University of Pune

Two Years M.Sc. degree course in

BIOTECHNOLOGY

M.SC. I BIOTECHNOLOGY

Syllabus for Affiliated Colleges

(To be implemented from Academic Year 2013-14)

Preamble:

Biotechnology has grown, extensively in last couple of decades.This advanced 'interdisciplinary' life science branch has a tremendous networking potential with modern cutting edge technology. This has given it a separate status in fundamental research as well as in modern industrial enterprise. Global and local focus has slowly shifted to not only current "Century of Knowledge" but also on to technology development and application in life sciences. In the milieu of research and industrialization for economic development and social change, biotechnology is an ideal platform to work.

The interdisciplinary nature of biotechnology flags involves many fundamental research fields from cell biology to molecular biology, from biochemistry to biophysics, from genetic engineering to stem cell research, from bioinformatics to genomics-proteomics, from environmental biology and to biodiversity, from microbiology to bioprocess engineering, from bioremediation to In silco drug discovery and so on. The proposed credit-based curriculum and grading system will even add much more to the existing interdisciplinary nature of biotechnology and will also offer many courses to the other branches of life science. The generative power of biological data is effectively harnessed by biotechnology like no other field. The relevance and application of these studies on living organisms and their bioprocesses is extensively covered in this field with the help of technology.

Economic and social renaissance is staged on biotechnology especially, since it's biomedical and cutting edge technological applications are tremendously powerful in shaping this century and exciting biofuture. Life science, IT industries and research institutes are always on a lookout for trained Biotechnologists as an efficient work force in fundamental research and industries. Education and research sectors require such interdisciplinary trained workforce to develop future generations of science leaders.

Introduction:

Master's in Biotechnology course syllabus is revised to cater to the needs of credit based-semester and grading system. The changing scenario of higher education in India and abroad is taken into consideration to make this syllabus more oriented towards current need of modern research and industrial sectors. The syllabus encompasses the fundamental academics at one end and latest technologies in life science at the other. Theory courses will help students develop their knowledge sets on various topics of biotechnology, to which, they are introduced at the undergraduate level. Extensive practical courses are designed to supplement the theory courses with hands on experimentation in wet-lab and on fields.

Empowerment of students to face research and industrial outlets is at the centre of this syllabus. Students having to select their own courses will develop the depth in specialization and also make them ready to face the cutting edge of life science establishment in the world without any further training. The colleges are encouraged to develop their own departmental courses based on available expertise, both, personnel and infrastructural.

We have prepared M.Sc. syllabus by keeping in vision the undergraduate curriculum. At the undergraduate level, students were introduced to many fundamental topics in life sciences such as molecular biology, developmental biology, fermentation technology, biodiversity, bioinformatics and tissue culture etc. At the post graduate level they will be exposed to the advanced principles of biochemistry, genetics, molecular and cell biology, environmental biology, microbiology, bioinformatics etc. along with technological advances and applications of basic principles to successfully carry out research and industrial developments. A research project/ industrial training modules are incorporated to provide a buffer zone for budding biotechnologists eager to enter the life science sector.

Objectives to be achieved:

- To help the students to build interdisciplinary approach
- To empower students to excel in various research fields of Life Sciences
- To inculcate sense of scientific responsibilities and social and environment awareness
- To help students build-up a progressive and successful career

Eligibility:

Students with B.Sc in Biotechnology securing a minimum of 55% marks.

M.Sc. Course structure

T/P	Code	Course title	Marks	Hours	Credits
Semester I					**25**
T	BT 101	Advanced Biological Chemistry	100	60	4
T	BT 102	Molecular Biology	100	60	4
T	BT 103	Environmental Biotechnology	100	60	4
T	BT 104	Cell Biology	100	60	4
P	BT 105	Exercises in Advanced Biological Chemistry	100	60	4
P	BT 106	Exercises in Molecular and Cell Biology	75	45	3
P	BT 107	Exercises in Environmental Biotechnology	50	30	2
Semester II					**25**
T	BT 201	Genetic Engineering	100	60	4
T	BT 202	Immunology	50	30	2
T	BT 203	Principles of Bacteriology and Virology	100	60	4
T	BT 204	Plant Biotechnology	100	60	4
P	BT 205	Exercises in Genetic Engineering	100	60	4
P	BT 206	Exercises in Immunology	50	30	2
P	BT 207	Exercises in Plant Biotechnology	75	45	3
P	BT 208	Exercises in Bacteriology and Virology	50	30	2
Semester III					**25**
T	BT 301	Animal Biotechnology	100	60	4
T	BT 302	Bioprocess engineering &Fermentation Technology	100	60	4
T	BT 303	Data Base Management and IPR in Biotechnology	50	30	2
T	BT 304	Advanced Genetics	75	45	3
T	BT 305	Bioinformatics	50	30	2
P	BT 306	Exercises in Animal Biotechnology	75	45	3
P	BT 307	Exercises in Bioprocess Engineering	75	45	3
p	BT 308	Exercises in Bioinformatics	50	30	2
T	BT 309	Seminars, Term paper writing	50	30	2
T	BT 310#	Scientific Research and Communications	100	60	4
T+P	BT 311#	Food Technology and Neutrigenomics	50+25	30+15	3
Semester IV					**32**
T	BT 401	Genomics and Proteomics	100	60	4
T	BT 402	Biochemical and biophysical techniques	100	60	4
P	BT 403	Exercises in Biochemical and Biophysical techniques	50	30	3
T+P	BT 404	Nanobiotechnology	50+25	30+15	3
T	BT 405	Stem Cell Technology and Regenerative Medicines	100	60	4
T	BT 406	Agricultural Biotechnology	100	60	4
P	BT 407	Project	250	150	10
T	BT 408#	Bio-entrepreneurship	50	30	2

 # = Departmental courses, T = theory courses, P = Practical courses,

T+P = Theory + Practical courses

The Project will consist of not more than ten percent of the total credits for the degree course. Students have to opt for minimum 75% credits from the parent department and remaining 25% can be opted from other department/s.
Courses offered in Semester I and Semester II are core courses (equivalent to 50 credits) meaning that these are compulsory. From among the courses of semester III and IV one has to complete 50 credits (Of which 25 credits can be opted from other Department/s). Thus total 100 credits to be completed for obtaining degree in Biotechnology.
"Departmental courses" can be offered in the third or fourth semester up to 4 credits. For these courses both internal and semester end examination should be conducted by the respective Departments and the grade points and grade obtained should be informed to the University examination unit.

Examination pattern:
Each course will have:
50% marks for internal (i.e. in-semester) assessment.
50% of marks for semester-end examination conducted by University of Pune.
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.

Theory examination:
Internal examination: At least one internal assessment must be conducted for the one credit course. (four tests for four credits course)
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:

- Written Test and/or Mid Term Test (not more than one or two for each course)
- Term Paper;
- Journal/Lecture/Library notes;
- Seminar presentation;
- Short Quizzes;
- Assignments;
- Extension Work;
- An Open Book Test (with the concerned teacher deciding what books are to be allowed for this purpose

External Examination:

Theory examination will be conducted for a period of maximum 45 minutes for each credit.

The Pattern of question paper for one credit course (12 Marks): There shall be a single question asked.

Question 1	3 out of 5 6 sub-questions, each of 4 marks; short answer type questions; answerable in 10 – 15 lines

The Pattern of question paper for two credit course (25 Marks): There shall be 2 questions in all.

Question 1	3 out of 5 sub-questions, each of 5 marks; short answer type questions; answerable in 10 – 15 lines
Question 2	1 out of 2 sub-questions, each of 10 marks; long answer type questions; answerable in 20-25 lines

The Pattern of question paper for three credit course (38 Marks): There shall be 3 questions in all.

Question 1	2 out of 4 sub-questions, each of 5 marks; short answer type questions; answerable in 10 – 15 lines
Question 2	4 out of 6 sub-questions, each of 5 marks; short answer type questions; answerable in 10 – 15 lines
Question 3	1 out of 2 sub-questions, each of 8 marks; long answer type questions; answerable in 20-25 lines

The Pattern of question paper for four credit course (50 Marks): There shall be 3 questions in all.

Question 1	4 out of 6 sub-questions, each of 5 marks; short answer type questions; answerable in 10 – 15 lines
Question 2	4 out of 6 sub-questions, each of 5 marks; short answer type questions; answerable in 10 – 15 lines
Question 3	1 out of 2 sub-questions, each of 10 marks; long answer type questions; answerable in 20-25 lines

Practical examination: Practical examination will be of the same duration as that of the practical exercises for that course. There shall be 10 marks for laboratory log book and journal, 10 marks for viva-voce. For practical course of four credits at least three experiments should be

asked. For the course of two/ three credits at least two experiments and for the course of single credit one experiment should be asked. Certified journal is compulsory for appearing for practical examination. There shall be two experts and two examiners per batch for the practical examination. One of the examiners will be external.
Setting question papers: Questions should be designed to test the conceptual knowledge and understanding of the basic concepts of the subject.

Examination rules.

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.
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 she\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.
A student cannot register for the third semester, if she/he fails to complete 50% credits of the total credits expected to be ordinarily completed within two semesters.

Evaluation:
Marks for all the examination have to be converted to the grade.
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.
The semester end and final grade sheets and transcripts will have only grades and grade points average.
On Completion of 100 credits by the student report card should display grade point and cumulative grade point average (CGPA).
Grading for individual course

Marks	**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 0	F: Fail	00

Final grade points

Grade point	Final grade
05.00-6.0	O
04.50-4.99	A
03.50-4.49	B
02.50-3.49	C
01.50-2.49	D
00.50-1.49	E
00-00-0.49	F

Grade point average = Total of Grade Points Earned X Credit hrs for each course

(CGPA) ----------

Total Credits Hours

Qualification of Teachers:

With minimum postgraduate degree in Microbiology/Zoology/Botany/Health Science/Environmental Science or other related branch of Life Science and NET/SET qualified as per UGC regulations. Preferably candidates with PhD degree should be appointed for post graduate teaching.

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T	BT 305	Bioinformatics	50	30	2
P	BT 306	Exercises in Animal Biotechnology	75	45	3
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BT 101: Advanced Biological Chemistry (4C)

Sr.No.	Topic	Lectures (60L)
1	Specific Biomolecules and their structure & function Carbohydrates – storage carbohydrates -starch & Glycogen Cellulose, peptidoglycan chitin Glycoproteins & Glycolipids Lipids- Liporoteins, Signaling molecules and hormones Proteins- Peptide hormones, Growth hormones, Kinases, Cytokine receptors	8
2	Protein Biochemistry Primary, Secondary, Tertiary, quaternary Structure Post translational Modifications : Protein folding- Molten globule, chaperon, Protein Misfolding Protein Processing- Proteolytic cleavage (Pre, Pro, removal Protein Modifications - Glycosylation Phophorylation Lipids attachment Glycolipids Protein degradation – Lysosomal & proteosomal ubiquitination Enzymes–Activity, Regulation, Kinetics single substrate, Enzyme in diagnostics	15
3	Disorders of Metabolism- Introduction, Nutritional disorder-PEM(Kwashiorkar and Marasmus),Obesity Metabolic disorders-Diabetes Inborn errors of metabolism- i) Protein-PKU, Alkaptonuria and Maple syrup and Gauchers Carbohydrates - glycogen storage disorders, Cori's disease and Pomes disease Lipids- Atherosclerosis Nucleic acids- Gout, Lesch-Nyhan syndrome, Sickle cell anaemia	7
4	Metabolomics Overview of primary metabolism, Integration of Metabolism The Metabolome – Metabolic flux, Metabolic flux analysis Metabolic engineering – 2 eg. Polyketides Synthesis, Xenobiotics	15

5	Phytochemsitry – Introduction to secondary Metabolism, primary metabolite as precursors of secondary Metabolite purple pathways for secondary Metabolite Synthesis : Mevalonate pathways Shikimate Isoprene Unit Pathways (IPP) Variation of species . temporal & special variation Study of secondary Metabolite for : structure, classifiacation, properties & Therapeutic Plant sources as examples for each type Alkaloids Phenols Terpenes Phytochemical investigation Extraction methods & Qualitative & Quantitative Analysis	15

References:

1. Proteins: biotechnologyand biochemistry, 1st edition (2001), Gary Walsch, Wiley, USA
2. Phytochemical Method, 3rd edition (1998), A.J. Harborne, Springer, UK.
3. Pharmacognosy, 14th edition, (2008), Dr. C. K. Kokate, A. P. Purohit, S. B. Gokhale, Nirali Prakashan, India.
4. Trease and Evans' Pharmacognosy, 16th edition (2009), William Charles Evans, Saunders Ltd. USA.
5. Introduction to Practical Biochemistry, (2000), S. K. Sawhney, Randhir Singh Narosa, 2000. Practical Enzymology, 2nd edition (2011), Hans BissWanger, Wiley-Blackwell, USA.
6. Biochemical Calculations, 2nd Ed., (1997) Segel Irvin H., Publisher: John Wiley and Sons, New York.
7. Enzymes: Biochemistry, Biotechnology & Clinical chemistry, (2001) Palmer Trevor, Publisher: Horwood Pub. Co., England.
8. Metabolic Engineering: Principles and Methodologies. (1998). Gregory N Stephanopoulos, Aristos A Aristidou, Jens Nielsen. Publisher: Academic Press, San Diego, US
9. Outlines of Biochemistry: 5th Edition, Erice Conn & Paul Stumpf ; John Wiley and Sons, USA
10. Fundamentals of Biochemistry. 3rd Edition (2008), Donald Voet & Judith Voet , John Wiley and Sons, Inc. USA
11. Lehninger, Principles of Biochemistry. 5th Edition (2008), David Nelson & Michael Cox, W.H. Freeman and company, NY.
12. Outlines of Biochemistry: 5th Edition, (2009), Erice Conn & Paul Stumpf ; John Wiley and Sons, USA
13. Biochemistry: 7th Edition, (2012), Jeremy Berg, Lubert Stryer, W.H.Freeman and company, NY
14. An Introduction to Practical Biochemistry.3rd Edition, (2001), David Plummer, Tata McGraw Hill Edu.Pvt.Ltd. India
15. Biochemical Methods.1st , (1995), S.Sadashivam, A.Manickam, New Age International Publishers, India

BT 102: Molecular Biology (4C)

Sr. No.	Topic	Lecture (Total 60)
1	**Genome Structure and Organization** Definition and organization of viral, prokaryotic and eukaryotic genomes: Structure of chromatin, nucleosome, chromatin organization and remodeling, higher order organization- chromosome, centromere, telomere, Histones and their effect on structure and function of chromatin. C value paradox and genome size, Cot curves, repetitive and non-repetitive DNA sequences, Cot ½ and Rot ½ values, satellite DNA, DNA melting and buoyant density. Gene families, clusters, Pseudogenes, super-families, Organelle genomes	8
2	**DNA Replication** DNA polymerases and mechanisms of DNA replication in prokaryotes and eukaryotes DNA replication models, connection of replication to cell cycle, Gene amplification (rRNA) Reverse Transcriptase	5
3	**DNA damage and Repair** Types of DNA damage, DNA repair mechanisms- nucleotide excision repair, base excision repair, mismatch repair, recombination repair, double strand break repair, transcriptional coupled repair	4
4	**Recombination** Homologous and site-specific recombination, models for homologous recombination- Holliday junction, NHEJ, Proteins involved in recombination- RecA, RuvA, B, C, Gene conversion	3
5	**Gene Expression in Prokaryotes and Eukaryotes** Transcription: Basic mechanism in prokaryotes and eukaryotes. RNA polymerases Chromatin remodeling in relation to gene expression, DNase hypersensitivity, DNA methylation. Regulation of transcription including transcription factors. Post-transcriptional processing and transport of RNA. Non coding RNAs, Organization and structure-function of ribonucleoproteins (Ribonome concept).	20
6	**Mobile DNA elements** Transposable elements in bacteria, IS elements, composite transposons, replicative and non-replicative transposons, Mu transposition, Controlling elements in TnA and Tn 10 transposition. SINES and LINES, retrotransposons	4
7	**Protein Synthesis, Modifications and Transport** Components of protein synthesis, Mechanism of protein synthesis, Genetic code Regulation of protein synthesis, Post translational modifications Transport of proteins, Protein turnover and degradation	15

Reference Books:

1. Genes XI, 11th edition (2012), Benjamin Lewin, Publisher - Jones and Barlett Inc. USA
2. Molecular Biology of the Gene, 6th Edition (2008), James D. Watson, Tania Baker, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Lodwick. Pearson Education, Inc. and Dorling Kindersley Publishing, Inc. USA
3. Molecular Biology, 5th Edition (2011), Weaver R., McGrew Hill Science. USA
4. Fundamentals of Molecular Biology, (2009), Pal J.K. and Saroj Ghaskadbi, Oxford University Press. India
5. Molecular Biology: genes to proteins, 4th edition (2011), Burton E Tropp, Jones & Bartlett Learning, USA

BT 103: Environmental Biotechnology (4C)

Sr. No.	Topic	Lectures (60L)
1	Threats to Environment	**15**
	Global and regional threats to the environment	1
	Air Pollution Monitoring: Air and Water quality standards, Transport and diffusion.	2
	Soil Pollution: Types, sources and impacts on the environment, Waste water disposal on land: Methods and specifications, Pesticide/ Insecticide/fungicide pollution- Impact on microbial diversity of soil.	4
	Solid waste: Sources and types, Impact on land of solid waste disposal, Recycle, Reuse and Recovery.	4
	Water pollution: Waste water sources, Waste water treatment plant- Physical, Chemical and Biological unit operations/processes-overview, Activated Sludge Process, Trickling Filters, Oxidation ponds, Anaerobic biological treatment process, Nitrogen and Phosphorus removal	4
2	Biotechnology in Remediation	**17**
	Introduction to bioremediation, Advantages, limitations and applications	3
	Types of Bioremediation and Factors affecting: Natural, Engineered, *Ex-situ* and *in-situ*	7
	Phytoremediation, Bioaugmentation, Biostimulation.	7
3	Environmental Laws and Policies	**12**
	International: in the view of global concerns, objectives of laws/regulations, importance Stockholm conference, Nairobi declaration, Rio conference,	4
	India: Environmental Policy and overview of laws, Anti Pollution Acts: The water Act. 1974, The Air Act 1981, The Environment Protection Act 1986- Their important objectives	4

	Sustainable development: Concept, Sustainability in use of bio-resources, Ecoplanning.	4
4	Remote sensing and Environmental Auditing	**16**
	Remote sensing and GIS- Principal, terminologies and objectives, Energy sources for remote sensing, Types of remote sensing, Applications- Agricultural, Forestry, Water Resource, Urban Planning, Wildlife Ecology, Disaster Assessment.	6
	Environmental Impact Assessment: Introduction, Objectives, Classification, Guidelines. Case Study.	5
	Environmental Audit: Introduction, Types, General Methodology, International and Indian Eco-standards ISO14000 series overview.	5

References:

1. Advanced Renewable Energy Sources (2012) **Gopal Nath Tiwari and R K Mishra,** *RSC Publishing, London.*
2. Agenda 21: Guidelines for Stakeholders **Patwardhan & Gunale,** *Pune.*
3. Air Pollution (2004) **HVN Rao and M N Rao** *Tata McGraw-Hill, , New Delhi*
4. Air Pollution Control **CP Mahajan,** *Capital Publishing Co, New Delhi*
5. Air Pollution Engineering Manual (2000) **Wayne T Davis (editor)**, *Air and Waste Management Association, Wiley Interscience,, New Jersey*
6. An Introduction To Geographic Information Technology (2009) **Suchandra Choudhury** *I K International Pvt Ltd., New Delhi*
7. Bioremediation (1994) **Baker, K.H and Herson**, *D.S.Mc Graw Hill, Inc. New York*
8. Biotreatment of Industrial & Hazardous Waste (1993) **M.V.Levin and Gealt,** *M.A McGraw Hill. Inc, New York*
9. Concepts and Techniques of Geographic Information Systems (2009) **C.P.Lo.Albert and K.W.Yeung** *2nd edition, Prentice Hall, Inc., New Jersey*
10. Ecology and environmental biology (2011) **Saha T K** *Books & Allied (p) Ltd, Delhi*
11. Environment Problems & Solutions (2001) **Asthana & Asthana** *S. Chand Limited, New Delhi*

12. Environmental Audit (2002) **Mhaskar A.K.** *Enviro Media Publications*
13. Environmental Biology (2000) **Varma & Agarwal** *S. Chand Limited, New Delhi*
14. Environmental biology and toxicology (2011) **Sharma PD** *Rajpal And Sons Publishing, Delhi*
15. Environmental biotechnology(2010) **Rana** *Rastogi Publications, Delhi*
16. Environmental chemistry (2003) **A. K. De** *5th edition, New Age International Ltd, New Delhi*
17. Environmental Chemistry (2007) **B.K. Sharma** *11th edition, Goel Publishing House, Delhi*
18. Environmental Protection and Laws (1995) **Jadhav and Bhosale** *V.M.Himalaya publishing House, Delhi*
19. Environmental risks and hazards (1994) **Susan Cutter** *Prentice Hall, Inc., New Jearsey*
20. Environmental Science (2011) **Santra S.C.** *New Central Book Agency,Kolkata*
21. Handbook of the Convention on Biological Diversity (2001) Secretariat of the Convention on
22. Management of Municipal Solid Waste (2006) **T V Ramchandra** *Capital Publishing, New Delhi*
23. Natural Resource Management And Sustainable Development In North-East India (2007) **Nursadh Ali** *Mittal Publication, Delhi*
24. Natural system for waste management and Treatment (1995) **Reed S.C, Crites RW and Middlebrooks EJ** *McGraw Hill, New York*
25. Non-conventional Energy Sources (1998) **G.D Rai** *Dhanpat Rai and Sons, New Delhi*
26. Remote sensing of the environment (2000) ***John R. Jensen*** *Dorling Kindersley India Pvt. Ltd*
27. Soil and Water Conservation Engineering (1981) **G. O. Schwab, Richard K. Frevert, Talcott W. Edminster, and Kenneth K. Barnes** *4th edition, John Wiley and Sons, New Jersey*
28. Text book of Environmental Engineering (2005) **P. Venugopala Rao** *PHI learning Pvt Ltd, Delhi*
29. Textbook of Remote sensing and GIS (2006) **M. Anji Reddy** *3rd edition, BS Publication, Hyderabad*
30. The ISO 14000 Handbook (1999) **Joseph Cascio** *2nd edition, ASQ Quality Press, Milwaukee,USA*
31. The Nature and Properties of Soils (1999) **N. C. Brady** *12th edition, Prentice-Hall, New Jearsey*
32. Waste Water Engineering: Treatment and Reuse (2002) **Met Calf & Eddy** *INC, Tata mc Graw Hill, New Delhi*
33. Watershed Management (1998) **JVS Murthy**, *New Age International Publishers, Delhi*
34. http://envfor.nic.in/index.php
35. http://www.earthsummit2012.org/

BT 104: Cell Biology (4C)

Sr. No.	Topic	Lectures (Total 60)
1	Cell structure and cytoplasmic membrane system– structure and functions of organelles and membrane trafficking, Methods in Cell Biology Cell structure and function with inter relationship of cell organelles (mitochondria, chloroplast, vacuoles, peroxisomes and lysosomes, nucleus and its components), energy transformation Cell membrane – Plasma membrane types (animal, plant and bacterial) and cytoplasmic membrane system- structural and functional organization Transport across plasma membrane and intra-cellular transport (vesicular and membrane transport) at molecular level	15
2	Cell signalling: communication between cells and environment Cytoskeleton- Structure- assembly and disassembly of cytoskeletal elements, role in cell division Extracellular matrix and cell junctions- relevance to tissue structure and function Signalling at cell surface, signalling molecules, hormones and receptors signalling pathways that control gene activity, signal transduction and second messengers	15
3	Cell differentiation, cell death, cell transformation Cell Cycle and its regulation Cell differentiation in plants and animals including terminal cell differentiation, Role of hormones and growth factors Programmed cell death Cell transformation and etiology of cancer	15
4	Plant Cell Structure of Plant Cell, Plant cell wall - primary and secondary, biogenesis role in growth and development, Plamodesmata- structure and function Plastids - biogenesis, structure and types	15

References:

1. Molecular Cell Biology. 7th Edition, (2012) Lodish H., Berk A, Kaiser C., KReiger M., Bretscher A., Ploegh H., Angelika Amon A., Matthew P. Scott M.P., W.H. Freeman and Co., USA
2. Molecular Biology of the Cell, 5th Edition (2007) Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter. Garland Science, USA
3. Cell Biology, 6th edition, (2010) Gerald Karp. John Wiley & Sons., USA
4. The Cell: A Molecular Approach, 6th edition (2013), Geoffrey M. Cooper, Robert E. Hausman, Sinauer Associates, Inc. USA

BT 105: Exercises in Advanced Biological Chemistry (4C)

Sr.No.	Topic	Practical (12 PX 5H)
1	Extraction, purification and characterization of protein precipitation Dialysis Column Chromatography- Gel filtration/ Ion exchange/ Affinity Native & PAGE/ Quantification	5
2	Enzymology : Beta- galactosidase/ LDH/ Invertase pH, Temperature, time, various Substrate concentration, inhibition, Km and Vmax and LB plot	4
3	Phytochemical Methods Extraction Methods: Preparation of extract, aqueous & organic solvents- at least one Alkaloid, Phenolic and Glycoside each Qualitative detection & Quantitative estimation	3

BT 106: Exercises in Molecular and Cell Biology (3C)

Sr. No.	Topic	Practical (9PX5H)
	Molecular Biology	**(4PX5H)**
1	Isolation of nuclei and chromatin Mononucleosome size determination by agarose gel electrophoresis	2
2	Extraction and Analysis of Histones	1
3	Isolation of RNA and analysis by agarose gel	1
	Cell Biology	**(5PX5H)**
4	Electron micrographs- Interpretation of photographs	1
5	Isolation of mitochondria and lysosomes and assay of SDH and acid phosphatase activity respectively	2
6	Programmed cell death during limb development In Chick	1
7	Cell types of plants - maceration of various tissue explants and identification of xylem vessels, tracheids, stomata, root hair etc.	1

BT 107: Exercises in Environmental Biotechnology (2C)

S. No.	Practical	Practicals (10PX3H)
1	Isolation of microorganism from polluted soil.	2
2	Genotoxicity assay on polluted water- Onion root tip and pollen germination assay.	2
3	Estimation of TSS, DO, BOD and COD of waste water.	2
4	Acquisition of “Google Earth” images for the known and unknown area for land use - land cover mapping.	1
5	Qualitative and quantitative estimation of biodegradation of pesticide/ insecticide/fungicide.	2
6	Review on EIA case study.	1

BT 201: Genetic Engineering (4C)

Sr.No.	Topic	Lectures (Total 60)
1	**Tools in genetic engineering:** DNA modifying enzymes and restriction enzymes for Genetic engineering , Vectors in gene cloning-Plasmid, Cosmid, Phages,Phasmids, Advanced cloning vectors-BAC, YAC, PAC, Transformation and Transfection, cDNA and genomic DNA library.	15
2	**Expression strategies and methods for producing industrially important molecules:** Various expression vectors in bacteria and eukaryotes-Yeast, Baculoviruse,Mammalian and Shuttle vectors. Induced expression strategies and protocols. Expression of industrially important products.	15
3	**Analytical techniques:** PCR – design and optimization, Types of PCR-Inverse, Nested, Reverse Transcription-PCR, Hot Start PCR, Quantitative PCR use to engineer DNA,amplification of specific sequences from a cDNA library, use in diagnosis of diseases. DNA sequencing- Maxam-Gilbert method, Sanger's Dideoxy chain termination method, Automated DNA sequencing method. Human genome sequencing. Genetic and Physical mapping techniques.	15
4	**Applications:** Genetic diseases-Detection and Diagnosis, Gene therapy – *ex vivo*, *in vivo*, gene delivery systems, viral and non viral. DNA marker technology in plants, DNA fingerprinting, Genetically engineered biotherapeutics and vaccines and their manufacturing, Transgenic animals and Bio-pharming.	13
5	**Biosafety regulations**	02

References Books:

1. From Genes to Genomes, 2nd edition, (2008), J.Dale and M.Schantz, John Wiley & Son Ltd.USA
2. Gene Cloning and DNA Analysis: an introduction, 6th edition, (2010) T. A. Brown, Wiley-Blackwell Publisher, UK
3. From Gene to Clones ; Introduction to gene technology, 4th edition, (2003), E. Winnacker, Panima Publisher, India
4. Molecular Biology Problem solver: A laboratory guide (2004), A. Gerstein, A John Wiley & Sons, Inc., Publication, USA.
5. Molecular Biology of the Gene, 6th Edition (2008), James D. Watson, Tania Baker, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Lodwick, Pearson Education, Inc. and Dorling Kindersley Publishing, Inc. USA

6. Molecular Biotechnology: 4th edition. (2010), Glick B.R., Pasternak J.J., Patten C. L., ASM press, USA.
7. Principles of Gene Manipulation & Genomics, 7th Edition (2006), Primrose and Twyman, Blackwell Publishing, USA.
8. Molecular cloning – a laboratory manual – (Vol. 1-3), 4rd edition, (2012), Green and Sambrook, Cold Spring Harbor Laboratory Press, USA

BT 202: IMMUNOLOGY (2C)

Sr. No.	Topic	Lectures (Total 30)
1	Immune system : Introduction to immune system Cells, Organs and Tissues of immune system.	5
2	Types of Immunity - Innate immunity, Acquired immunity Protective and Destructive	2
3	Complement system: Components of Complement system Three pathways of complement activation	3
4	Antigen-Antibody reactions – Applications in Diagnostics	3
5	Hypersensitivity	2
6	Auto immunity, molecular mimicry, therapy	2
7	Transplant immunology	2
8	Parasitic immunology	1
9	Techniques in molecular immunology Hybridoma technology (Monoclonal antibody) Antibody engineering, Chimeric antibodies, Phage display	3
10	Animal models and transgenic animals and their use in immunological studies. Routes of Inoculation Transgenic animals	2
11	Experimental immunology : Vaccine development (Recombinant, Combined and polyvalent vaccines) Stem cell technology	3
12	Manufacturing of immuno-diagnostics and Clinical Trials	2

Refernces:

1. Kuby immunology, Judy Owen , Jenni Punt , Sharon Stranford., 7th edition (2012), Freeman and Co., NY
2. Textbook of basic and clinical immunology, 1st edition (2013), Sudha Gangal and Shubhangi Sontakke, University Press, India
3. Immunology, 7th edition (2006), David Male, Jonathan Brostoff, David Roth, Ivan Roitt, Mosby, USA.

BT 203: Principles of Bacteriology and Virology (4C)

Sr. No.	Topic	Lectures (Total 60)
	Bacteriology	**(30L)**
1	Bacterial Characteristics: Introduction to bacterial world, Landmarks in and scope of bacteriology. Bacterial Cell Structure and Function: Cell wall (Gram positive, Gram negative and Archea), Cell membrane (Gram positive, Gram negative and Archea), Spore (endospore formation, germination and structure), Flagella, Capsule, Fimbriae and Pilli , Cell inclusions. Morphological features of bacteria, Characteristics of aerobes, anaerobes, cyanobacteria and actinomycetes. Nutrition (nutritional classes), Growth, Bacterial cell division (process and proteins involved) growth media types. Control of bacterial growth (Sterilization and disinfection), handling pathogens, safety in microbiology laboratory. Metabolic diversity of bacteria, Extremophiles and their adaptations. Pathogenicity and Virulence of Bacteria.	15L
2	**Methods/ Techniques in Bacteriology:** Cultivation of Aerobes, anaerobes and microaerophiles. Pure culture techniques(Streak and spread plate, serial dilution, pour plate, enrichment and single cell isolation) Dyes and stains (classification), staining techniques and principles : Positive, negative, Gram, Acid fast, endospores, cell wall, nuclear ,capsule, flagella, metachromatic/storage granules. General strategy and techniques used for identification of unknown bacteria (Cultural characteristics, Morphology, motility, biochemical tests, Molecular characterization) Introduction to Bergey's Manual.	10L
3	Applied Bacteriology: Bacteriology and Public health: Mycobacteria, Enterobacteria, Protozoa (Role as human pathogens) Bacteriology and Agriculture: Agrobacterium, Nitrogen Fixation. Industrially important bacteria. Bacteriology and environment : Bioremediation (Petroleum and Xenobiotics) Bacteriology and Biotechnology (any two examples)	5L
	Virology	**(30L)**
4	Introduction to viruses: General properties of viruses Morphology and ultrastructure of Viruses	3
5	Classification of viruses: ICTV system, Baltimore system	3
6	Viral replication: DNA and RNA viruses with example, Bacteriophages	2
7	Viral Diagnosis: Microscopy, Cultivation, Serological and Molecular methods, Infectivity assays, immunodiagnosis	4

8	Antivirals: Physical and Chemical agents, Therapeutic agents, Vaccines	3
9	Types of Infections : Acute and persistent infections with example	5
10	Epidemiology: Principles and Applications, Common terminologies, National and Global epidemiology (With suitable example)	3
11	Immuno pathogenesis : Immunosuppression, Tumors (With example)	2
12	Emerging viral diseases: Re-emerging and New emerging viral diseases with example (Influenza, H1N1,SARS,Nipah and Marburg), Current outbreaks	2
13	Animal and Poultry viruses: Diseases and Importance with example	2
14	Plant viruses: Diseases and Importance with example	1

References:

1. Introduction to Microbiology. 3rd Edition, (2004), Ingraham JL and Ingraham CA. Thomson Brooks / Cole.
2. Brock's Biology of Microorganisms. 11th Edition, (2006). Madigan MT, Martinko JM. Pearson Education Inc. , USA
3. Fundamental Principles of Bacteriology. 7th Edition, (1971) Salle AJ. Tata MacGraw Publishing Co. India
4. Microbiology: An introduction, 5th edition,(1992), Tortora, G.J., Funke B.R., Case C.L, Benjamin Pub.Co. NY
5. Microbiology, 4th edition (1990), Davis B.D. ,Debacco, J.B. Lippincott Co. NY
6. Zinsser, W , 1976, Microbiology Edition, W .K Jklik, NY
7. Medical Bacteriology, 14th edition, (1988), Dey, N.C and Dey, TK., Allied Agency, India
8. Text book of microbiology 5th edition (1996), Ananthnarayana, R. and C.E, Jayaram Panakar, Orient Longman.
9. General Microbiology, 5th edition (1987), Stanier R.Y., Adelberg E.A. and Ingraham J.L.. Macmillan Press Ltd.
10. Principles of Virology 3rd edition, (1999), Flint Jane. S., ASM (American Society of Microbiology) Press Publisher, 2 volumes., USA.
11. Field's Virology - 2 volumes, 5th edition, (2006), Bernard.N. Fields, Lippincott and Williams Wilkins, USA

BT 204: Plant Biotechnology (4C)

Sr. No.	Topic	Lectures (Total 60L)
1	**Algal biotechnology –** qualitative (product improvement, strain improvement) and quantitative (yield) improvement in economically important algae like *Spiruluna, Dunaliella, Botrycoccus, Chlorella*. **Fungal biotechnology –** qualitative (product improvement, strain improvement) and quantitative (yield) improvement in economically important fungi like mushrooms (*Agaricus, Pleurotus, Lentinus*), yeasts, *Aspergillus*, industrially important fungi.	15
2	**Micropropagation -** Advantages over conventional methods, stages of micropropagation (stage 0 to stage 4), organogenesis, somatic embryogenesis and artificial seeds. Discuss advantages and limitations with at least one case study each from fruit crops, vegetable crops, ornamental crops and silviculture crops (one timber yielding and one non-timber crop).	8
3	*In vitro* androgenesis and its applications, somatic hybridization, cybridization and their applications.	7
4	**Transgenic plants –** Introduction, vertical versus horizontal gene transfer, barriers to horizontal gene transfer, experimental methods of transgenesis (vector and non vector based gene transfer), algal and fungal transgenics and their applications (biofuels, single cell proteins, pigments, neutraceuticals, pharmaceuticals, biopesticides)	15
5	**Transgenic plants -** for– biotic (weeds, insects, viruses, fungi and bacteria) and abiotic (drought, salt, temperature, poor soil quality and oxidative) stress tolerance, production of secondary metabolites, increase in productivity by manipulation of photosynthesis and nitrogen fixation, molecular farming (improvement in protein, lipids, carbohydrates, plantibodies, vaccines, therapeutic proteins and active principles.	15

References :

1. Chawla HC (2004) – Introduction to plant biotechnology (Science Publ)
2. Davies K (Ed) (2004) – Plant pigments and their manipulation – Annual plant revies, vol 14 (Blackwell Publ)
3. Altman A, Hasegawa PM (Ed) (2012) – Plant Biotechnology and agriculture. Prospects for the 21st century (Academic press).
4. Bhojwani SS. & Razdan MK (1996). - Plant Tissue Culture : Theory & Practice (Elsevier)
5. Hou CT, Shaw JF (2009) – Biocatalysis and agricultural biotechnology (CRC Press)
6. Slater A, Scott NW, Fowler MR (2008) – Plant Biotechnology: the genetic manipulation of plants (Oxford Press)
7. Rai M (2009) – Fungal Biotechnology (IK International)
8. Vasil IK, Thorpe TA (1994) – Plant cell and tissue culture (Springer)
9. H K Das Textbook of Biotechnology 4th editio

BT 205: Exercises in Genetic Engineering (4C)

Sr. No.	Topic	60Hours (15P x 4H)
1	Isolation of plasmid DNA.	1
2	*In vitro* DNA ligation,	1
3	Transformation of *E.coli*	1
4	Restriction mapping	1
5	Southern blotting and hybridization	2
6	RFLP	1
7	Isolation of cytoplasmic RNA	1
8	Electrophoresis of RNA on denaturing gels.	1
9	Northern and dot blotting technique.	2
10	PCR and cDNA synthesis by RT-PCR	2
11	Amplification by RAPD/AFLP Markers	2

BT 206: Exercises in Immunology (2C)

Sr. No.	Topic	Practical (6Px 5H)
1	ELISA	1P
2	Immunodiffusion	1P
3	Immunoelectrophoresis	1P
4	Rocket immunoelectrophoresis	1P
5	Western blotting	1P
6	Widal Test	1P

BT 207: Exercises in plant biotechnology (3C)

Sr. No.	Topic	Practicals (15Px3H)
1	*Chlorella* or *Spirulina* culture and biochemical analysis of products	2
2	Initiation maintenance and confirmation of Hairy root culture	2
3	*In vitro* induction of somatic embryogenesis	2
4	Induction of Androgenesis *in vitro*	2
5	Protoplast isolation	1
6	Micropropagation (stages 0 to 4)	4
7	Cell suspension culture and growth analysis	2

BT 208: Exercises in Bacteriology and Virology (2C)

Sr. No.	Topic	Practical (Total 30H)
	Bacteriology	**(3Px 5H)**
1	Cleanliness, Good laboratory practices, media preparation, Sterilization of media and glasswar (Operation of autoclave/sterility test and Hot air Oven).	1
2	Use and care of Microscope, Staining techniques – Monochrome, Negative, Gram, Endospore, Capsule.	1
3	Isolation of Pure Culture(from air/soil/water) – Streak and Spread plate, Serial dilution and pour plate technique and identification isolated bacteria (genus level): by morphology, motility ,cultural characteristics, biochemical tests (sugar utilization, enzyme production) Cultivation of Anaerobes (any one method)	1
	Virology	**(5Px 3H)**
1	Electron microscopic observations of ultrastrucutre of animal viruses (Pox, Influenza, Rabies and TMV)	1
2	Propagation of viruses in animals/tissue culture/embryonated eggs.	2
3	Phage Titration.	2