

**SOLAPUR UNIVERSITY, SOLAPUR**  
**M. Sc. –II- BIOTECHNOLOGY**  
**SYLLABUS**  
**(CHOICE BASED CREDIT SYSTEM)**  
**(w. e. f. June-2016-17)**

The syllabus of M.Sc. – Biotechnology course of two years duration has been prepared as per the Choice based credit system (C.B.C.S.). M. Sc. II syllabus is to be implemented from June 2016. The syllabus of M. Sc. Part I was implemented with effect from June 2015. The syllabus has been prepared taking into consideration the UGC guidelines, SET, NET examination syllabus, the syllabus of other universities and the specific inputs of the Expert Committee Members.

**General Structure of the Course:** The course will be of four semesters spread over two academic years. Each semester will have four theory papers of 70 marks each for University External Examination and 30 marks each for Internal Examination and two practical courses of 70 marks each for University External Examination and 30 marks each for Internal practical course. The distribution of marks is as mentioned below.

Theory Paper (Semester Exam),	16 X (70+30) marks	1600 marks
Practical's (Semester End Exam.),	8 X (70+30) marks	800 marks
Seminars for each Semester,	4 X (25 Marks)	100 marks

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**Total: 2500 marks**

### SEMESTER-I

Theory Paper No.	Title of Theory Paper	Marks			Credits
		UA	CA	Total	
I	Microbiology	70	30	100	4
II	Concepts of Biochemistry	70	30	100	4
III	Inheritance biology	70	30	100	4
IV	Biostatistics and Bioinformatics	70	30	100	4
Practical Course No.	Title of Practical Course	Marks			Credits
		UA	CA	Total	
I	Microbiology and Concepts of Biochemistry	70	30	100	4
II	Inheritance biology and Biostatistics and Bioinformatics	70	30	100	4
	Seminar - I	--	25	25	1
				<b>625</b>	<b>25</b>

### SEMESTER-II

Theory Paper No.	Title of Theory Paper	Marks			Credits
		UA	CA	Total	
V	Cell Biology	70	30	100	4
VI	Enzyme Technology	70	30	100	4
VII	Molecular Cell Processing	70	30	100	4
VIII	Immunology and Immuno techniques	70	30	100	4
Practical Course No.	Title of Practical Course	Marks			Credits
		UA	CA	Total	
III	Cell Biology and Enzyme Technology	70	30	100	4
IV	Molecular Cell Processing and Immunology and Immuno techniques	70	30	100	4
	Seminar - II	--	25	25	1
				<b>625</b>	<b>25</b>

**Practical Course:** (Semester End Examination) Practical Paper - I to IV for semester I and II. Practical Examination will be of 4 days (per day per subject) for each semester

### SEMESTER-III

Theory Paper. No	Title of Theory Paper	Marks			Credits
		UA	CA	Total	
IX	Advanced analytical Techniques	70	30	100	4
X	Genetic Engineering	70	30	100	4
XI	Research Methodology and IPR	70	30	100	4
XII* Open Elective	A. Advanced Pharmaceuticals OR B. Computational Structure Biology and Drug Designing	70	30	100	4
Practical's Course No.	Title of Practical Course	Marks			Credits
		UA	CA	Total	
V	Advanced analytical Techniques	35	15	50	2
VI	Genetic Engineering	35	15	50	2
VII	Research Methodology and Intellectual Property Right (IPR)	35	15	50	2
VIII* Open Elective	A. Advanced Pharmaceuticals OR B. Computational Structure Biology and Drug Designing	35	15	50	2
	Seminar-III	--	25	25	1
				<b>625</b>	<b>25</b>

\*Theory Paper-XII is offered as elective under CBCS to the students.

### SEMESTER-IV

Theory Paper. No	Title of Theory Paper	Marks			Credits
		UA	CA	Total	
XIII	Animal Biotechnology and Stem Cell technology	70	30	100	4
XIV	Industrial and Environmental Biotechnology	70	30	100	4
XV	Plant Biotechnology	70	30	100	4
XVI* Open Elective	A. Advanced Pharmacognosy OR B. Medical Biotechnology and Bio-nanotechnology	70	30	100	4
Practical's Course No.	Title of Practical Course	Marks			Credits
		UA	CA	Total	
IX	Animal Biotechnology & Stem Cell technology and Industrial & Environmental Biotechnology and Plant Biotechnology	70	30	100	4
X* Open Elective	A. Advanced Pharmacognosy OR B. Medical Biotechnology and Bio-nanotechnology	35	15	50	2
XI**	Project and Viva Voce	35	15	50	2
	Seminar-IV	--	25	25	1
				<b>625</b>	<b>25</b>

\*Theory Paper – VIII & XVI are offered as elective under CBCS to the students.

\*Practical Paper – VIII & X are offered as elective under CBCS to the students

\*\* Practical - XI – Project work has to be done by individual student. It may be in-house project including inter department/programme or projects in organizations outside the institution i.e. in Research Laboratories / Industry / other agencies

**Practical Course (SEM-III):** (Semester End Examination) Practical Papers – V to VIII for semester III Practical Examination will be of 4 days (per day per subject).

**Practical Course (SEM-IV):** (Semester End Examination) Practical Papers – IX will be of 2 days, Practical Paper -X will be of 1 day and Practical Paper -XI will be of 1 day.

### SUMMARY

Course	No. of Papers	Total marks	Examination Pattern		Total Credits
			UA	CA	
Core	14	1400	980	420	56
Elective	04 (any two)	200	140	60	08
Practical Course	08	800	560	240	32
Seminars	04	100	-	100	04
<b>TOTAL</b>		<b>2500</b>	<b>1680</b>	<b>820</b>	<b>100</b>

**Nature of Examination:** Each semester will have theory University external examination of four papers of 70 marks each (2 and 1/2 hrs. duration). The practical examination of Semesters I to IV will be conducted at the end of the each Semester. Duly certified copy of laboratory record must be produced at the time of examination.

Practical Examination of M. Sc. II The practical examination will be of 4 days for each semester. There will be 70 marks University external practical examination while 30 marks internal examination. The distribution of marks for each Practical paper -V, VI, VII, VIII and IX will be of 70 marks and Semester IV Practical paper-X & elective will be of 50 marks Project work and its report of 50 marks will be included in Practical paper -XI whereas distribution of marks for Practical paper -XI will be below:

The report shall be examined by the Examiners (appointed by the University) who will assign marks out of 35 for project work as follows:


- 1) Selection of the project topic - 2 marks
- 2) Literature review - 2 marks
- 3) Objectives - 2 marks
- 4) Experimental Design - 5 marks
- 5) Result and Discussion - 2 marks
- 6) Conclusion and findings - 2 marks
- 7) Report Writing - 10 marks
- 8) Oral presentation and Viva - 10 marks

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**Total: 35 marks**

\*\* The valuation to be done by both external and internal examiners at the time of Practical paper V to XI practical examination. Valuation of Seminars is to be done by Departmental Faculty involved in Biotechnology.

Nature of Theory question paper for each theory paper.

	<b>SOLAPUR UNIVERSITY, SOLAPUR</b> <b>Nature of Question Paper for Semester Pattern</b> <b>CHOICE BASED CREDIT SYSTEM -CBCS</b> <b>M.Sc. Biotechnology</b>	
<b>Time:- 3 hrs</b>		<b>Total Marks-70</b>
<b>Note: 1) Section - I Compulsory</b> <b>2) Answer any four questions from Section - II</b>		
<b>Section - I</b>		
<b>Q. 1 A) Multiple choice questions</b>		<b>(07)</b>
i) -----		
a)                      b)                      c)                      d)		
ii)		
iii)		
iv)		
v)		
vi)		
vii)		
<b>B) Define the following terms</b>		<b>(07)</b>
i)		
ii)		
iii)		
iv)		
v)		
vi)		
vii)		
<b>Section - II</b>		
<b>Q. 2) Long answer type question</b>		<b>(14)</b>
<b>Q. 3) Long answer type question</b>		<b>(14)</b>
<b>Q. 4) Long answer type question</b>		<b>(14)</b>
<b>Q. 5) Answer any TWO of the following</b>		<b>(14)</b>
i) Short answer type question		
ii) Short answer type question		
iii) Short answer type question		
<b>Q. 6) Write Short notes on any TWO of the following</b>		<b>(14)</b>
i) Short note		
ii) Short note		
iii) Short note		

N.B. In Q.5 and 6 the sub-questions (i, ii, and iii) in a given question should be from different topics of the syllabus.

At least 25 % questions should be problem oriented, where-ever possible, in view to train students for the SET/NET/GATE and other competitive examinations. These questions should test the understanding of candidate rather than the memory. The question paper should cover all the Units included in the syllabus of the respective paper and the weightage of the questions should correspond to the number of lectures allotted to the respective Units / Topics.

# M. Sc. BIOTECHNOLOGY SYLLABUS

## SEMESTER- III

### PAPER-IX: ADVANCED ANALYTICAL TECHNIQUES (45L-4 Credits)

UNIT	Title of Units	Total Hours
<b>I</b>	<b>Microscopy &amp; Centrifugation:</b> Light microscope, Fluorescence microscope, Phase contrast microscope, Electron microscope, confocal microscopy. Centrifugation: Small bench top centrifuges, large capacity refrigerated, centrifuges, High speed refrigerated centrifuges, preparative and analytical ultracentrifuge, Molecular weight determination.	<b>8</b>
<b>II</b>	<b>Chromatographic techniques:</b> Principles of chromatography, size exclusion, ion exchange and affinity chromatography. High performance liquid chromatography (HPLC), Gas liquid chromatography (GLC), Thin layer chromatography (TLC), Paper chromatography, GC-MS, LC-MS, Chromatofocussing.	<b>8</b>
<b>III</b>	<b>Electrophoresis:</b> General principles, factors affecting migrating rates, factors affecting migration of ions, support media, Techniques of electrophoresis: low and high voltage, capillary electrophoresis, electro osmotic flow techniques, instrumentation, zone electrophoresis and applications. Electrophoresis of proteins: SDS-PAGE, Native gels, Gradient gel, Iso-electric focusing, 2-D gel electrophoresis (2-D PAGE), cellulose acetate electrophoresis, continuous flow electrophoresis; Detection, estimation and recovery of proteins, Western blotting. Electrophoresis of nucleic acids: agarose gel electrophoresis of DNA, DNA sequencing gels, Pulse field gel electrophoresis, electrophoresis of RNA, Capillary electrophoresis.	<b>10</b>
<b>IV</b>	<b>Electrochemical technique and Spectroscopy:</b> Principles of electrochemical techniques, redox reactions, pH electrode, ion-sensitive and gas sensitive electrodes, The Clark oxygen electrode, Biosensors. Spectroscopic techniques: Properties of electromagnetic radiation, interaction with matter. Gamma ray spectroscopy, X-ray spectroscopy, UV and Visible spectroscopy, Infrared and Raman spectroscopy, Electron spin resonance spectroscopy, Nuclear magnetic resonance spectroscopy, Circular dichorism spectroscopy, Atomic spectroscopy, MALDI Tof, Lasers, Spectro-fluorimetry, turbidometry and nephelometry, X-ray crystallography.	<b>10</b>
<b>V</b>	<b>Radio isotope techniques:</b> The nature of radioactivity, detection and measurement of radioactivity: detection based on gas ionization- Geiger Muller counter- principles and applications. Detection based on excitation Liquid Scintillation counter-principle and applications. Supply, storage and purity of radiolabelled compounds, specific activity, inherent advantages and restrictions of radio tracer experiments, safety aspects, applications- of radio isotopes in biological sciences.	<b>09</b>

**Recommended Text Books:**

1. Keith Wilson and John Walker. Practical Biochemistry- principles and techniques; Cambridge University press, London, UK.
2. David T Plummer, Tata McGraw- Hill publishing company limited; McGrqw office, New Delhi.
3. C.R. Kothari, 2nd Edition, 2004. Research methodology- methods and techniques. New Age International (P) limited publishers, New Delhi.
4. Instrumental methods of chemical analysis - P.K. Sharma
5. Biophysical chemistry - Upadhyay. Upadhyay and Nath
6. A Biologist's guide to principle and techniques of practical biochemistry - Brigian L. Williams.
7. Handbook of Biomedical Instrumentation - R.S. Khandpur, Tata McGraw Hill.

UNIT	Title of Units	Total Hours
		<b>45</b>
<b>I</b>	<b>Tools for Genetic Engineering:</b> DNA manipulation enzymes- Exonucleases, Restriction endonucleases, Ligase. Gene cloning Vectors-Properties and structure of natural and artificial plasmids, Bacteriophages ( $\lambda$ and M13), Cosmids, animal and plant viruses, Phagmids	<b>08</b>
<b>II</b>	<b>Expression strategies:</b> Various expression vectors in bacteria and eukaryotes- Yeast, Baculovirus, Mammalian and Shuttle vectors. Induced expression strategies and protocols. Expression of industrially important products.	<b>06</b>
<b>III</b>	<b>In Vitro construction, screening and Isolation of rDNA Molecules:</b> Isolation of vector and donor DNA and its purification, assembly of gene of interest and vector DNA, Amplification of Recombinant DNA Molecules. Definition and introduction to genomic library, Construction of Genomic & cDNA library, Preparation of primers and probes, Direct Screening, Indirect Screening, Colony hybridization, Immuno-Screening.	<b>11</b>
<b>IV</b>	<b>Analytical techniques:</b> RFLP, RAPD, Microarray, DNA chips. Blotting techniques- Southern, Northern, Western. DNA sequencing- Maxam & Gilbert method, Sanger's dideoxy chain termination method, Automated DNA sequencing. Genetic and Physical mapping techniques. Principle and applications of transformation methods- Cacl2 method, Electroporation, Microinjection, Gene-gun.	<b>12</b>
<b>V</b>	<b>Applications of rDNA technology:</b> Genetic diseases- Detection and Diagnosis, Gene therapy – <i>ex vivo</i> , <i>in vivo</i> , DNA marker technology in plants, DNA fingerprinting, Genetically engineered biotherapeutics and vaccines and their manufacturing, Transgenic animals and Bio-pharming	<b>08</b>

### Recommended Text Books:

1. Sambrook J, Fritsch E. F. and Maniatis (1989) Molecular cloning, vol. I, II, III, II ndedition, Cold spring harbor laboratory press, New York.
2. DNA Cloning : A practical approach D.M. Glover and D.B. Hames, RL Press, Oxford, 1995
3. Molecular and cellular methods in Biology and Medicine, P.B. Kaufman, W. Wu , D. Kim and L.J. Cseke, CRC Press Florida 1995
4. Methods in Enzymology Guide to Molecular Cloning Techniques, Vol. 152 S.L. Berger and A.R. Kimmel, Academic Press Inc, San Diego, 1996
5. Methods in Enzymology Gene Expression Technology, Vol. 185D. V. Goedel, Academic Press Inc, San Diego, 1990
6. Molecular Biotechnology, 2nd Ed. S. B. Primrose, Blackwell Scientific publishers, Oxford, 1994
7. Milestones in Biotechnology, Classic Papers on Genetic Engineering, J. A. Davis and W. S. Reznikoff, Butterworth-Heinemann Boston 1992
8. Route Maps in Gene Technology, M. R. Walker, and R. Rapley, Blakwell Science, Oxford, 1997
9. Genetic Engineering: An Introduction to Gene Analysis and Exploitation in Eukaryotes, S.M. Kingsman, Blackwell Scientific Publications, Oxford, 1998.



**PAPER XI: RESEARCH METHODOLOGY AND INTELLECTUAL PROPERTY****RIGHT (IPR)****(45L-4 Credits)**

<b>UNIT</b>	<b>Title of Units</b>	<b>Total Hours</b>
<b>I</b>	<b>Research:</b> Definition, Importance and Meaning of Research, Objectives of research, Characteristics of Research, Types of Research. Steps in Research; Identification, Selection and Formulation of Research Problem, Research Design, Formulation of Hypothesis, Review of Literature.	<b>08</b>
<b>II</b>	<b>Sampling Techniques &amp; Parametric Tests:</b> Sampling theory, Types of Sampling, Steps in Sampling, Sample Size, Advantages and limitations. Collection of Data: Primary Data, Data Collection Methods, Secondary Data, Relevance, Limitations and Cautions, Testing of significance Mean, Proportion, Variance and Correlation, Testing for Significance of Difference between Means, Proportions, Variances and Correlation Co efficient. Chi-square tests, ANOVA.	<b>10</b>
<b>III</b>	<b>Thesis and Manuscript writing:</b> Abstract, Introduction, Materials and Methods, Results and Discussion, Summary and Conclusion, References (IMRAD). Preparation of Manuscript; Author instructions, modes of paper communication, criteria for publication. Computer and internet application in Research. Presentation of a scientific Paper, Preparation of Oral Presentation and Poster Presentation for conferences. Use of Audio-Visual aids in Presentation.	<b>12</b>
<b>IV</b>	<b>Introduction to IPR and Patents:</b> Intellectual property, Protection of Intellectual property, World organizations, forms of protection- patent, copyright, trademark, geographical indications, trade secrets. Criteria and procedure of patenting, patenting biological material. Patent procedure in India. Types of patenting, Patenting of biological materials with examples and case studies.	<b>10</b>
<b>V</b>	<b>Plant breeder's right:</b> UPOV, Breeders exemption, Plant variety protection in India. Farmer's right, advantages and disadvantages of PBR. Technology transfer- Introduction, types of technology transfer and Indian scenario.	<b>05</b>

**Recommended Text Books:**

1. Statistical Methods by S.P. Gupta.
2. Research Methodology, Method and Techniques by C.R. Kothari or by Santosh Gupta.
3. Research Methodology by Gurumani.
4. Text book of Biotechnology, P K Gupta
5. Text book of Biotechnology, B D Singh.

OPEN ELECTIVE

PAPER-XII: A) ADVANCE PHARMACEUTICALS

(45L-4 Credits)

UNIT	Title of Units	Total Hours
		<b>45</b>
<b>I</b>	<b>Physical pharmaceuticals covering the following aspects</b> Introduction to Advance Pharmaceuticals, Solids: Particle characterization by size, shape and surface of individual particle and for contacted particle. Handling of solids, pharmaceutical granulation, compression and compaction properties of binary mixtures, lubricant sensitivity, characterization of granules and compacts.	<b>08</b>
<b>II</b>	<b>Dissolution:</b> Theory of dissolution, concept of drug release. Dissolution test apparatus: different designs, factors affecting dissolution rate. Dissolution of different dosage forms: solids, suspensions, topicals, suppositories and controlled release systems. Enhancement of dissolution rate. Solid dispersions: Types, methods of preparation, selection of carrier, characterization and applications	<b>10</b>
<b>III</b>	<b>Surfactant System:</b> Phase behavior of surfactant in binary and ternary systems. Factors affecting phase behavior; Micellization; micelle structure, shape, size factors affecting CMC and micelle size, thermodynamics and kinetics of micelle formation. Pharmaceutical aspects of Solubilization, Solubilization in non-aqueous system, interactions with polymers and oppositely charged species. Hydrotropy in pharmaceuticals, surfactants in emulsions and suspensions. Biological implications of surfactants; Effect on: dissolution of drugs, permeability of membranes, drug absorption, antibacterial activity. Cyclodextrin inclusion complexes and co-solvents.	<b>12</b>
<b>IV</b>	<b>Polymer science:</b> Types and applications of polymers, polymerization reactions, methods of polymerization and characterization of polymers, thermodynamics of polymer solutions.	<b>05</b>
<b>V</b>	<b>Stability studies:</b> Kinetics activation energy calculations, accelerated stability studies, factors responsible for destabilization of pharmaceutical products and techniques to improve, shelf life calculations. Physical testing of solution, suspension, emulsion, aerosol, powder, tablet and sustained release products.	<b>10</b>

**Recommended Text Books:**

1. Kitahard and A. Watanabe; Electrical Phenomena at Interfaces; Marcel Dekker.
2. Martin, P. Bustamante and A. H. Chun; Physical Pharmacy; Waverly.
3. D. M. Parikh; Handbook of Pharmaceutical Granulation Technology; Marcel Dekker.
4. G. Alderborn and C. Nystrom; Pharmaceutical Powder Compaction Technology; Marcel Dekker.
5. H. G. Brittain; Physical Characterization of Pharmaceutical solids; Marcel Dekker.
6. J. T. Cartensen; Drug Stability; Marcel Dekker.
7. James J. Wells; Pharmaceutical Preformulation, Ellis Harwood Ltd.
8. Lieberman, Rieser and Banker; Pharmaceutical Dosage Forms; Disperse system; Marcel Dekker.

9. M. N. Rubinstein; Pharmaceutical Technology, Drug stability, John Wiley and sons.
10. Martin Rhodes; Principles of Powder Technology, John Wiley and sons.
11. N. G. Stanley – Wood; Enlargement and compaction of particle solids; Butterworths.
12. P. H. List and P. C. Schmidt; Pharmaceutical Technology, CRS Press.
13. P. J. Tarcha; Polymer for Controlled Drug Delivery, CRC Press.
14. Robinson; Novel Drug Delivery Systems, Marcel Dekker.
15. Kitahara and A. Watanabe; Electrical Phenomena at Interfaces; Marcel Dekker.
16. Martin, P. Bustamante and A. H. Chun; Physical Pharmacy; Waverly.
17. D. M. Parikh; Handbook of Pharmaceutical Granulation Technology; Marcel Dekker.
18. G. Alderborn and C. Nystrom; Pharmaceutical Powder Compaction Technology; Marcel Dekker.
19. H. G. Brittain; Physical Characterization of Pharmaceutical solids; Marcel Dekker.
20. J. T. Cartensen; Drug Stability; Marcel Dekker.
21. James J. Wells; Pharmaceutical Preformulation, Ellis Harwood Ltd.
22. Rieser and Banker; Pharmaceutical Dosage Forms; Disperse system; Marcel Dekker.
23. M. N. Rubinstein; Pharmaceutical Technology, Drug stability, John Wiley and sons.
24. Martin Rhodes; Principles of Powder Technology, John Wiley and sons.
25. N. G. Stanley – Wood; Enlargement and compaction of particle solids; Butterworths.
26. P. H. List and P. C. Schmidt; Pharmaceutical Technology, CRS Press.
27. P. J. Tarcha; Polymer for Controlled Drug Delivery, CRC Press.
28. Robinson; Novel Drug Delivery Systems, Marcel Dekker.

**OPEN ELECTIVE****PAPER-XII: B) COMPUTATIONAL STRUCTURE BIOLOGY AND DRUG DESIGNING****(45L-4 Credits)**

<b>UNIT</b>	<b>Title of Units</b>	<b>Total Hours</b>
<b>I</b>	<b>Introduction to Structural and Pathway Databases:</b> structural data, exploring the structural databases such as Protein Data Bank (PDB) at RCSB, Catalytic Site Atlas (CSA), Homology Derived Structures of Proteins (HSSP), Protein Data Bank Europe (PDBe), PDBeChem, PDBeFold, PDBeMotiff, PDBeNMR, PDBSum, SCOP and CATH. Introduction to biological Pathway Databases.	<b>09</b>
<b>II</b>	<b>Structure Prediction Methods:</b> Statistical methods of Chou-Fasman, Garnier-Osguthorpe- Robson method, Neural network method, Position specific scoring matrices, Motifs and domains, folds and protein folding.	<b>09</b>
<b>III</b>	<b>Homology Modeling:</b> Introduction to homology modeling, Fold recognition and Threading, RNA structure prediction, architectures and topologies of protein and DNA using molecular visualization software, Structure validation	<b>06</b>
<b>IV</b>	<b>Molecular interaction:</b> Molecular interaction; protein-protein, protein-DNA, Protein-Lipid, Protein- Ligand, Protein-Carbohydrate, DNA-Drug interaction, Metalloproteins, Pi ... Pi interactions, C-H...Pi interactions	<b>06</b>
<b>V</b>	<b>Drug Discovery and Drug designing:</b> Natural products, drugs, principles of drug development, Drug discovery, mutation in drug targets, automated drug design, structure based and ligand based drug design methods, combinatorial chemistry, high throughput screening (HTS), <i>in silico</i> ADMET properties, QSAR, developing lead library, DOCKING; introduction to docking method to generate new structure, tools and molecular docking programs-AUTODOCK, HEX and VLife MD suite, Virtual Screening, Drug metabolism; Cytochrome p450, pharmacodynamics and pharmacokinetics, clinical trials, FDA approval	<b>15</b>

## **Recommended Text Books**

1. Wilkins, M.R., Williams, K.L., Appel, R.D., Hochstrasser, D.F. (Editors) 1997
2. Proteome Research: New Frontiers in Functional Genomics. Springer Verlag Berlin Heidelberg.
3. Baxevanis, A.D. and Francis Ouellette, B.F. 2004 Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins. Second Edition, Wiley.
4. Graur, D. and Li, W-H. 2000 Fundamentals of Molecular Evolution. Sinauer Ass., USA.
5. Essential Bioinformatics, Jin Xiong
6. Rastogi S. C., Mendiratta. N., Rastogi. P. 2005 Bioinformatics methods and application, Genomics, Proteomics, and Drug Discovery.

<b>PRACTICAL PAPER-V</b>	<b>ADVANCED ANALYTICAL TECHNIQUES</b> <span style="float: right;"><b>(45L-4 Credits)</b></span>
	<ol style="list-style-type: none"> <li>1. Electrophoresis of proteins under native and denaturing conditions (PAGE)</li> <li>2. Agarose Gel electrophoresis of nucleic acids.</li> <li>3. Separation of proteins using column chromatography.</li> <li>4. Demonstration of techniques: gas chromatography high performance liquid chromatography (HPLC) and atomic absorption spectroscopy AAS.</li> <li>5. Separation and identification of amino acid mixture/ plant pigments by Paper chromatography technique.</li> <li>6. Thin layer chromatographic separation of sugars and membrane lipids.</li> <li>7. Quantification and purity check of given DNA sample using spectroscopy.</li> <li>8. Determination of isoelectric point of amino acids.</li> </ol>

<b>PRACTICAL PAPER-VI</b>	<b>GENETIC ENGINEERING</b> <span style="float: right;"><b>(45L-4 Credits)</b></span>
	<ol style="list-style-type: none"> <li>1. Isolation of Genomic DNA from bacteria</li> <li>2. Isolation of plasmid DNA.</li> <li>3. <i>In vitro</i> DNA ligation</li> <li>4. Transformation of <i>E. coli</i></li> <li>5. Southern blotting and hybridization</li> <li>6. Restriction Fragment Length Polymorphism (RFLP)</li> <li>7. DNA amplification by PCR</li> <li>8. Isolation of Bacteriophage and purification of phage lysate</li> </ol>

<b>PRACTICAL PAPER-VII</b>	<b>RESEARCH METHODOLOGY AND INTELLECTUAL PROPERTY RIGHT (IPR)</b> <span style="float: right;"><b>(45L-4 Credits)</b></span>
	<ol style="list-style-type: none"> <li>1. Access to various scientific Journals and data retrieval.</li> <li>2. Preparation of manuscript for publication.</li> <li>3. Presentation of a scientific Paper / Document using power point</li> <li>4. Preparation and presentation of scientific poster for conference using power point.</li> <li>5. Performing plagiarism check in the manuscript.</li> <li>6. Access to patent web sites and preparation of report on IPR.</li> <li>7. Chi-square tests</li> <li>8. ANOVA</li> </ol>

<b>OPEN ELECTIVE PRACTICAL PAPER-VIII</b>	<b>A) ADVANCED PHARMACEUTICALS (45L-4 Credits)</b>
	<ol style="list-style-type: none"> <li>1. Powder characterization: Microscopy – Particle size analysis, calculation of shape factors.</li> <li>2. Powder Characterization: Compression and compaction – Huckel plot studies, tensile strength.</li> <li>3. Solubilization : <ul style="list-style-type: none"> <li>• Effect of dielectric constant on solubility</li> <li>• Complexation</li> <li>• Ternary phase diagram.</li> <li>• Solid dispersion</li> </ul> </li> <li>4. Stability of multiple emulsions</li> <li>5. Polymer science: Rheological and thermal characterization of polymers. Stability study</li> <li>6. Degradation kinetic study of a drug in a solution.</li> <li>7. Accelerated stability studies of a formulation.</li> <li>8. Dissolution studies of various dosage forms.</li> </ol>

**OR**

<b>OPEN ELECTIVE PRACTICAL PAPER-VIII</b>	<b>B) COMPUTATIONAL STRUCTURE BIOLOGY AND DRUG DESIGN (45L-4 Credits)</b>
	<ol style="list-style-type: none"> <li>1. Accessing to Structural Databases and Data retrieval using RCSB PDB, CSA, PDBe, PDBeChem, PDBeFold, PDBeMotif, PdbSum.</li> <li>2. Structural classification using CATH, SCOP resources.</li> <li>3. Secondary structure prediction using SOPMA and GOR.</li> <li>4. Homology modeling by SWISSMODEL, and Modeller 9V2 and Model Validation using RAMPAGE or PROCHECK,</li> <li>5. Prediction of protein-protein, protein-DNA, protein-ligand interactions and</li> <li>6. Drugbank database and ChEMBL database</li> <li>7. Design of ligands using ACD lab and ChEMSKETCH and Development of lead library and high throughput screening using <i>In silico</i> ADMET Properties.</li> <li>8. Docking studies using AUTODOCK and HEX.</li> </ol>

❖ **SEMINAR-III**

**(25 Marks, Credit-1)**

## SEMESTER- IV

### PAPER-XIII: ANIMAL BIOTECHNOLOGY AND STEM CELL TECHNOLOGY

(45L-4 Credits)

UNIT	Title of Units	Total Hours
<b>I</b>	<b>Introduction, history of animal cell culture and cell culture media</b> Introduction, importance, history of cell culture development, different tissue culture techniques including primary and secondary culture, continuous cell lines, suspension culture, organ culture, hybridoma technology, culture of lymphocyte, oviductal, epithelial cell culture, stem cell and Induced pluripotent stem (iPS) cells. Different type of cell culture media, growth supplements, serum free media, balanced salt solution, other cell culture reagents, culture of different tissues and its application. Bioreactor Design, Mechanochemical Regulation of Cell Behaviour, <i>In vitro</i> and <i>In vivo</i> Synthesis of Tissues and Organs, Micro-Scale Patterning of Cells and their Environment, Three-Dimensional Scaffolds.	<b>12</b>
<b>II</b>	<b>Characters of cells and behavior:</b> Behavior of cells in culture, division, their growth pattern, metabolism of estimation of cell number. Scaling up the cell culture to large scale/industrial level production	<b>05</b>
<b>III</b>	<b>Concept of cell line and transgenic animal:</b> Development of cell lines, characterization and maintenance of cell lines, cryopreservation, common cell culture contaminants. Culture of cells for production of various biological, Concepts of transgenic animal technology; strategies for the production of transgenic and knock out animals– significance in biotechnology - stem cell cultures in production of transgenic animals	<b>08</b>
<b>IV</b>	<b>Stem Cells – Basics, Properties and Classification:</b> Types of Stem cells – Hematopoietic Stem Cells, Mesenchymal Stem Cells, Embryonic Stem Cells, Fetal Stem Cells, Stem cells from adult organs- Characteristics, Isolation, Culture and Characterization protocols Three-Dimensional Cell Culture, Organ Culture, Organotypic Culture. Extra Cellular Matrices Morphogenesis and Tissue Engineering	<b>10</b>
<b>V</b>	<b>Tissue Engineering and Transplantation Techniques:</b> Immunoisolation Techniques, Modes of Cell and Tissue Delivery, Regeneration of Bone and Cartilage Islet Cell transplantation and Bioartificial Pancreas Bioprinting of Organs and Tissues ,Stem Cells in Gastrointestinal , Liver, Pancreas, Kidney, Heart, Spinal Cord and Lung Regeneration Stem Cells in Eye Diseases and Disorders	<b>10</b>

#### Recommended Text Books:

1. I.M. Butley. Animal Cell Culture and Technology. Second edition, Taylor and Francis
2. Freshney RI. 2005. Culture of Animal Cells. Wiley Liss.
3. Portner R. 2007. Animal Cell Biotechnology. Humana Press.
4. R. Lanza, J. Gearhart et al (Eds), Essential of Stem Cell Biology. (2009), Elsevier Academic press.



5. R. Lanza and I. Klimanskaya, Essential Stem Cells Methods. (2009), Academic Press
6. J. J. Mao, G. Vunjak-Novakovic et al (Ed): Translational Approaches in Tissue Engineering & Regenerative Medicine 2008, Artech House, INC Publications.
7. Robert Lanza et al. Principles of Tissue Engineering, 3rd Edition. Academic Press; 3 edition (August 21, 2007)
8. Stein et al. Human Stem Cell Technology and Biology: A Research Guide and Laboratory Manual. Wiley-Blackwell; 1 edition (January 4, 2011)
9. Lanza et al. Handbook of Stem Cells, Two-Volume Set: Volume 1-Embryonic Stem Cells; Volume 2-Adult & Fetal Stem Cells (v. 1).Academic Press (September 28, 2004).

**PAPER-XIV: INDUSTRIAL AND ENVIRONMENTAL BIOTECHNOLOGY****(45L- 4Credits)**

<b>UNIT</b>	<b>Title of Units</b>	<b>Total Hours</b>
<b>I</b>	<b>Introduction to bioprocess engineering</b> , bioreactors, isolation, preservation and maintenance of industrial microorganisms, microbial growth kinetics, media formulation for industrial fermentation, Air and media sterilization. Designing of a fermenter/bioreactor. Types of fermentation process batch, fed batch and continuous, biotransformation, analysis of mixed microbial populations, specialized bioreactors (pulsed, fluidized, photo bioreactors etc.) Measurement and control of bioprocess parameters.	<b>09</b>
<b>II</b>	<b>Upstream Process:</b> Industrial production of chemicals: alcohols, acids (citric, acetic and gluconic), solvents (glycerols, acetone, butanol), antibiotics (penicillin, streptomycin, tetracycline) amino acids (lysine, glutamic acid), single cell proteins, single cell oil, dairy products, wine, beer and other alcoholic Beverages.	<b>09</b>
<b>III</b>	<b>Downstream process:</b> introduction, removal of microbial cells and solid matters, foam separation, filtration, centrifugation, cell disruption, precipitation, liquid-liquid extraction, chromatography, membrane process, drying and crystallization, effluent treatment.	<b>09</b>
<b>IV</b>	<b>Scope of Biotechnology-</b> in Environmental protection. Nonconventional energy sources. Environment protection Act: Environmental laws, Environmental policies, Environmental ethics. UN declaration. Environmental protection and conservation. Environmental Impact Assessment, Ecoplanning and Sustainable Development	<b>09</b>
<b>V</b>	<b>Bioremediation-</b> Biotechnology for clean environment, Biomaterials as substitutes for non-degradable materials, Metal microbe interactions: Heavy Metal Pollution and impact on environment, Microbial Systems for Heavy Metal Accumulation, Biosorption, molecular mechanisms of heavy metal tolerance. Bioindicators and biosensors for detection of pollution, Hazardous Waste Management, Xenobiotics, Biological Detoxification of PAH, Air Pollution Control, Solid Waste Management.	<b>09</b>

**Recommended Text Books:**

1. Sullia S. B & Shantharam S: (1998) General Microbiology, Oxford & IBH Publishing Co. Pvt. Ltd.
2. Glaser A.N & Nilaido. H (1995) Microbial Biotechnology, W.H Freeman & Co.
3. Prescott & Dunn (1987) Industrial Microbiology 4th Edition, CBS Publishers & Distributors.
4. Prescott & Dunn (2002) Industrial Microbiology, Agrobios (India) Publishers.
5. Crueger W. & Crueger A. (2000) A text of Industrial Microbiology, 2nd Edition, Panima Publishing Corp.
6. Stanbury P.F, Ehitaker H, Hall S.J (1997) Principles of Fermentation Technology., Aditya Books (P) Ltd. S.N.Jogdan (2006) Industrial Biotechnology, Himalaya Publishing House
7. Amann, R.I. Stromley, J. Stahl : Applied & Environmental Microbiology

8. Dash : Concepts of Ecology
9. Chattergy : Environmental Biotechnology
10. Varma & Agarwal : Environmental Biology
11. B.K. Sharma : Environmental Chemistry
12. Peavy & Rowe : Environmental Pollution
13. Asthana & Asthana : Environment Problems & Solutions

**PAPER-XV: PLANT BIOTECHNOLOGY (45L-4 Credits)**

UNIT	Title of Units	Total Hours
<b>I</b>	<b>Plant Physiology and Basic Techniques in Plant Tissue Culture:</b> Plant Nutrition: Microelements and micronutrients in plant metabolism, Functions & Deficiency diseases. Plant Hormones: Types & Mechanism of Action. Role of Hormones in growth of Plants. Lab setup of Plant Tissue Culture laboratory, Tissue culture Media, Initiation and Maintenance of callus & Suspension culture, single cell clones.	<b>09</b>
<b>II</b>	<b>Micro propagation:</b> Organogenesis, Somatic Embryogenesis, Synthetic seeds. Shoot tip culture/Auxiliary bud culture, Rapid clonal propagation. Embryo Culture & Embryo Rescue. Acclimatization of Plants. Somaclonal Variations/ <i>In vitro</i> mutagenesis Selected successful examples of Plants of Diverse Origin using Tissue Culture technology, Rescue of endangered plants.	<b>08</b>
<b>III</b>	<b>Protoplast Culture, Anther Culture and Cryopreservation:</b> Protoplast Isolation, Culture, Fusion, Selection of Hybrid Cells and Regeneration of Hybrid Plants, Symmetric and Asymmetric hybrids. Anther, Pollen and Ovary culture for production of Haploid Plants and Homozygous lines. Cryopreservation, Slow growth & DNA Banking for germ plasma Conservation.	<b>08</b>
<b>IV</b>	<b>Plant Transformation Technology:</b> Basics of Tumor formation, Hairy root, features of Ti & Ri Plasmid and their uses, Mechanism of DNA transfer role of Virulence gene, Binary vectors, Use of 35s & other promoters, genetic markers, viral vectors & their applications, Multiple gene transfers: vector less or direct DNA transfer, Use of reporter gene, Particle bombardment, electroporation, Microinjection, transformation in monocots, Transgene stability & gene silencing in Plant transformation.	<b>10</b>
<b>V</b>	<b>Applications of Plant Biotechnology:</b> Commercial micro propagation. Metabolic engineering & Industrial products, Plant secondary metabolites control mechanisms & manipulation of Phenyl Propanol pathway, Shikimate pathway, Alkaloids, Industrial enzymes, Biodegradable plastics, Therapeutic proteins: lysosomal enzymes, Antibodies and edible vaccines. Purification strategies, oleosin partitioning technology. Agriculture Diseases resistant plants, Biotic & Abiotic stress resistant plants, Enhancement of nutritional value of crop Plants & molecular farming, Applications in Biodiversity conservation.	<b>10</b>

**Recommended Text Books:**

1. An introduction to Plant Tissue Culture 2nd edn. Razdan, M. K, Science Publishers, USA.
2. Textbook of plant biotechnology, Chawala P.K.2002, Oxford & IBH, New Delhi.
3. Bhojwani, S. S. and M. K. Razdan 1996.Plant Tissue Culture:Theory and Practice, Elsevier Pub.
4. Chrispeels, M. J. 2002. Plant Tissue Culture: Genetical Aspects. Jones and Bortlett Publishers, International.
5. Chopra V. L. et al 1999. Applied Plant biotechnology. Science Publishers Inc.
6. Verpoorte, R. and A.W. Alfermann (Eds) 2000.Metabolic Engineering of plant secondary metabolism, lower Academic Publisher.

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

**OPEN ELECTIVE**

**PAPER-XVI: A) ADVANCED PHARMACOGNOSY**

**(45L-4 Credits)**

<b>Unit</b>	<b>Title of Units</b>	<b>Total Hours</b>
		<b>45</b>
<b>I</b>	<b>General Research Methodology:</b> Definition of research, meaning of research objective of research, types of research, Review of literature and sampling techniques.	<b>06</b>
<b>II</b>	<b>Herbal drug Industry:</b> Infrastructure of herbal drug industry involved in production of standardized extracts and various dosage forms. Entrepreneurship Development. Project selection, project report, technical knowledge, plant design, layout and construction. Pilot plant scale-up techniques, case studies of herbal extracts. Formulation production management.	<b>06</b>
<b>III</b>	<b>Herbal drug regulatory affairs:</b> Basic principles of clinical studies, Stability, Safety and toxicology of herbal drugs. Adverse drug reaction in herbal drugs. Effect of herbal medicines on clinical laboratory testing. Regulation and dispensing of herbal drugs.	<b>06</b>
<b>IV</b>	<b>Information Retrieval systems of Herbal Drugs &amp; Literature survey of following therapeutic groups</b> <b>Immunomodulators:</b> Withaniasomnifera, Centellaasiatica, Embelicaofficinalis, Ocimum sanctum <b>Antipeptic ulcer:</b> Glyceriza root, Azadirachtaindica, Gingiberofficinalis <b>Hepatoprotectives:</b> Silibummarianum, Phyllanthusniruri, Picrorrhizakurroa, Andrographispaniculata <b>Anticancer :</b> Taxus species, Camptotheca acuminata <b>Antifertility :</b> Embelicaribes, Azadirachtaindica, Gossypium species <b>Nervine Tonic:</b> Centellaasiatica, Acoruscalamus, Valerianawallich <b>Anti-AIDS :</b> Areca catechu, Theasinensis	<b>18</b>
<b>V</b>	<b>Volatile oils and Dyes:</b> Volatile oil of commercial significance. Review of Natural sweeteners : Dyes and Pigments, Preservatives	<b>09</b>

**Recommended Text Books**

1. Ayurvedic formulary of India, Govt. of India, 1962.
2. British Herbal Pharmacopoeia, (vol. I, II & III) Her majestys Services, U.K.
3. Cultivation and Utilization of aromatic plants: Atal & Kapoor, RRL, Jammu
4. Cultivation and Utilization of medicinal plants: Atal & Kapoor, RRL, Jammu.
5. Drug and Cosmetic act, (with latest amendments including Ayurvedic GMP), Govt. of India.
6. Herbal Drug industry: R.D. Chudhary, Eastern Publishers, New Delhi 1996.
7. Introduction to spices, plantation crops, medicinal and aromatic plants: N.Kumar et al , Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, 1997.
8. Pharmacognosy: Trease W.C., Evans G.E. Bailliere and Tindall, London, 14th edtn.
9. Research in Education : John w. Best & James V. Kahn, Practice Hall of India Pvt. Ltd., New Delhi, 1996.
10. Various journals related to medicinal plants.
11. Various journals related to spices, perfumes, food and nutrition.
12. Various Research Journals on Medicinal natural products. Wealth of India , CSIR, New Delhi ( Related Volumes ).

OPEN ELECTIVE

PAPER-XVI: B) MEDICAL BIOTECHNOLOGY AND BIO-NANOTECHNOLOGY

(45L-4 Credits)

UNIT	Title of Units	Total Hours
<b>I</b>	<b>Medical biotechnology: Microbial Diseases:</b> Normal microbial flora of human body, host-microbe interactions. Infection and infectious process, routes of transmission of microbes in the body. Epidemiology, description and pathology of human diseases caused by bacteria; <i>Staphylococcus</i> , <i>E. coli</i> , <i>Salmonella</i> , <i>Pseudomonas</i> , <i>Klebsiella</i> , <i>Vibrio cholera</i> , <i>Clostridium</i> , <i>Mycobacteria</i> , syphilis, <b>Fungi:</b> Description and pathology of diseases Caused by <i>Aspergillus</i> , <i>Candida</i> , <i>Micrococcosis</i> , <b>Protozoa:</b> Malaria and Ameobiosis. <b>Viruses:</b> pathogenesis of HSV, HIV.	<b>10</b>
<b>II</b>	<b>Laboratory diagnosis:</b> Laboratory diagnosis of common infective syndromes and parasitic, Molecular diagnosis of various diseases. <b>Biosensors:</b> Concept and development of biosensors- Historical perceptive. Market potential and limitations, new generations of biosensors, Biosensors in medical diagnostics. Industrial applications of biosensors	<b>05</b>
<b>III</b>	<b>Chemotherapy:</b> Principles of chemotherapy, Mode of antibiotics: Penicillin, Streptomycin, Sulfonamides, and Polymyxins Antifungal drugs (Nystatin), Antiviral agents. Problems of drug resistance and drug sensitivity, Drug resistance in bacteria (MDR bacteria). Interferon-Induction of interferon, types of inducers. Inactivation of viruses - Photodynamic inactivation. Vaccination for prevention of diseases, Application of phages in therapeutics.	<b>10</b>
<b>IV</b>	<b>Bio-Nanotechnology:</b> Introduction to Nanoworld, Nanoscience and Nanotechnology - nanoparticles, Nanowires, Nanorods, Nanotubes, thin films and multilayer. Applications in nanotechnology viz. Biosensors, separation of cells and cell Organelles, environmental cleaning, drug delivery, gene therapy etc.	<b>10</b>
<b>V</b>	<b>Synthesis of nanostructures:</b> Natural in inorganic, Natural in organism, chemical and physical methods–Sol Process, Micelle, Chemical Precipitation, Hydrothermal Method, Pyrolysis, Bio-based Protocol, Chemical Vapor Deposition, Sputtering etc. Functionalization of nanoparticles for biological applications. Recent trends in Nanobiotechnology.	<b>10</b>

### **Recommended Text Books:**

1. Nanomedicine books series by Robert A. Freitas Jr. Nanomedicine Volume I: basic capabilities, Landes, Austin, Tx, 1999
2. Robert A. Freitas Jr., Nanomedicine, volume IIA: Biocompatibility Lands, Austin, Tx 2003.
3. C. Wei, Nanomedicine, An issue of medical Clinics, 91-5, Elsevier Saunders, 2007
4. D.E. Reisner, bionanotechnology: Global Prospects, CRC Press, Boca Raton, FL 2008.
5. William F. Ganong. Review of medical Physiology Text Book Volume-I Springer
6. Ethical Guidelines for Biomedical Research on Human Subjects 2000. Indian Council of Medical Research, New Delhi



<b>PRACTICAL PAPER-IX</b>	<b>ANIMAL BIOTECHNOLOGY &amp; STEM CELL TECHNOLOGY AND INDUSTRIAL &amp; ENVIRONMENTAL BIOTECHNOLOGY AND PLANT BIOTECHNOLOGY</b> <b>(45L-4 Credits)</b>
	<p><b>Animal Biotechnology &amp; Stem Cell Technology</b></p> <ol style="list-style-type: none"> <li>1. Preparation of reagents and media for cell culture.</li> <li>2. Isolation of cells by enzymatic and mechanical disaggregation method.</li> <li>3. Primary culture of oviduct/ epithelial/ fibroblast cell and viability count by trypan blue.</li> <li>4. Isolation and cultivation of lymphocytes</li> <li>5. Suspension culture technique</li> </ol> <p><b>Industrial &amp; Environmental Biotechnology</b></p> <ol style="list-style-type: none"> <li>1. Fermentative production of Organic solvents: - Ethanol/Acetone/ Butanol.</li> <li>2. Alcoholic beverages: Beer/ Wine</li> <li>3. Fermentative production of Amino Acid: L-glutamic acid/Phenylalanine/ L-lysine &amp; Vitamins: Vitamin B12.</li> <li>4. To study the BOD &amp; COD levels of different water systems.</li> <li>5. Bacteriological analysis of water by presumptive, confirmatory and completed tests</li> <li>6. Isolation of xenobiotic degrading microorganisms</li> </ol> <p><b>Plant Biotechnology</b></p> <ol style="list-style-type: none"> <li>1. Preparation of Media.</li> <li>2. Ex-plant Surface Sterilization</li> <li>3. Callus Culture and Organ Culture</li> <li>4. <i>In vitro</i> rooting and acclimatization.</li> <li>5. Protoplast isolation and culture.</li> <li>6. Anther Culture/ Production of haploids.</li> <li>7. Synthetic seed preparation</li> </ol>

<b>OPEN ELECTIVE PRACTICAL PAPER-X</b>	<b>A) ADVANCED PHARMACOGNOSY (50 Marks, Credits-2)</b>
	<ol style="list-style-type: none"> <li>1. Evaluation and standardization of a given herbal drug by physical, chemical and biological methods.</li> <li>2. Isolation of total oleo-resin from ginger</li> <li>3. Isolation of pectin</li> <li>4. Isolation of papain</li> <li>5. Isolation of glycyrrhizin form Glycyrrhizaglabra</li> <li>6. Isolation and estimation of total phenolics</li> <li>7. Isolation of lycopene from Tomatoes</li> <li>8. Isolation of <math>\alpha, \beta</math> Glucosamine from crab shells</li> </ol>

**OR**

<b>OPEN ELECTIVE PRACTICAL PAPER-X</b>	<b>B) MEDICAL BIOTECHNOLOGY AND BIO-NANOTECHNOLOGY (50 Marks, Credits-2)</b>
	<ol style="list-style-type: none"> <li>1. Preparation of selective and differential media used in diagnostic microbiology.</li> <li>2. Laboratory examination: Collection and microbiological examination of sputum, pus, urine and blood by differential staining.</li> <li>3. Normal micro flora of throat and skin on Blood agar /Chocolate Agar and Biochemical test</li> <li>4. Mycology - Laboratory diagnosis of fungal diseases. Direct microscopy - cultures using Sabouraud's Dextrose Agar medium - Filamentous fungi, yeasts, and dimorphic fungi. <i>Aspergillus niger</i>, <i>Candida albicans</i>. (Slides).</li> <li>5. Antibiotic susceptibility test.</li> <li>6. Synthesis of <math>Fe_2O_3/AuCl_2/AgNO_3</math>/carbon Dots by chemical method.</li> <li>7. Synthesis of nanoparticles using biological process – (any one method).</li> <li>8. Detection of nanoparticles in colloidal solutions using UV-VIS and FTIR</li> </ol>

**PRACTICAL PAPER XI: PROJECT DISSERTATION AND VIVA VOCE: Students have to begin their projects in 3rd Semester and submit the report in 4<sup>th</sup> Semester. (50 Marks, Credits-2)**

**SEMINAR-IV**

**(25 Marks, Credits-1)**