours: 10**

Protoplast isolation, culture and fusion. Selection of hybrid cells and regeneration of hybrid plants; symmetric and asymmetric hybrids; cybrids. Anther and pollen culture; production of haploid plants and homozygous lines. *In vitro* pollination, embryo culture and embryo rescue. Synthetic seed production.

Unit IV **Credit hours: 10**

Agrobacterium mediated gene transfer: Molecular biology of *Agrobacterium* infection, Ti plasmid, organization of T DNA, integration of T DNA into plant genome, vectors derived from pTi: cointegrate pTi vectors and binary vectors. Cryopreservation and germplasm conservation.

Unit V **Credit hours: 15**

Growth of plant cells in bioreactors, Production of active molecules, chemicals and secondary metabolites from plant cell cultures, metabolic engineering for secondary metabolites. Extraction of alkaloids and steroids, selection for cells for higher yields, cloning, mechanism of production. Application of plant biotechnology for production of quality oil and industrial enzymes. Elicitors and hairy root cultures for production of useful metabolites.

Suggested Readings

1. Robert Smith. Plant tissue culture : Techniques and Experiments. South Asia Edition.
2. Gamborg and Phillip. Plant Cell, Tissue and Organ Culture. Narosa.
3. Dixon and Gonzales. Plant Cell Culture. Panima.
4. Narayanswamy. Plant Cell and Tissue Culture. McGraw Hill.
5. Bhojwani, S.S. and Rajdan, M.K. Plant Tissue Culture : Theory and Practices a revised Edition. Elsevier.

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6. Razdan, M.K. Introduction to plant tissue culture. Oxford & IBH Publishers.
7. Chawla, H.S. Introduction to Plant Biotechnology. Oxford & IBH Publishers.
8. Dey, K.K. Plant Tissue Culture.

CC12 (M3BT04CT12): ADVANCED BIOTECHNOLOGY (THEORY)

TOTAL HOURS: 60 **CREDITS: 4**

Unit I **Credit hours: 10**

Genomics: DNA micro Arrays, strategies of whole genome sequencing and shot gun approach, contigs and genome assembly. Metagenomics- Introduction and applications. Proteomics technologies: Protein Arrays, Protein chips and their application, 2D Gel electrophoresis and its application, Mass spectrometry and protein identification.

Unit II **Credit hours: 10**

Stem cell basics: properties and types. Stem cell therapy. *In vitro* fertilization: Principle, methods and applications. Transplantation: Types of grafts, immunologic basis of graft rejection, mechanism and types of rejection, clinical manifestation of graft rejection, immuno suppressive therapy, immuno tolerance to allograft, clinical transplantation.

Unit III **Credit hours: 15**

Gene therapy: introduction, types, strategies and gene delivery system. Therapeutic applications of gene therapy in genetical and neurological disorders. Tissue engineering: design, scaffolds, biomaterials; production of complete organs like skin, cartilage, kidney, heart and eyes.

Unit IV **Credit hours: 10**

Cancer biology: introduction, types, development and causes, carcinogens, tumor suppressor genes, oncogenes; mechanism of activation, cancer prevention and treatment with special reference to nano biotechnological approach.

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Unit V **Credit hours: 15**

Introduction to Nano biotechnology, Biomaterials and biological materials-examples and uses. DNA nanotechnology, Nanopore and Nanoparticles-biological arrays- nanoprobes for analytical applications. Nano biosensors-nanoscale organization-characterization-quantum size effects-sensors of the future.

Suggested Readings

1. Kuby *et al.* Immunology. W.H. Freeman and Company.
2. Weinberg R A . the biology of cancer. John wiley and sons.
3. Poole and owens, introduction to nanotechnology. Wiley student edition .
4. Lesk A. introduction to protein sciences, oxford university press, second edition.
5. Jonathan Pevsner. Bioinformatics and Functional Genomics. Wiley India pvt. Ltd.

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SEMESTER –IV

DSE1: MINOR RESEARCH PROJECT

TOTAL HOURS: 60 **CREDITS: 4**

DSE2: a. AGRICULTURE BIOTECHNOLOGY

TOTAL HOURS: 60 **CREDITS: 4**

Unit I **Credit hours: 15**

Micropropagation and its application in forestry, floriculture, agriculture and conservation of biodiversity and threatened plants. Hardening and acclimatization – success and bottlenecks. Greenhouse: design, management and operation. Quality control, packaging and shipment, cost-benefit analysis.Global market, commercial oppurtunities in plant tissue culturewith special reference to plant tissue culture industries in India.

Unit II **Credit hours: 10**

Scaling-up production and automation in plant propagation. Use of robotics in plant production. Mass scale plant production facilities: design and planning, media preparation, storage, dispensation and examination and control. Air conditioning, air handling and purification, evaporative cooling, water treatment: softening, demineralization, distillation, reverse osmosis.

Unit III **Credit hours: 10**

In vitro approaches to genetic manipulations of plants. Development of transgenic plants for crop improvement, molecular farming, and study of regulated gene expression. Commercial status and biosafety concern of transgenic plant and ethical issues. Plantibodies, plant-derived vaccines.

Unit IV **Credit hours: 10**

Application of plant genetic engineering: current status and commercial opportunities for genetically engineered plants for stress tolerance: drought, salt, flooding and temperature, biotic and abiotic stress tolerance-insects, fungi, bacteria, viruses, weeds, herbicide and pesticide.

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Development of male sterile plants. Applications of plant tissue culture in plant pathology: development of virus free plant and development of disease resistant plants, growth of obligate parasites in culture.

Unit V **Credit hours: 15**

Genetic engineering for increasing crop productivity by manipulation of photosynthesis, nitrogen fixation, nutrient uptake efficiency. Quality improvement of protein, lipids, carbohydrates, vitamins and mineral nutrients. Molecular breeding and molecular tagging of genes. Brief idea of gene synteny, map based cloning and their use in transgenesis.

DSE 2: b. ENVIRONMENTAL BIOTECHNOLOGY (THEORY)

TOTAL HOURS: 60 **CREDITS: 4**

Unit I **Credit hours: 15**

Applications of microbes in biodegradation and bioremediation: Microbial degradation of cellulose, lignin, pesticides, xenobiotics and other recalcitrant chemicals, petroleum and hydrocarbons and its ecological significance. Bioprospecting and bioleaching, Bioaccumulation of heavy metals ions from industrial effluents. Biomining: Biooxidation-Direct and indirect mechanisms, Bacterial oxidation of sphalerite, chalcopyrite and Pyrite, Microbial leaching; Recovery of metals from solutions; Microbes in petroleum extraction.

Unit II **Credit hours: 10**

Biomagnification and degradative plasmids, biotransformation. Biodeterioration and its control. Biological control and biopesticides. definition, significance, types , sources, manufacture, use and mode of action. Entemopathogenic fungi, viral insecticides. significance of *Bacillus thuringiensis* in biocontrol.

Unit III **Credit hours: 15**

Microbes and pollution :waste water; Types, Sources, Microbiology. Methods of waste water treatment. Eutrophication: Definition, causes and effects. Algal blooms, Red tides. Solid waste: Source, types and characterization. Methods of treatment: Physical, chemical, biological,

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aerobic, anaerobic, primary, secondary and tertiary treatments. Use of genetically engineered organisms for control of pollution.

Unit IV **Credit hours: 10**

Bioconversion of Solid Waste: Composting, vermi composting and vermi culture. Microbial biofertilizers: types, sources, manufacture and significance. Green manuring, Mycorrhizae as fertilizers: Rhizhobia and other symbiotic and non symbiotic nitrogen fixing microbes as biofertilizer. Application of microbes as biofertilizers. Significance and application of PSB (Phosphate Solubilizing Bacteria) and PGPR (Plant Growth Promoting Rhizobacteria).

Unit V **Credit hours: 10**

Microbes as biological weapons, Role of microbes in production of Biofuels. Biogas production and factors affecting methane formation. Biosensors: Principle, working, Types of biosensors Applications of biosensors in environmental monitoring. Application of microbes as biosensors.

Suggested Readings

1. Mooray Moo-Young. (Eds). Comprehensive Biotechnology (Vol. I, II, III) Pergamon Press, England.
2. Metcalf and Eddy. Waste water engineering treatment and uses. McGraw Hill.
3. Jogdand, S.N. Environmental Biotechnology. Himalaya Publication House.
4. De, A.K. Environmental Chemistry. Wiley Eastern Ltd.
5. Abbasi and Abbasi. Renewable Energy Sources and their environmental impact. Prentice Hall of India, Pvt. Ltd.
6. Chatterji, A.K. Introduction to Environmental Biotechnology. Prentice Hall of India.
7. Thakur, I. S. Text Book of Environmental Biotechnology. I. K. International Publisher, New Delhi.
8. Mohapatra, P. K. Text Book of Environmental Biotechnology. I. K. International Publisher, New Delhi.

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DSE3: a. FOOD AND DAIRY BIOTECHNOLOGY (THEORY)

TOTAL HOURS: 60 **CREDITS: 4**

Unit – I **Credit hours: 12**

Starter cultures and their biochemical activities; production of alcoholic beverages; production of Single cell protein and Baker's yeast; Mushroom cultivation, Food and dairy products: Cheese, bread and yogurt. Fermented vegetables – Saurkraut; Fermented Meat – Sausages

Unit - II **Credit hours: 12**

Novel microorganisms eg. LAB (Probiotics), Cyanobacteria, methylotrophs, enzyme biotransformations, Role of Plant tissue culture for improvement of food additives; color and flavor, Genetic modifications of microorganisms; detection and rapid diagnosis. Genetically modified foods and crop.

Unit - III **Credit hours: 12**

Food borne infections and intoxications; with examples of infective and toxic types-Clostridium, Salmonella, Staphylococcus Mycotoxins in food with reference to *Aspergillus* species.

Unit - IV **Credit hours: 12**

Food preservation: canning, dehydration, ultrafiltration, sterilization, irradiation. Chemical and naturally occurring antimicrobials. Fermented foods and beverages. Use of biosensors in food industry.

Unit - V **Credit hours: 12**

Quality assurance: Microbiological quality standards of food Intellectual property rights and animal welfare, Government regulatory practices and policies. FDA, EPA, HACCP, ISI Risk analysis; consumer and industry perceptions.

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Suggested Readings:

1. Adams MR and Moss MO. (1995). Food Microbiology. 4th edition, New Age International (P) Limited Publishers, New Delhi, India.
2. Banwart JM. (1987). Basic Food Microbiology. 1st edition. CBS Publishers and Distributors, Delhi, India.
3. Davidson PM and Brannen AL. (1993). Antimicrobials in Foods. Marcel Dekker, New York.
4. Dillion VM and Board RG. (1996). Natural Antimicrobial Systems and Food Preservation. CAB International, Wallingford, Oxon.
5. Frazier WC and Westhoff DC. (1992). Food Microbiology. 3rd edition. Tata McGraw-Hill Publishing Company Ltd, New Delhi, India.
6. Gould GW. (1995). New Methods of Food Preservation. Blackie Academic and Professional, London.
7. Jay JM, Loessner MJ and Golden DA. (2005). Modern Food Microbiology. 7th edition, CBS Publishers and Distributors, Delhi, India.
8. Lund BM, Baird Parker AC, and Gould GW. (2000). The Microbiological Safety and Quality of Foods. Vol. 1-2, ASPEN Publication, Gaithersberg, MD.
9. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9th edition. Pearson Education

DSE 3: b. FERMENTATION TECHNOLOGY (THEORY)

TOTAL HOURS: 60 **CREDITS: 4**

Unit I **Credit hours: 10**

Fermentation processes: types; batch culture, continuous culture, fed-batch culture, Applications and examples. Growth kinetics, Measurement of growth (cell number, indirect and direct methods), Effects of temperature, pH, high nutrient concentration on growth and product formation. TDT,TDP, Death Kinetics.

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Unit II **Credit hours: 15**

Bioreactors and Fermentors: Design and components, types, functions, Maintenance of aseptic conditions, Reactors for specialized applications. Sterilization of Bioreactors, nutrients, air supply, products and effluents, process variables and control, physical and chemical environment sensors. Media and materials required for industrial process-sources, formulation, antifoams and optimization. Sterilization of media.

Unit III **Credit hours: 10**

Scale up, Downstream processing: Introduction, removal of cells and solid matter. Foam reparation, precipitation, centrifugation, cell disruption. Product recovery processes and unit operations. Microorganisms used in industrial processes, Screening, Isolation, Preservation, Strain improvement and storage of industrially important microorganisms. Inoculum development for large scale bioprocess.

Unit IV **Credit hours: 15**

Production of commercially important products: Enzymes, organic acids, amino acids, Vitamins B12, hormones, Antibiotics, Steroids. Yeast: types and applications, productions of bread, pre fermentating, fermentative and post fermentative practices. Alcoholic beverages: types and production. Starter cultures and their biochemical activities. Application of microbial enzymes in food industry.

Unit V **Credit hours: 10**

Microbial spoilage of food and poisoning. bacterial and mycotoxins. Principles and methods of food preservation. Microbiological quality standards of food. Regulatory practices and policies: FDA, EPA, HACCP, ISI. Detection and Enumeration of microbes in Foods. Food plant sanitation. Indicator organisms, coliform bacteria, probiotics; organismsm and significance. Prebiotics and synbiotics. Microbial anti oxidants. Biosurfactants as emulsifiers, Applications of microbial polysaccharides as stabilizers and thinners, flavors etc.

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Suggested Readings

1. Hui, Y. Handbook of Food and Beverage Fermentation Technology (Food Science and Technology).
2. Rastogi, S.C. Biotechnology: Principles And Applications.
3. Panday, A. Advances in Fermentation Technology.
4. Stanbury, P.F. Principles of fermentation Technology

DSE 4: a. MEDICAL AND PHARMACEUTICAL BIOTECHNOLOGY

TOTAL HOURS: 60 **CREDITS: 4**

Unit I **Credit hours: 10**

Disease diagnosis: probes, detection of genetic diseases. Uses of products of non recombinant and recombinant organisms for disease treatment. Drug manufacturing process. Drug design: ligand based, structure based, active site identification, ligand fragment link, scoring method. computer aided drug design.

Unit II **Credit hours: 15**

Drug metabolism: Non Synthetic-oxidation, reduction, hydrolysis etc., conjugation reactions-methylation, sulphation etc. Factors affecting drug metabolism, Drug development process: pharmacological microbial, recombinant, biochemical and molecular level screening system and their construction strategies.

Unit III **Credit hours: 15**

Drug delivery-theory of controlled release drug delivery systems: zero order kinetics, theory of diffusion: release and diffusion of drug polymers. Types of drug delivery- Targeted, Thin film, self microemulsifying, acoustic, neural, drug carrier, liposomes, microspheres, nanofibers etc.

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Unit IV **Credit hours: 10**

Antibiotics- mechanism, side effects, metabolisms, bioavailability, representative member, resistance, uses of β lactam (penicillin), aminoglycosides (Streptomycin), tetracycline, metronidazole, rifampicin, daptomycin, sulphonamides, multiple drug resistance.

Unit V **Credit hours: 10**

Production of Biopharmaceuticals- Insulin, Inerferon. Vaccines-Live vaccines, killed vaccines-Subunit vaccines-Recombinant vaccines-DNA vaccines, Applications of biotechnology in forensics. Microencapsulation in medicine, Biosensors and their applicaiton in medicine. Detection of genetic diseases: amniocentesis, carrier detection.

Suggested Readings:

1 Christopher, H. Gene cloning and Manipulation. Cambridge University, Press.
2 Nicholl, D.S.T. An introduction to genetic engineering. Cambridge University Press.
3 Sambrook, Russell and Maniatis. Molecular Cloning : A Laboratory Manual (Vol. I, II and III).Cold Spring Harber Laboratory.
4 Glover, D.M. and Hames, B.D. DNA Cloning : A (Practical) approach. IRL Press. Oxford.
5 Brown, T.A. Gene cloning. Blackwell Publisher.
6 Kreuzar, H. and Massey, A. Recombinant DNA technology. A.S.M. Press, Washington.
7 Primrose, S.B. Molecular Biotechnology. Panima.
8 Watson and Zoller. Recombinant DNA. Panima.
9 Boylan, M. Genetic engineering – science and ethics on new frontier. Pearson Edu.
10 Old and Primrose. Principles of Gene Manipulation.
11 Glick and Pasternak. Molecular Biotechnology. ASM Press Washington, USA.

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DSE 4: b. HOST-PARASITE INTERACTIONS

TOTAL HOURS: 60 **CREDITS: 4**

Unit I **Credit hours: 12**

Microbial parasites: Historical account; Bacteria, Fungi, Viruses, Protozoas, Helminthes and Arthropods, Prions; Host-parasite relationship; Infection-mode of transmission in infection, factors predisposing to microbial pathogenecity, types of infectious diseases

Unit II **Credit hours: 12**

Invasion of Microbes: Adsorption to the potential sites, membrane trafficking in eukaryotic cells, routes of invasion and selection of intracellular niche, bacterial manipulation of host cell cytoskeleton, nosocomial infection; Normal microflora of human body; Bacterial toxins and virulence genes; Strategies of host defense.

Unit III **Credit hours: 12**

Methods of Disease Diagnosis: Sampling site-normally sterile and with normal microflora; Sample collection-method of collection, transport and processing of samples, interpretation of results; Diagnostic methods- cultured: microscopy, microbial antigen; non-cultured: PCR based microbial typing: Eubacterial identification based on 16s rRNA sequences.

Unit IV **Credit hours: 12**

Diagnosis of Infections : Bacteria- *Streptococcus*, Coliforms, *Salmonella*, *Shigella, Vibrio* and *Mycobacterium*; Fungi-Major fungal diseases, Dermatophytoses, Candidiosis and Aspergillosis DNA and RNA Viruses- POX virus, Rhabdo Virus, Hepatitis Virus and Retro Virus.

UNIT V **Credit hours: 12**

Diagnosis of Infections Viruses-AIDS Virus; Protozoan diseases-Amoebiosis, Malaria, Trypnosomiosis, Leishmaniasis; Helminthis diseases- *Fasciola hepatica* and *Ascaris lumbricoides*; Filariasis and Schistomiosis.

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Suggested Readings

1. Bailey and Scott□s Diagnostic Microbiology (2002). Betty A. Forbes, Daniel F. Sahm, Alice S. Weissefeld, Ernest A Trevino. Published by C.V. Mosby
2. Medical Microbiology (1997). Edited by Greenwood. D, Slack. R and Peutherer. J, ELST Publishers.
3. Fundamental of Molecular Diagnostics (2007). David E. Bruns, Edward R. Ashwood, Carl A. Burtis. Sauders group.
4. Henry□s Clinical Diagnosis and Management by Laboratory Methods (2007). Mepherson.
5. Molecular Diagnostics for the Clinical Laboratorian 2nd ed. (2006). W.B.Coleman. Humana Press.

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BT SEC1 (M2BT07SEC01): SKILL DEVELOPMENT COURSES
DEPARTMENT OF BIOTECHNOLOGY

TECHNIQUES OF MOLECULAR BIOLOGY

TOTAL HOURS: 30 **CREDITS: 2**

Duration- 6 Months

Overview- This short-term training course is intended to offer students a platform to learn various modern tools of molecular biology that are now regularly used in advanced research laboratories. It has been designed to sensitize the participants about the enormous potential of several advanced techniques to enable them to utilize these techniques in their fields of research.

Eligibility: Higher secondary /U.G. /P.G. in Science

Goal

Our intentions are to provide these candidates with an exposure to an international quality biotechnology research environment. Through this experience, the student will become skilled in various molecular biology techniques and become efficient in solving major biotechnological queries.

Fee – 15,000/- per student

Student intake - 20

Course details-

UNIT I **Credit hours: 6**

Instrumentation in Molecular Biology.

UNIT II **Credit hours: 6**

Isolation and purification of Genomic DNA, Quantitative and Qualitative Analysis of Nucleic acids, Isolation and purification of Plasmid DNA

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UNIT III **Credit hours: 6**

Agarose Gel Electrophoresis, SDS Poly Acrylamide Gel Electrphoresis for Protein

Native Poly Acrylamide Gel Electrphoresis

UNIT IV **Credit hours: 6**

Restriction Digestion, PCR Techniques

UNIT V **Credit hours: 6**

Isozyme analysis

BT SEC2(M3BT07SEC02): TECHNIQUES OF PLANT BIOTECHNOLOGY

TOTAL HOURS: 30 **CREDITS: 2**

Duration - 6 Months

Overview- The objective of the training program is to prepare young tissue culturist to work on important problems in plant tissue culture. This involves not only collaborations, but also exchange of ideas among the larger group of trainees and training faculty in the fields of Biotechnology. These interactions range from informal conversations in the laboratory and shared equipment facilities, but also in organized seminars, joint group meetings, journal clubs and graduate classes.

Eligibility: Higher secondary /U.G. /P.G. in Science

Goal

Our goal is to produce intellectually critical and skilled technologists with the skills necessary for a productive career in the Biotechnology. Through this experience, the trainee becomes skilled at posing questions about fundamental biological processes and designing experiments to answer those questions. The training is augmented by formal courses offered by the Biology by seminar programs that highlight current research in Plant tissue culture and related disciplines, by the close involvement of a Thesis Advisory Committee, and by research seminar and journal club presentations by trainees.

Fee – 15,000/- per student

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Student intake – 20

Course Details-

UNIT I **Credit hours: 6**

Instrumentation in Plant tissue culture

UNIT II **Credit hours: 6**

Preparation of Stock solution, Preparation of media, Preparation of Hormone stock solution

UNIT III **Credit hours: 6**

Sterilization techniques

UNIT IV **Credit hours: 6**

Callus culture, Embryo culture, Anther culture, Meristem culture, Root culture

UNIT V **Credit hours: 6**

Synthetic seed, Somatic embryogenesis