

M.SC. BIOTECHNOLOGY

Scheme PG A2: Semester 1st

Course ID	Course Title	Course ID	L	T	P	L	T	P	Total Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
Core Course(s)														
CC-A01	Microbiology– Lab I	241/BIOT/CC101	03	00	02	03	00	01	04	25	50	05	20	100
CC-A02	Molecular Biology – Lab I	241/BIOT/CC102	03	00	02	03	00	01	04	25	50	05	20	100
CC-A03	Cell Biology – Lab II	241/BIOT/CC103	03	00	02	03	00	01	04	25	50	05	20	100
Discipline Specific Elective Courses (Select any one course from the following)														
DSE-01	Bio-statistical methods and Data Analysis – Lab II OR Genetic Engineering – Lab II	241/BIOT/DS101	02	00	02	02	00	01	03	15	35	05	20	75
Multidisciplinary Course(s)														
MDC-01	One from the Pool	241/BIOT/MD101	02	00	02	02	00	01	03	15	35	05	20	75
Ability Enhancement Course(s)														
AEC-01	One from the Pool	241/BIOT/AE101	02	00	00	02	00	00	02	00	50	00	00	50
Value-added Course(s)														
VAC-01	One from the Pool	241/BIOT/VA101	02	00	00	02	00	00	02	00	50	00	00	50
Total Credits									22					550

Scheme PG A2: Semester 2nd

Course Code	Course Title	Course ID	L	T	P	L	T	P	Total Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
Core Course(s)														
CC-A04	Cell and Tissue Culture – Lab III	241/BIOT/CC204	03	00	02	03	00	01	04	25	50	05	20	100
CC-A05	Molecular Cytogenetics – Lab III	241/BIOT/CC205	03	00	02	03	00	01	04	25	50	05	20	100
CC-A06	Biochemistry and Biotechniques– Lab IV	241/BIOT/CC206	03	00	02	03	00	01	04	25	50	05	20	100
Discipline Specific Elective Courses (Select any one course from the following)														
DSE-02	Bioinformatics – Lab IV OR Proteomics and Genomics – Lab IV	241/BIOT/DS202	02	00	02	02	00	01	03	15	35	05	20	75
Multidisciplinary Course(s)														
MDC-02	One from the Pool	241/BIOT/MD202	02	00	02	02	00	01	03	15	35	05	20	75
Ability Enhancement Course(s)														
AEC-02	One from the Pool	241/BIOT/AE202	02	00	00	02	00	00	02	00	50	00	00	50
Skill Enhancement Course(s)														
SEC-01	One from the Pool	241/BIOT/SE201	01	00	02	01	00	01	02	05	20	05	20	50
Total Credits									22					550

Note: internship or field training or project of 4-6 weeks during summer vacation @ 4 credits.

Scheme PG A2: Semester 3rd

Course Code	Course Title	Course ID	L	T	P	L	T	P	Total Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
Core Course(s)														
CC-A07	Enzyme Technology – Lab V	241/BIOT/CC307	03	00	02	03	00	01	04	25	50	05	20	100
CC-A08	Biotechnology and Human Welfare – Lab V	241/BIOT/CC308	03	00	02	03	00	01	04	25	50	05	20	100
CC-A09	Immunology – Lab VI	241/BIOT/CC309	03	00	02	03	00	01	04	25	50	05	20	100
Discipline Specific Elective Courses (Select any one course from the following)														
DSE-03	Molecular Medicine and Diagnostics– Lab VI OR Biosafety, Bioethics and IPR Issues – Lab VI	241/BIOT/DS303	02	00	02	02	00	01	03	15	35	05	20	75
Multidisciplinary Course(s)														
MDC-03	One from the Pool	241/BIOT/MD303	02	00	02	02	00	01	03	15	35	05	20	75
Skill Enhancement Course(s)														
SEC-02	One from the Pool	241/BIOT/SE302	01	00	02	01	00	01	02	05	20	05	20	50
Value added Course(s)														
VAC-02	One from the Pool	241/BIOT/VA302	02	00	00	02	00	00	02	00	50	00	00	50
Seminars														
Seminar	Seminar	241/BIOT/SEMINAR301	02	00	00	02	00	00	02	00	50	00	00	50
Internship/Field Activity#														
INTRSP	Industrial Visit/ Field Work and Report Writing	241/BIOT/INTRSP301	02	00	00	02	00	00	04	00	50	00	00	50
Total Credits									28					600

Four credits of internship earned by a student during summer internship after 2nd semester will be counted in 3rd semester of a student who pursue 2 year PG Programme without taking exit option.

Scheme PG A2: Semester 4th

Course Code	Course Title	Course ID	L	T	P	L	T	P	Total Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
Ability Enhancement Course(s)														
AEC-03	Manuscript Writing**/ Pool	241/BIOT/AE403	02	00	00	02	00	00	02	00	50	00	00	50
Dissertation/Project Work														
Dissertation	Industrial Training/Research Project/ Dissertation	241/BIOT/DISSERTATION401	0	0	40	0	0	20	20	00	00	100	400	500
Total Credits									22					550

BIOTECHNOLOGY: SEMESTER-I								
Course Type	Course ID	Name of the Course	Credit	Contact Hours/Week	Internal Assessment marks	End Term Marks	Max. Marks	Exam Duration
CC-A01	241/BIOT/CC101	Microbiology	3	3	25	50	75	3 hrs.
4 credit		Practical	1	2	5	20	25	4 hrs.
Course Learning Outcomes (CLO)								
<ol style="list-style-type: none"> Analyse the Scope and Importance of Microbiology, understand the microbial world, exhibit the knowledge for isolation, purification, and preservation of microbial cultures and biosafety measures Distinguish various types of microbes, understand the classification strategy and describe various approaches to identify the microbes, discuss and analyze the industrial importance of microbes. Exhibit the knowledge of various sterilization techniques, analyze their use and safety measures, also understand and describe the role & action of antibiotics, disinfectants and techniques to evaluate their potency, explain validation of various sterilization processes. Understand the role of micro-organisms in the environment, for making industrially important fermented foods and discuss the food borne diseases, spoilage of food items by microbes and analyse the food spoilage prevention strategy. 								
Instructions for Paper-Setter								
<ol style="list-style-type: none"> Nine questions will be set in all. All questions will carry equal marks. Question No. 1, which will be short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit wise selecting two questions from each Unit I to IV. The candidate will be required to attempt question No. 1 and four more questions selecting one question from each unit. 								
UNIT	TOPICS							CONTACT HOURS
I	Various branches and Applications of Microbiology, History and contributions of various scientists to this science with particular reference to the contribution of the following scientists- A. V. Leeuwenhoek, Louis Pasteur, Edward Jenner, Robert Koch, Alexander Fleming and Joseph Lister. Spontaneous generation versus biogenesis. Distinguishing features of prokaryotic and eukaryotic microbial cells, Morphology and arrangement of bacterial cells, Bacterial- flagella, fimbriae, capsule, spores and cysts, cell walls of Gram +ve and Gram -ve bacteria, Nutritional requirements and nutritional categories of microorganisms, Influence of environmental factors on microbial growth (temperature, oxygen concentration, pH, pressure, solute, light, radiations), Enrichment culture techniques for isolation of microorganisms, pure culture techniques and preservation techniques, study of growth curve, Quantitative measurement of growth.							12
II	Distinguishing features of bacteria, viruses, fungi, protozoa, algae; Introduction to Microbial Classification and Taxonomy, Taxonomic ranks, Various approaches for identification of microorganisms including molecular approaches; Gram (+) and Gram (-) bacteria of medical and industrial importance; Characteristics of Mycobacterium and Mycoplasmas; photosynthetic prokaryotes (purple bacteria, green bacteria, cyanobacteria) and actinomycetes; brief account of different types of viruses with special reference to lambda phage, herpes, adenoviruses and retroviruses; virioids and prions; fungi and algae of industrial importance.							11
III	Sterilization methods- dry heat, moist heat, radiations, filtration, and gaseous sterilization. Validation of sterilization processes; Factors affecting antimicrobial action, Mode of action of antimicrobial agents, Antibiotics and their mode of action, Microbiological assay of antibiotics (ampicillin, streptomycin, tetracycline etc.), characteristics of an ideal antimicrobial chemical agent, Disinfectants and techniques to evaluate the potency of antimicrobial chemical agents, Types of toxins and their mode of action.							11
IV	Microbial ecology: Biogeochemical cycles (carbon cycle, nitrogen cycle, phosphorous cycle, sulphur cycle); Physical environment: Microenvironment & Niche, Microorganisms and ecosystems. Soil microbiology: Types & functions of microorganisms in soil. Microorganism associations with vascular plants (Mycorrhizae, Rhizobia), Microbial spoilage of foods. Methods to control food spoilage, Food borne diseases. Microbiology of fermented foods.							11

V Practical	<ol style="list-style-type: none"> 1. Determination of T_m value. 2. Plasmid purification using DNA binding membrane 3. Lab rules and safety measures in Microbiology lab. 4. Commonly used equipment for microbial work 5. Use of bright-field microscope 6. Preparation of cotton plugs and culture media 7. Aseptic techniques 8. Sub-culturing/ Picking off technique 9. Measurement of the growth of microbial culture. 10. Study of Thermal death point and thermal death time of microbes. 11. Micrometry. 12. Growth curve of bacteria. 13. Various staining methods – Gram staining, capsule, spore, fungal staining, Acid fast staining, Negative staining etc. 14. Isolation and enumeration of micro-organisms of air, water and soil. 15. Pure culture of micro-organisms. 16. Biochemical tests useful in bacterial taxonomy. 	30
Learning Resources		
<ol style="list-style-type: none"> 1. Lim, D.V. (1998) Microbiology, West Publishing Company, New York. 2. Brock, T.D. (1990) Microbiology: A text book of Industrial Microbiology, Sameur Association. 3. Tortora, G. J., Funke, B. R. and Case, C. L. (2016) Microbiology: An introduction, Pearson Education. 4. Atlas, R.M. (1998) Microbiology: Fundamental and Applications, Macmillan Publishing Company, New York. 5. Pelczar, M.J., Chan, E.G.S. and Krieg, N.R. (2007) Microbiology, McGraw Hill Inc. 6. Heritage, J., Evance, E.G.V. and Killington, R.A. (1999) Microbiology in action, Cambridge University Press 7. Willey, J., Sherwood, L. and Woolverton, C. J. (2017) Prescott's Microbiology, McGraw-Hill Education 8. Stanier, R. Y., Ingraham, J. L., Wheelis, M. L., Painter, P. R. (2005) General Microbiology, MacMillan Press Ltd. 		

BIOTECHNOLOGY: SEMESTER-I								
CourseType	Course ID	Name of theCourse	Credit	Contact Hours/Week	Internal Assessment marks	End Term Marks	Max. Marks	Exam Duration
CC-A02	241/BIOT/CC102	Molecular Biology	3	3	25	50	75	3 hrs.
4 credit		Practical	1	2	5	20	25	4 hrs.
Course Learning Outcomes (CLO)								
<ol style="list-style-type: none"> The youth will know DNA replication and DNA repair mechanisms Students will come to know about the process of protein sorting and its mechanisms Students will get the knowledge about the genes and the proteins associated with Cancer i.e. oncogenes and tumor suppressor proteins. The students will gain the knowledge about molecular markers and its application. 								
Instructions for Paper-Setter								
<ol style="list-style-type: none"> Nine questions will be set in all. All questions will carry equal marks. Question No. 1, which will be short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit wise selecting two questions from each Unit I to IV. The candidate will be required to attempt question No. 1 and four more questions selecting one question from each unit. 								
UNIT	TOPICS							CONTACT HOURS
I	DNA Replication: Mechanism of DNA replication in Prokaryotic and eukaryotic cells. Enzymes and accessory proteins involved in DNA replication and DNA repair. Transcription: Prokaryotic & Eukaryotic transcription, RNA polymerase, General and specific transcription factors, Transcriptional and post-transcriptional gene silencing, Modifications in RNA: 5'- Cap formation, Transcription termination, 3'-end processing and polyadenylation, Splicing, Editing, Nuclear export of mRNA & its stability.							12
II	Translation: Prokaryotic and eukaryotic translation, Regulation of translation, co- and post translational modifications of proteins. Protein Localization: Synthesis of secretory and membrane protein & their import into nucleus, mitochondria, and peroxisomes, Receptor mediated endocytosis, Oncogenes and Tumor Suppressor Genes: Viral and cellular oncogenes, Structure, Function and mechanism of action of pRB and p53 tumor suppressor proteins							11
III	Antisense and Ribozyme Technology: Molecular mechanism of antisense molecules, inhibition of splicing, polyadenylation and translation, disruption of RNA structure and capping, Biochemistry of ribozyme; hammer head & their designing strategies, hairpin and other ribozymes. Applications of Antisense and ribozyme technologies. Homologous Recombination: Holliday junction, gene targeting, gene disruption, and Cre/Lox recombination, RecA and other recombinases Molecular Mapping of Genome: Genetic and physical maps & their applications.							11
IV	Molecular markers in genome analysis: RFLP, RAPD and AFLP analysis, Molecular markers & their applications viz., forensic, disease prognosis, genetic counseling, Pedigree, animal trafficking and poaching; Germplasm maintenance, taxonomy and bio-diversity Genome Sequencing: Genomesizes, organelle genomes, Genomic libraries, YAC, BAC libraries, Strategies for sequencing genome, Packaging, transfection and recovery of clones, Application of Sequencing, sequence information for identification of defective genes.							11

<p style="text-align: center;">V Practical</p>	<ol style="list-style-type: none"> 1. Isolation of Genomic DNA. 2. Isolation of RNA. 3. Quantitative analysis of DNA. 4. Restriction digestion of DNA. 5. Ligation of DNA fragments. 6. Molecular weight analysis using agarose gel electrophoresis. 7. Isolation of plasmid DNA. 8. Western blotting. 9. Southern blotting. 10. Preparation of competent cell. 	<p style="text-align: center;">30</p>
Learning Resources		
<ol style="list-style-type: none"> 1. Molecular Biology of the Gene, J.D. Watson, N.H. Hopkins, J.W. Roberts, J.A. Steitz and A.M. Weiner. The Benjamin/Cummings Pub. Co., Inc., California. 2. Molecular Cell Biology, J. Darnell, H. Lodish and D. Baltimore Scientific American Books, Inc., USA. 3. Molecular Biology of the Cell, B. Alberts, D. Bray, J. Lewis, M. Raff, K. Roberts and J.D. Watson. Garland Publishing Inc., New York. 3. Gene VI, Benjamin Lewin, Oxford University Press, U.K. 4. Molecular Biology and Biotechnology. A comprehensive desk reference, R.A. Meyers(Ed.), VCH Publishers, Inc., New York. 5. Molecular Cloning: a Laboratory Manual, J. Sambrook, E.F. Fritsch and T. Maniatis, Cold Spring Harbor Laboratory Press, New York. 6. Introduction to Practical Molecular Biology, P.D. Dabre, John Wiley & Sons Ltd., New York. 8. Molecular Biology LabFax, T.A. Brown (Ed.), Bios Scientific Publishers Ltd., Oxford 		

BIOTECHNOLOGY: SEMESTER-I								
CourseType	Course ID	Name of theCourse	Credit	Contact Hours/Week	Internal Assessment marks	End Term Marks	Max. Marks	Exam Duration
CC-A03	241/BIOT/CC103	Cell Biology	3	3	25	50	75	3 hrs.
4 credit		Practical	1	2	5	20	25	4 hrs.
Course Learning Outcomes (CLO)								
<ol style="list-style-type: none"> This core course will make students able to understand how the cell functions as a unit of life. Through this course, students will be able to appreciate the importance of various cell function and structures in the evolution of multicellular organisms. The studies will make the students reveal elegance, dynamics and economy in the living cell and a gratifying unity in the principles by which a cell functions. The students will know about the basic cellular and molecular approaches for cancer development and treatment. 								
Instructions for Paper-Setter								
<ol style="list-style-type: none"> Nine questions will be set in all. All questions will carry equal marks. Question No. 1, which will be short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit wise selecting two questions from each Unit I to IV. The candidate will be required to attempt question No. 1 and four more questions selecting one question from each unit. 								
UNIT	TOPICS							CONTACT HOURS
I	Biomembranes: Molecular composition and arrangement, functional consequences, membrane transportation; diffusion, active transport and pumps, uniports, symports and antiports, Donnan equilibrium; ion movements and cell function; Maintenance of cellular pH; Receptor mediated endocytosis, The Extra Cellular Matrix Cell-cell interactions: adhesion junctions, tight junctions, gap junctions, plasmodesmata Ca ⁺⁺ dependent and Ca ⁺⁺ independent Homophilic cell-cell adhesion							12
II	Cytoskeleton and cell movement: Structure and organization of actin filaments, Actin, myosin and cellular movements, Structure and dynamic organizations of microtubules, Intermediate filaments, Cilia and flagella, Cell matrix adhesion, Integrins, Collagen, Non-collagen components, Protein sorting and transport, Protein uptake into the ER, Membrane proteins and Golgi sorting, Mechanism of vesicular transport, Lysosomes, Molecular mechanism of secretory pathway							11
III	Cell cycle: The eukaryotic cell cycle, Regulators of cell cycle progression, The events of M phase, Meiosis and fertilization, Genome organization, Chromosomal organization of genes and noncoding DNA, Mobile DNA, Pathways of intracellular signal transduction, Signaling networks							11
IV	Cell death and cell renewal: Apoptosis, Stem cells and the maintenance of adult tissues, Embryonic stem cells and therapeutic cloning, Biology of Cancer, Oncogenes, Tumor suppressor genes, Molecular approaches to cancer treatment, Biology of Ageing							11
V Practical	<ol style="list-style-type: none"> Preparation of mitotic and meiotic chromosomes. Calculation of morphometric data and preparations of idiogram. Determination of chiasma frequency and terminalization coefficient. Preparation of polytene chromosomes and mapping. Study of permanent slides of different types of cancer and their stages 							30
Learning Resources								

1. Molecular Cell, Biology, J. Darnell, H. Lodish and D. Baltimore Scientific AmericanBook, Inc., USA.
2. Molecular Biology of the Cell, B. Alberts, D. Bray, J. Lewis, M. Raff, K. Roberts and J.D. Watson. Garland Publishing Inc., New York.

BIOTECHNOLOGY: SEMESTER-I								
CourseType	Course ID	Name of theCourse	Credit	Contact Hours/Week	Internal Assessment marks	End Term Marks	Max. Marks	Exam Duration
DSE-01 4 credit	241/BIOT/DS/101	Bio-statistical methods and Data Analysis	2	2	15	35	50	3 hrs.
		Practical	1	2	5	20	25	4 hrs.
Course Learning Outcomes (CLO)								
<ol style="list-style-type: none"> This paper will help in understanding the students about a set of observations and then designing an experiment. Students will be able to acquire, analyze and understand the significance of data. Students will gain the knowledge about the hypothesis testing. The paper will also help in understanding various Non-parametric tests. 								
Instructions for Paper-Setter								
<ol style="list-style-type: none"> Nine questions will be set in all. All questions will carry equal marks. Question No. 1, which will be short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit wise selecting two questions from each Unit I to IV. The candidate will be required to attempt question No. 1 and four more questions selecting one question from each unit. 								
UNIT	TOPICS							CONTACT HOURS
I	Data Analytics: Introduction, types, characteristics and advantages of data analytics. Descriptive statistical techniques: Central tendency, Dispersion, Skewness and Kurtosis. Correlation and Regression: Simple, Partial and Multiple.							8
II	Probability Theory: Concept and Approaches, Application of Additive and Multiplication Laws, Bay's Theorem, Mathematical Expectations. Probability Distribution: Binomial, Poisson, Normal.							7
III	Hypothesis Testing. Parametric tests: t-test and Analysis of Variance – one way classification, two way classification. Chi-Square test & its application.							7
IV	Non-Parametric Tests: The Runs test of randomness; tests of two-matched samples: Wilcoxon test, Signed Rank- Sum test; Test involving two independent samples: The Mann- Whitney U Test; Tests for K Related samples: The Kruskal Wallis H test, Friedman's test. Overview of Analytic Tools: Excel as analytic tool, SPSS, Data Visualization in Tableau, Elementary idea and Use of R Programming and Python in Analytics, Data Mining, Big Data.							8
V Practical	<ol style="list-style-type: none"> Descriptive statistics: Systemic tabular summarization of data (before analysis), measures of central tendency, measures of dispersion (using calculators). Tests of significance (Mean, Standard Deviation, proportion). Chi Square Test of Goodness of fit, test of independence of attributes, Analysis of Variance (One way and two ways). 							30
Learning Resources								
<ol style="list-style-type: none"> Daniel, Wayne W. (2007) Biostatistics: A Foundation for Analysis in Health Sciences 10th Edition, Wiley Series. Pagano, Marcello and Gauvreau, Kimberlee (2000) Principles of Biostatistics, 2nd Edition, CRC Press Chap T. Le, Introductory Biostatistics (2017), Wiley India Pvt Ltd. P.N. Arora and P. K. Malhan, Biostatistics, Himalaya Publishing House B. K. Mahajan, Methods in Biostatistics: For Medical Students and Research Workers, JPB 								

BIOTECHNOLOGY: SEMESTER-I								
CourseType	Course ID	Name of theCourse	Credit	Contact Hours/Week	Internal Assessment marks	End Term Marks	Max. Marks	Exam Duration
DSE-01 4 credit	241/BIOT/DS101	Genetic Engineering	2	2	15	35	50	3 hrs.
		Practical	1	2	5	20	25	4 hrs.
Course Learning Outcomes (CLO)								
<ol style="list-style-type: none"> The student should be able to design and comprehend experimental strategies for alteration of genes and gene products in variety of organisms. CO2 Students could use various approaches to conduct genetic engineering and their applications in biological research as well as in biotechnology industries. This paper deals with various scopes in genetic engineering along with molecular tools. The students will gain the knowledge about the gene tagging and its role. 								
Instructions for Paper-Setter								
<ol style="list-style-type: none"> Nine questions will be set in all. All questions will carry equal marks. Question No. 1, which will be short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit wise selecting two questions from each Unit I to IV. The candidate will be required to attempt question No. 1 and four more questions selecting one question from each unit. 								
UNIT	TOPICS						CONTACT HOURS	
I	Scope in Genetic Engineering. Isolation of enzymes, DNA sequencing, synthesis and mutation, detection and separation cloning, gene expression. Cloning and patenting of life forms. Molecular Tools and Their Applications, Restriction enzymes, modification enzymes, DNA and RNA markers.						7	
II	Nucleic Acid Purification, Yield Analysis, Amplification and its Applications, Gene Cloning Vectors, Restriction Mapping of DNA Fragments and Map Construction, Nucleic Acid Sequencing, cDNA Synthesis and cloning. Alternative Strategies of Gene Cloning. Transgenic and gene knockout technologies. Targeted gene replacement, chromosome engineering						7	
III	Microarray, Site-directed Mutagenesis and Protein Engineering. DNA transfection, Northern blot, Primer extension, S1 mapping, RNase protection assay, Reporter assays Expression strategies for heterologous genes, Vector engineering and codon optimization, host engineering, in vitro transcription and translation, expression in bacteria expression in bacteria, yeast, insect cells, mammalian cells and in plants.						8	
IV	Recombinant proteins: Purification and folding, characterization and stabilization. Phage Display, T-DNA and Transposon Tagging. Gene tagging and its role. Gene therapy: Vector engineering strategies of gene delivery, gene replacement/augmentation, gene correction, gene editing, gene regulation and silencing.						8	
V Practical	<ol style="list-style-type: none"> Bacterial culture and antibiotic selection medias. Prepration of competent cells. Isolation of plasmid DNA. Isolation of lambda phage DNA. Quantitation of nucleic acids. Agarose gel electrophoresis and restriction mapping of DNA Construction of restriction map of plasmid DNA. Cloning plasmid/phagemid vectors. Preparation of helper phage and its titration Preparation of single stranded DNA template DNA sequencing Gene expression in E. coli and analysis of gene product PCR and Reporter Gene assay (Gus/CAT/b-GAL) Western Blotting 						30	
Learning Resources								
<ol style="list-style-type: none"> Gene cloning and DNA analysis – An Introduction (2006) 5th edition, T.A Brown, Blackwell publisher. Essential genes (2006), Benamin Lewin, Pearson education international. Genome-3 (2007) T.A Brown. Garland science, Taylor & Francis, NewYork. Principles of gene manipulation and Genomics (2006) 7th edition, S.B Primose and R.M Twyman, Blackwell publishing. Principles of Genetic Engineering (2009), Mousumi Debnath, pointer publisher, Jaipur. Molecular Biotechnology-Principles and Applications of Recombinant DNA (2003) 3rd edition, Bernard R Glick and Jack J pasternak. ASM press, Washington. Human Molecular Genetics (2004) 3rd edition, Tom Strachan & Andrew P Read, Garland science. Molecular Biology of Gene (2008) 6th edition, Watson, Baker, Bell, Gann, Levine and Losick, Pearson education Inc. Biotechnology-Appling the genetic Revolution (2009), Clark and Pazdernik, Academic Press Molecular Cloning : A Laboratory Manual (2000), J. sambrook, E.F. Fritsch and T.Maniatis, Cold Spring Harbor Laboratory Press, New York DNA Cloning : A Practical Approach (1995) , D.M. Glover and B.D. Hames, IRL Press, Oxford, 								

BIOTECHNOLOGY: SEMESTER-II

CourseType	Course ID	Name of the Course	Credit	Contact Hours/Week	Internal Assessment marks	End Term Marks	Max. Marks	Exam Duration
CC-A04	241/BIOT/CC204	Cell and Tissue Culture	3	3	25	50	75	3 hrs.
4 credit		Practical	1	2	5	20	25	4 hrs.
Course Learning Outcomes (CLO)								
<ol style="list-style-type: none"> 1. Acquire potential to develop and establish and maintain an independent animal cell culture laboratory. 2. Have knowledge of the maintenance and characterization of animal cell cultures 3. Understand the concepts, applications and recent theoretical knowledge of tools and techniques related to cell cultures and different modes of <i>in vitro</i> regeneration. Know how to develop and establish a PTC laboratory for small scale to industrial level. 4. Attain knowledge about production of novel hybrid plants and their significance in agriculture and plant breeding. They would be able to launch start-ups and become entrepreneurs for various products and processes related to plant tissue culture. 								
Instructions for Paper-Setter								
<ol style="list-style-type: none"> 1. Nine questions will be set in all. All questions will carry equal marks. 2. Question No. 1, which will be short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit wise selecting two questions from each Unit I to IV. The candidate will be required to attempt question No. 1 and four more questions selecting one question from each unit. 								
UNIT	TOPICS							CONTACT HOURS
I	Animal cell and tissues culture: Historical background, development, advantages and limitations of cell & tissue culture, Requirements of cell & tissue culture, Aseptic techniques: elements of aseptic environment, sterile handling, Culture vessels and substrates, Techniques of cell culture – batch, batch fed and continuous cultures, cytotoxicity and viability assays, cell separation techniques, flow cytometry and fluorescence associated cell sorting. Design and types of media, advantages and disadvantages of serum and serum free media, replacement of serum, development of serum free media.							12
II	Primary culture: types of primary cell culture, isolation of the tissue, primary culture, Sub-culturing of animal cells, Cloning and selection: dilution and suspension cloning, scaling up in suspension and monolayer, large scale production of cells using bioreactors, micro-carriers and perfusion techniques. Cell line characterization: need for characterization, authentication, cell morphology, chromosome content, DNA content, RNA and protein expression, enzyme activity, antigen markers. Industrial products of animal cell cultures, Applications of animal cell culture							11
III	Introduction to plant cell tissue culture and historical perspective. Laboratory organization setup (R & D level and industrial level); Aseptic manipulations and bio-safety aspects in PTC; Culture media – components, preparation and development/formulation of media for new plant system. Callus culture, Initiation and maintenance of cell cultures: static techniques of single cell culture, suspension culture and types, assessment of growth and viability of cultured cells. Organogenesis and factors influencing organogenesis. Somatic embryogenesis: process of somatic embryos production, factors influencing and its importance in plant breeding and propagation. Production of synthetic seeds. Large scale plant micropropagation – technique, factors affecting <i>in vitro</i> culture of plants, applications and limitations of micropropagation. Meristem, shoot tip culture, production and indexing of virus free plants. Somaclonal variations, molecular basis of variation and their significance in plant breeding.							11
IV	<i>In vitro</i> production of haploid plants – Androgenesis (anther and pollen culture) and Gynogenesis, Factors affecting androgenesis, ontogeny of androgenesis, diploidization of haploid plants. Significance and uses of haploids in agriculture. Wide hybridization and embryo rescue technique. Protoplast culture and somatic hybridization – Isolation, culture and fusion of protoplast, selection of							11

	fusion products, assessment of somatic hybrid plants, production of cybrids, applications of protoplast culture and somatic hybridization in the improvement of crop plants. <i>In vitro</i> germplasm conservation and cryopreservation	
V Practical	<ol style="list-style-type: none"> 1. Components of an animal cell culture lab, aseptic techniques used in animal cell culture 2. Preparation of medium and primary cell culture 3. Staining and counting of animal cells, viability/cytotoxic/Proliferative assays in animal cells 4. Trypsinization/Disaggregation of cells 5. Estimation of lipid peroxides in cytotoxicity induced animal cells 6. Freezing and thawing of cells 7. To study the PTC laboratory organization setup 8. Aseptic manipulations and bio-safety measures in PTC lab. 9. Preparation of MS medium stocks, hormones, autoclaving, filter sterilization of hormones and antibiotics. 10. Preparation of Murashige and Skoog's basal and regeneration media. 11. Preparation of aseptic plant material via seed germination. 12. Callus induction using various explants. 13. Regeneration of shoots (micro-propagation), root induction, role of hormones in morphogenesis. 14. Acclimatization of tissue culture plants and establishment in pots. 15. Anther culture. 16. Protoplast isolation and culture. 17. Initiation and maintenance of cell suspension cultures of plant cells. 18. Development of synthetic seeds. 19. To study development of Somatic Emryogenesis. 	30
Learning Resources		
<ol style="list-style-type: none"> 1. Animal Cell Culture - Practical Approach (3rd edition), Ed. John R.W. Masters, Oxford, 2000. 2. Animal Cell Culture Methods In: Methods in Cell Biology, Vol. 57, Ed. Jenni P Mather and David Barnes, Academic Press. 3. Animal Cell Culture Techniques. Ed. Martin Clynes, Springer. 4. Biotechnology, Vol. 7b 1993 Rehm. H.J. and Reed, G.(eds) VCH Publications. 5. Cell Culture Lab Fax. Eds. M Butler & M. Dawson, Bios Scientific Publications Ltd. Oxford. 6. Plant tissue culture – Theory and Practice (2005) by Bhojwani S. S. and Razdan M. K., Elsevier publication. 7. Elements of Biotechnology by P. K. Gupta, 4th Reprint (2nd Edition): 2019-2020, Rastogi pub. 8. Introduction to Biotechnology (2009) by H. S. Chawla, 3rd edition, Science publishers, USA 9. Plant cell, organ and tissue culture (1995) by Gamborg O.L. and Phillips G.C., Springer Verlag pub. Germany. 10. Plant Tissue Culture – Basic & Applied (2005) by Jha T.B. & Ghosh B., Universities press. 		

BIOTECHNOLOGY: SEMESTER-II								
CourseType	Course ID	Name of theCourse	Credit	Contact Hours/Week	Internal Assessment marks	End Term Marks	Max. Marks	Exam Duration
CC-A05	241/BIOT/CC205	Molecular Cytogenetics	3	3	25	50	75	3 hrs.
4 credit		Practical	1	2	5	20	25	4 hrs.
Course Learning Outcomes (CLO)								
<ol style="list-style-type: none"> Students will be able to study the molecular composition of the chromosomes. They will gain the knowledge about mutations and molecular basis of cell cycle and its check points The paper deals with nature and mechanism of genomic imprinting. Students will gain the knowledge about mutations and detection of mutagens. 								
Instructions for Paper-Setter								
<ol style="list-style-type: none"> Nine questions will be set in all. All questions will carry equal marks. Question No. 1, which will be short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit wise selecting two questions from each Unit I to IV. The candidate will be required to attempt question No. 1 and four more questions selecting one question from each unit. 								
UNIT	TOPICS							CONTACT HOURS
I	Biology of Chromosomes: Molecular anatomy of eukaryotic chromosomes; Metaphase chromosomes: Centromere, Kinetochore, Nucleolus organizers and rRNA genes, Telomere: structure and Functions, Heterochromatin and euchromatin, Giant Chromosomes: Polytene Chromosomes, Lampbrush Chromosomes							12
II	Sex Chromosomes: Sex determination and the Y Chromosome, Dosage compensation in <i>C. elegans</i> , <i>Drosophila</i> and Humans, Nature and mechanism of genomic imprinting, X-inactivation and imprinting, Sex specific imprinting							11
III	Genes in Pedigrees: Mendelian pedigree pattern, Inheritance of mitochondrial diseases, Complications to the basic pedigree patterns, Non-Mendelian traits. Somatic Cell Genetics: Cell fusion and somatic cell hybrids – agents and mechanism of fusion, Heterokaryon – Cell lines and selection systems and chromosome segregation,							11
IV	Gene Mutations : Spontaneous mutations – Base pair substitution and frame shift mutations Induced mutations – Radiation, chemical and environmental, In-vitro site specific mutagenesis. Detection of mutagens – The Ames test and sister chromatid exchanges, Genetics of Cell Cycle: Genetic regulation of cell division in yeast and eukaryotes, Molecular basis of cellular check points.							11
V Practical	<ol style="list-style-type: none"> Making karyological preparations from testicular material of suitable insects by squash and air drying techniques to study the structure and behaviour of chromosomes during mitosis and meiosis. Study of chiasma frequency and terminalisation co-efficient. Study of mitosis from hepatic caecae of suitable insects and preparation of karyotype and idiogram. Demonstration of banding techniques (C, G and T). Study of NORs in insect chromosomes. Making preparations from salivary glands of <i>Chironomus</i> larvae / <i>Drosophila</i> larvae to study polytene chromosomes. Effect of temperature on polytene chromosomes. Preparation of human buccal smear to study sex chromatin. Nuclear sexing from polymorphonuclear leucocytes. 							30

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| | <ol style="list-style-type: none"> 10. Identification of meiotic and mitotic stages from permanent slides. 11. Gel electrophoresis: Practical demonstration. 12. Isolation of genomic DNA. 13. PCR: Introduction and practical demonstration. | |
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Learning Resources		
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| <ol style="list-style-type: none"> 1. Atherly, A.C., J.R. Girton and J.F. McDonald. The Science of Genetics. Saunders College Publishing, Harcourt Brace College Publishers, NY. 2. Brooker, R.J. Genetics : Analysis and Principles. Benjamin/Cummings, Longman Inc. 3. Fairbanks, D.J. and W.R. Anderson. Genetics – The Continuity of Life. Brook/Cole Publishing Company ITP, NY, Toronto. 4. Gardner, E.J., M.J. Simmons and D.P. Snustad. Principles of Genetics. John Wiley and Sons. Inc., NY. 5. Griffiths, A.J.F., J.H. Miller, D.T. Suzuki, R.C. Lewontin and W.M. Gelbart. An Introduction to Genetic Analysis. W.H. Freeman and company, NY. 6. Lewin, B. Genes. VI. Oxford University Press, Oxford, New York, Tokyo. 7. Snustad, D.P. and M.J. Simmons. Principles of Genetics. John Wiley and Sons. Inc., NY. 8. Watson, J.D., N.H. Hopkins, J.W. Roberts, J.A. Steitz and A.M. Weiner. Molecular Biology of Genes. The Benjamin/Cummings Publishing Company Inc., Tokyo. 9. Tom Strachan & Read, A.P. Human Molecular Genetics 3rd edition, Garland Publishing 2004, London. | | |
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BIOTECHNOLOGY: SEMESTER-II								
CourseType	Course ID	Name of theCourse	Credit	Contact Hours/Week	Internal Assessment marks	End Term Marks	Max. Marks	Exam Duration
CC-A06 4 credit	241/BIOT/CC206	Biochemistry & Biotechniques	3	3	25	50	75	3 hrs.
		Practical	1	2	5	20	25	4 hrs.
Course Learning Outcomes (CLO) <ol style="list-style-type: none"> Students will be able to understand the general reactions of various metabolic pathways. It will make the students to understand the structure and classification of biomolecules. This paper will provide the basic understanding of various biological techniques. The youth will be able to understand the basics of various techniques It will make the students to understand the applications of these techniques for animal kindness. 								
Instructions for Paper-Setter <ol style="list-style-type: none"> Nine questions will be set in all. All questions will carry equal marks. Question No. 1, which will be short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit wise selecting two questions from each Unit I to IV. The candidate will be required to attempt question No. 1 and four more questions selecting one question from each unit. 								
UNIT	TOPICS							CONTACT HOURS
I	Amino acids and peptides-classification, chemical reactions and physical, properties, Sugars - classification and reactions, metabolism of carbohydrate, Heterocyclic compounds-and secondary metabolites in living systems -nucleotides, pigments, isoprenoids, Separation techniques for different biomolecules. Bio-energetics and oxidative phosphorylation. Blood clotting – biochemistry, body fluids –pH and acid base balance and their importance in clinical biochemistry, muscle contraction. Techniques in the study of proteins, carbohydrates and lipids.							12
II	Lipids- classification, structure and functions Proteins-protein and protein legand interactions, end group analysis, hierarchy in structure, Ramachandran map. Conformational properties of polynucleotides, Polysaccharides - types, secondary and tertiary structural features, analysis- theoretical and experimental; Protein folding – biophysical and cellular aspects, enzymes coenzymes, in born errors of metabolism.							11
III	Microscopy: Principles and applications of light, phase contrast, fluorescence microscopes, scanning and transmission electron microscopes. Centrifuge technique: Principle, types of centrifuge, density gradient centrifuge in isolation of cell, cell organelles and biomolecules. Chromatography: Principles and applications of gel filtration, ion-exchange, affinity, thin layer, gas chromatography and high pressure liquid chromatography (HPLC) and FPLC. Application of chromatographic technique in biology. Electrophoresis and centrifugation: Principles and applications of agarose and polyacrylamide gel electrophoresis; ultracentrifugation (velocity and buoyant density).							11

IV	Spectroscopy: Fluorescence, UV, visible, Infrared, Atomic absorption spectroscopy, NMR and ESR spectroscopy; Mass spectrometry (LC-MS, GC-MS), X-ray diffraction. Tracer Biology: Principles and applications of tracer techniques in biology; radioactive isotopes and half-life of isotopes; autoradiography. Application of different spectroscopic technique in biology. Nature and types of radiation, preparation of labelling biological sample, detection and measurement of radiation, GM counter, Scintillation counter. Flow cytometry. Safety measurement in handling radioisotopes, ELISA, RIA and non-radiolabelling.	11
V Practical	<ol style="list-style-type: none"> 1. Titration of amino acids 2. Reactions of amino acids, sugars and lipids 3. Isolation of DNA and protein 4. Quantitation of Proteins and Sugars 5. UV, Visible, Fluorescence and IR spectroscopy, Absorption spectra 6. Demonstration of working of different types of microscopes. 7. Demonstration of Chromatography i.e. TLC, HPLC, GC. 8. To demonstrate the separation of proteins with the help of electrophoresis. 9. To study various molecular biology techniques i.e. PCR. 10. To demonstrate the use of spectrophotometer. 11. Purification of protein by column chromatography. 12. Visit of various laboratories in the university, preparation and submission of report. 	30
Learning Resources		
<ol style="list-style-type: none"> 1. Devi, P. 2000. Principles and Methods of Plant Molecular Biology, Biochemistry and Genetics. Agrobios, Jodhpur, India. 2. Cooper, T.G. 1977. Tools in Biochemistry. John Wiley, New York, USA. 3. Dryer, R. L. and Lata, G. F. 1989. Experimental Biochemistry. Oxford University Press, New York. 4. Hames, B.D.(Ed.).1998. Gel Electrophoresis of Proteins: A Practical Approach, 8th edition. PAS, Oxford University Press, Oxford, UK. 5. Scott, R.P.W. 1995. Techniques and Practice of Chromatography. Marcel Dekker, Inc., New York. 6. Wilson, K. and Walker, J. 1994. Practical Biochemistry: Principles and Techniques, 4th edition. Cambridge University Press, Cambridge, U 7. A Biologists guide to Principles and Techniques of Practical Biochemistry, K. Wilson and K.H. Goulding, ELBS Edn. 8. Lehninger AL, Nelson DL & Cox MM (1993) Principles of Biochemistry, 2nd edn. New York: Worth. 9. Stryer L (1995) Biochemistry, 4th edn. New York: WH Freeman. 10. Voet D, Voet JG & Pratt CW (1999) Fundamentals of Biochemistry. New York: Wiley. 		

BIOTECHNOLOGY: SEMESTER-II								
CourseType	Course ID	Name of theCourse	Credit	Contact Hours/Week	Internal Assessment marks	End Term Marks	Max. Marks	Exam Duration
DSE-02 4 credit	241/BIOT/DS202	Bioinformatics	2	2	15	35	50	3 hrs.
		Practical	1	2	5	20	25	4 hrs.
Course Learning Outcomes (CLO)								
<ol style="list-style-type: none"> The youth will be able to understand the basics of various techniques It will make the students to understand the applications of these techniques for animalkindness Learn role of various <i>in silico</i> tools in managing large data generated by various Biotechnological techniques and tools. Develop concept of sequence alignment, matrix, algorithms and tools to generate more accurate predictions of various Biological data. 								
Instructions for Paper-Setter								
<ol style="list-style-type: none"> Nine questions will be set in all. All questions will carry equal marks. Question No. 1, which will be short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit wise selecting two questions from each Unit I to IV. The candidate will be required to attempt question No. 1 and four more questions selecting one question from each unit. 								
UNIT	TOPICS						CONTACT HOURS	
I	Computers: An overview of computers, microcomputers, VDUs and printer; What is programming? Algorithms; Languages and packages: Introduction to MS Office, MS Access, introduction to SQL (structured query language) Handling arrays, procedures. Colour, sound and graphics; Use of standard packages.						7	
II	Introduction to PERL: Scalar variables, strings and numbers, Assignment statements, Arrays, Hashes, Operators, Input from file, Standard Input, Conditional and logical operators, loops, I/O, Input from file named in command line, Regular expression, Pattern matching, Pattern modifiers. Applications of PERL in Bioinformatics: Storing DNA sequence, DNA to RNA transcription, Finding motifs, Counting nucleotides, Generating random numbers, simulating DNA mutation, generating random DNA, Analyzing DNA						7	
III	Biological Sequence Databases: Overview of various primary and secondary databases that deal with protein and nucleic acid sequences. Databases to be covered in detail are GenBank, EMBL, DDBJ, Swiss Prot, PIR, and MIPS for primary sequences. Preliminary ideas of query and analysis of sequence information. Sequence Comparison Methods: Method for the comparison of two sequences viz., Dot matrix plots, Needleman Wunsch & Smith Waterman algorithms. Analysis of computational complexities and the relative merits and demerits of each method. Theory of scoring matrices and their use for sequence comparison.						8	
IV	Database Search Algorithms: Methods for searching sequence databases like FASTA and BLAST algorithms. Statistical analysis and evaluation of BLAST results. Pattern Recognition Methods in Sequence Analysis: Concept of a sequence pattern, regular expression based patterns. The use of pattern databases like PROSITE and PRINTS. Concept of position specific weight matrices and their use in sequence analysis. Theory of profiles and their use with special reference to PSIBLAST. Markov chains and Markov models and their use in gene finding. Concept of HMMS, the Forward backward and the Viterbi algorithm. The Baum Welch algorithm for training a HMM. Use of profile HMM for protein family classification.						8	

V Practical	<ol style="list-style-type: none"> 1. Retrieve Nucleotide sequences from NCBI serve. 2. Retrieve Protein sequences from PDB. 3. Analysis of sequences Similarity using BLAST/pBLAST/nrBLAST 4. To predict protein secondary structures by using iPred. 5. Perform phylogenetic analysis using PHYLIP. 6. Perform multiple sequence alignment by using ClustalW. 7. Primer design 8. Computational modeling of genomic, transcriptomic and proteomic 	30
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Learning Resources

1. Jin Xiong (2006) Essential Bioinformatics. Cambridge publisher
2. ZhumurGhosh and BibekanandMallick (2008) Bioinformatics: Principles and Applications. Oxford University Press publisher
3. OrpitaBosu and SimminderKaurThukral(2007).Bioinformatics. Oxford University Presspublisher
4. M.Lesk (2002) Introduction to Bioinformatics. Oxford University Press publisher

5. Fundamental Concepts of Bioinformatics, Dan E. Krane, Michael L. Raymer, Michael L. Raymer, Elaine NicponMarieb, 2002, Benjamin/Cummings
6. P. Rastogi and N. Mendiritta (2013) Bioinformatics: Methods and Applications: Genomics, Proteomics and Drug Discovery. Prentice-Hall of India Pvt.Ltd; 4th Revisededition
7. Mount and David W (2004) Bioinformatics: sequence and genome analysis. Cshl Press,2nd edition
8. Harisha S (2007) Fundamentals of Bioinformatics. I K International Publishing HousePvt. Ltd
9. Dan E. Krane (2003) Fundamentals concepts of bioinformatics. Dorling Kindersley (RS);First edition
10. David Edwards and Jason Stajich (2009) Bioinformatics: Tools and Applications.Published by Springer

BIOTECHNOLOGY: SEMESTER-II								
CourseType	Course ID	Name of theCourse	Credit	Contact Hours/Week	Internal Assessment marks	End Term Marks	Max. Marks	Exam Duration
DSE-02 4 credit	241/BIOT/DS202	Proteomics and Genomics	2	2	15	35	50	3 hrs.
		Practical	1	2	5	20	25	4 hrs.
Course Learning Outcomes (CLO)								
<ol style="list-style-type: none"> Understand the concept of genome, proteome and metabolome and their correlation with each other. Learn about genetic organization of nuclear genomes of prokaryotes and eukaryotes, features of eukaryotic organelle genomes, genome evolution and molecular phylogenetics. Conceptualize about different techniques used for proteomics and metabolomics. Learn application of techniques for further research studies in Genomics, Proteomics and Metabolomics. 								
Instructions for Paper-Setter								
<ol style="list-style-type: none"> Nine questions will be set in all. All questions will carry equal marks. Question No. 1, which will be short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit wise selecting two questions from each Unit I to IV. The candidate will be required to attempt question No. 1 and four more questions selecting one question from each unit. 								
UNIT	TOPICS							CONTACT HOURS
I	Genomics: Genome sequencing strategies and programs, new technologies for high throughput sequencing, methods for sequence alignment and gene annotation; Approaches to analyze differential expression of genes - ESTs, SAGE, microarrays and their applications; gene tagging; gene and promoter trapping; knockout and knock-down mutants; dynamic modulation of protein structure and function							8
II	Comparative genomics of model plants and related crop species; Recombination-based cloning techniques; RNAi and gene silencing, genome imprinting, small RNAs and their biogenesis, role of small RNAs in heterochromatin formation and gene silencing, genomic tools to study methylome and histone modifications.							8
III	Analysis of proteins by different biochemical and biophysical procedures like CD (Circular Dichroism), NMR, UV/Visible and fluorescent spectroscopy, protein identification and analysis on ExPASy server, other protein related databases, 1-D and 2-D gel electrophoresis for proteome analysis, Sample preparation, gel resolution and staining; Mass spectrometry based method for protein identification like PMF (protein mass fingerprinting) and LCMS.							7
IV	Image analysis of 2D gels: Data acquisition, spot detection & quantitation, gel matching, data analysis, presentation, databases, conclusions; DIGE (Differential In Gel Electrophoresis), alternatives to 2-DE for protein expression analysis; Analysis of post-translational modifications and protein-protein interactions; protein chips and arrays, future directions in proteomics, scope of functional proteomics.							7
V Practical	<ol style="list-style-type: none"> Gateway cloning Real-time PCR Northern and Western Blotting Bioluminescence imaging Phage titration, Phage library amplification 							30

	<ol style="list-style-type: none"> 6. Site-directed mutagenesis 7. 2D electrophoresis 8. Differential staining procedures including MS-compatible staining 9. Gel filtration chromatography for desalting 10. Native molecular weight determination 11. Immunoprecipitation for antibody quantification 	
Learning Resources		
<ol style="list-style-type: none"> 1. Buchanan B, Grissem G, and Jones R (2000) Biochemistry and Molecular Biology of Plants, American Society of Plant Physiologists, USA. 2. Hammes GD (2005) Spectroscopy for the Biological Sciences; Wiley Interscience, USA. 3. Harlow and Lane D (Eds.) (1988) Antibodies – A Laboratory Manual; Cold Spring Harbor Laboratory, USA. 4. Lieber DC (2006) Introduction to Proteomics: Tools for New Biology; Humana Press, NJ. 5. Pennington SR, Dunn MJ (Eds.) (2002) Proteomics: From Protein Sequence to Function, BIOS Scientific Publishers, United Kingdom. 6. Sambrook J and Russell DW (2001). Molecular Cloning – A Laboratory Manual, Vols I –III, Cold Spring Harbor Laboratory, USA. 7. Singer M and Berg P (1991). Genes and Genomes: A Changing Perspective; University Science Books, CA, USA. 		