CURRICULUM – CORE COURSES

15GN102L	**Molecular Techniques Laboratory I** (Applicable for students admitted from 2016-17 onwards)	**L**	**T**	**P**	**C**
		0	**0**	**4**	**2**
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P Professional Core				
Course designed by	Department of Genetic Engineering				
Approval	32nd Academic Council Meeting held on 23rd July 2016				

PURPOSE	The course imparts practical knowledge on nucleic acid isolation, digestion and ligation. This course also gives knowledge on transformation and recombinant selection							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Learn basic molecular techniques, DNA isolation and electrophoresis	a	b	c	d	f		
2.	Learn protein isolation, estimation and analysis	b	a	d	f			
3.	Learn thin layer chromatography	a	b	c	d	f		
4.	Learn column chromatography	a	b	c	d	f		

Session	**Description of Experiments**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
1.	Introduction to micropipette handling, pH measurement, stoichiometry and buffer preparation	8	C	1	2
2.	Isolation of genomic DNA from bacteria or plants or blood	8	C,I,O	1	1,2
3.	Agarose gel electrophoresis of genomic DNA	4	C,I,O	1	1,2
4.	Spectrophotometric quantification of genomic DNA	4	C,I,O	1	1,2
5.	Isolation of total protein from bacteria/ legume seeds	8	C,D,I,O	1	1,2
6.	Estimation of total protein concentration using Lowry's/ Bradford's method	4	C,I,O	2	1,2
7.	SDS PAGE analysis of total protein	8	C,D,I,O	3	1,2
8.	Thin layer chromatography of plant crude extract	8	C,D,I,O	3	2
9.	Qualitative analysis of sugars	4	C,D,I,O	4	2
10.	Quantitative estimation of reducing sugars	4	C,D,I,O	4	2
	Total contact hours	**60**			

LEARNING RESOURCES	
Sl. No.	**REFERENCES**
1.	Michael, R. G., Sambrook. J., "*Molecular Cloning – A Laboratory Manual"*, 4th edition, Cold Spring Harbor Laboratory Press, 2012..
2.	Laboratory Manual

Course nature		**Practical**				
Assessment Method (Weightage 100%)						
In-Aemester	**Assessment tool**	Experiments	Record	MCQ/Quiz/Viva Voce	Model examination	**Total**
	Weightage	**40%**	**5%**	**5%**	**10%**	**60%**
				End semester examination weightage :		**40%**

15GN103	Training in Laboratory Safety	L	T	P	C
		1	1	0	1
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P Professional Core				
Course designed by	Department of Genetic engineering				
Approval	32nd Academic Council Meeting held on 23rd July 2016				

PURPOSE	Students of Genetic Engineering will be spending most of their time working in the laboratories, either for practical or for projects. Some experiments would involve the use of chemicals and equipments that require cautious handling. This course will train the students on how to safely handle the chemicals, equipments and biological materials and also on how to dispose them safely into the environment.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1	Gain knowledge on lab ethics and honesty in carrying out the experiments	a	j	k				
2	Acquire knowledge on lab safety to keep the lab safe for everyone	a	j	k				
3	Know about personal safety to take care of oneself from the hazards of chemicals and equipments used	a	j	k				
4	Gain knowledge on environmental safety to safely dispose the toxic chemicals into the environment	a	j	k				

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
1.	General rules - personal precautions	1	C	1-4	1,2
2.	Types of gloves	1	C	3	1,2
3.	Hygienic and clean working space	2	C	1-4	1,2
4.	Report minor and major accidents	2	C	1-4	1,2
5.	Report defective equipments and lab maintenance.	1	C	1-4	1,2
6.	Handling different chemicals-(toxic, flammable, carcinogenic, cryogenics, compressed gases)	2	C,D	1-4	1,2
7.	Understanding MSDS - importance of labels (poison, radioactive, corrosive etc)	2	C	1-4	1,2
8.	Routes of entry - health hazards- protection and emergency action (first aid)	2	C	1-4	1,2
9.	Radioactive chemicals-types of radiation, safe handling and disposal, radiation counter.	2	C	1-4	1,2
10.	Biosafety levels (1-4) - types of samples	2	C	1-4	1,2
11.	Standard practices and handling - biosafety cabinets	2	C	1-4	1,2
12.	Containment/safe disposal of biohazardous samples	1	C,D	1-4	1,2
13.	Handling and disposal of recombinant/genetically modified organisms.	1	C	1-4	1,2
14.	Safe handling and proper maintenance of instruments like centrifuge, UV transilluminator, Autoclave, Water bath, Hot air oven	4	C,D	1-4	1,2
15.	Importance of log book and reporting faulty instruments.	2	C,D	1-4	1,2
16.	General causes of fire, classification of fire, portable fire extinguishers	1	C	1-4	1,2
17.	Safety of people in the event of fire, fire protective clothing	1	C	1-4	1,2
18.	First aid for burns, injuries. First aid kit.	1	C	1-4	1,2
	Total Contact Hours	**30**			

LEARNING RESOURCES	
Sl. No.	**REFERENCES**
1.	Keith Furr, A., Handbook of Laboratory Safety Manual, CRC Press, 5th edition, 2000.
2.	Laboratory Manual

Course nature					**Theory (100% internal continuous assessment)**			
Assessment Method (Weightage 100%)								
In-semester	**Assessment tool**	**Cycle test I**	**Cycle test II**	**Cycle Test III**	**Surprise Test**	**Quiz**	**Final Assessment**	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50 % (Record 10%, Viva Voce 10%, Experiments 30 %)**	**100%**
							End semester examination weightage :	**0**

15GN201	**Principles of Genetics**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P Professional Core				
Course designed by	Department of Genetic Engineering				
Approval	32nd Academic Council Meeting held on 23rd July 2016				

PURPOSE	The course introduces basic and advanced concepts in genetics. It gives complete understanding on the laws of inheritance, chromosome structure, various chromosomal aberrations, linkage, genetic mapping as well as quantitative and evolutionary genetics.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Understand Mendelian genetics and epistasis	b	c	l				
2.	Learn about eukaryotic chromosome structure and organelle heredity	b	c	l				
3.	Understand changes and variations in chromosome structure and number	b	c	l				
4.	Learn and understand linkage, crossing over and genetic mapping	b	c	l				
5.	Learn about quantitative traits and Hardy-Weinberg law	b	c	l				

Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
	Unit I: Mendelian Genetics	**8**			
1.	Introduction to Genetics; terminology; symbols	1	C	1	1,4
2.	Mendel's experiments - monohybrid cross; Dominance, Recessive, Codominance, Semidominance	1	C,D	1	1,4
3.	Lethal alleles; Complementation analysis	1	C	1	1,4
4.	Dihybrid ratios; Principles of segregation; Independent assortment; Trihybrid ratios	1	C	1	1,4
5.	Epistasis and its types; Multiple alleles	2	C	1	1,4
6.	Laws of probability; Chi-square analysis and problems	2	C, D	1	1,2
	Unit II: Chromosomes and Inheritance	**9**			
7.	Structural organization of eukaryotic chromosome	2	C	2	1
8.	Cell Cycle; Mitosis and Meiosis	2	C	2	1
9.	Meiosis and Mendel's principles	1	C	2	1
10.	Giant chromosomes: polytene and lampbrush	1	C	2	1
11.	Extranuclear inheritance – Mitochondrial inheritance	1	C	2	1
12.	Extranuclear inheritance – Chloroplast inheritance	1	C	2	1

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
13.	Morgan's discovery of sex linkage in *Drosophila*; Inheritance of sex linked genes in *Drosophila*	1	C	2	1
	Unit III: Changes in Chromosome Structure and Number	**8**			
14.	Chromosomal deletions in *Drosophila*	1	C	3	1
15.	Chromosomal duplications in *Drosophila*	1	C	3	1
16.	Mechanisms of chromosomal inversions; Chromosomal inversion in *Drosophila*	1	C	3	1
17.	Mechanisms of chromosomal translocations; Chromosomal translocation in *Drosophila*	2	C	3	1
18.	Position effects of chromosome rearrangements	1	C	3	1
19.	Nondisjunction and aneuploidy in *Drosophila*	1	C	3	1
20.	Polyploidy in plants and animals	1	C	3	1
	Unit IV: Linkage and Chromosome Mapping	**10**			
21.	Linkage and crossing-over	1	C	4	1
22.	Cytological basis of crossing-over, Stern's experiment and McClintock's experiment	2	C	4	1
23.	Concept of genetic mapping	2	C	4	1,3
24.	Mapping by two-factor cross	1	C,D	4	1
25.	Mapping by three-factor cross	1	C,D	4	1
26.	Mapping by somatic cell hybridization	1	C,D	4	1
27.	Mapping in bacteria by transformation	1	C,D	4	1
28.	Mapping in bacteria by transduction	1	C,D	4	1
	Unit V: Population and Evolutionary Genetics	**10**			
29.	Estimating allele frequencies	2	C	5	1
30.	Hardy-Weinberg principle	1	C,D	5	1,2
31.	Synthetic theory of evolution	1	C	5	1
32.	Quantitative traits	2	C	5	1,2
33.	Polygenic inheritance	1	C	5	1
34.	Panmictic index	1	C	5	1
35.	Inbreeding; heterosis	1	C	5	1,2
36.	Speciation (sympatric and allopatric)	1	C	5	1,2,3
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1	Gardner. E.J., Simmons, M.J., Snustad. D.P., "*Principles of Genetics*", 8th edition, Wiley Student Edition, 2006.
	REFERENCE BOOKS/OTHER READING MATERIALS
2	Strickberger. M.W., "*Genetics*", 3rd edition, Pearson India, 2015.
3	Pierce. B.A., "*Genetics: A Conceptual Approach*", 4th edition, W.H. Freeman Publishers, 2011.
4	Stansfield. W.D., "*Schaum's Outline of Theory and Problems of Genetics*", 3rd Edition, Schaum Publishing Company, 1991.

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
					End semester examination weightage :		**50%**

15GN202	Microbial Genetics	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P Professional core				
Course designed by	Department of Genetic Engineering				
Approval	32nd Academic Council Meeting held on 23rd July 2016				

PURPOSE	This course introduces the fundamentals of microbial genetics through the study of the characteristics of microorganisms, multiplication, growth kinetics, gene transfer methods, mutation and phage life cycle.

INSTRUCTIONAL OBJECTIVES	**STUDENT OUTCOMES**						
At the end of the course, student will be able to							
1. Understand the working different microscopes	a						
2. Gain knowledge about microbial classification and taxonomy	a	b	e				
3. Study the bacterial growth kinetics and the factors influencing the growth	a	b	e				
4. Understand the gene transfer mechanism, mutation and phage life cycle	a	b	e				

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Unit I: Introduction to Microbiology	**10**			
1.	Basic of microbial existence: History of Microbiology	1	C	1	1,3
2.	Microscopy: Bright, Dark field, Florescence, Phase contrast, and Scanning Electron Microscope, Transmission Electron Microscope	3	I,O	1	1,3
3.	Microscopic examination of microorganisms	1	C,D,I	1	1,3
4.	Morphology and fine structure of Bacteria -Cell wall, Flagella, Pili, Fimbriae, Capsules, Slime layer, Endospores, Cysts, Cytoplasmic inclusions.	5	C,I	1	1,3
	Unit II: Microbial Taxonomy and Classification	**10**			
5.	Taxonomy ranks, Classification systems	2	C	2	3
6.	Major Characteristics used in Taxonomy, Major divisions	2	C,D,I	2	3
7.	Bergey's Manual of Systemic Bacteriology: (Archaea, Proteobacteria, Low G+C Gram Positive bacteria, High G+C Gram Positive bacteria, Planctomycetes, Spirochetes, Bacteriodetes and Fusobacteria)	5	C,D,I	2	3
8.	Classification of fungi and viruses	1	C,D	2	1,3
	Unit III: Microbial Growth, Nutrition and Pure Culture Techniques	**9**			
9.	Different types of media	1	C	3	3
10.	Growth kinetics and methods to quantitate bacterial growth	3	C,D,I	3	3
11.	Influence of environmental factors on growth	2	C,D	3	3
12.	Control of growth-physical, chemical methods ,antibiotics	2	D,I,O	3	1,3
13.	Isolation and preservation of microorganisms	1	I,O	3	3
	Unit IV: Bacterial Genetics	**6**			
14.	Conjugation, sex factors	1	C	4	2
15.	High frequency recombination	1	C,D	4	2
16.	Transduction (Generalized, Specialized)	1	C,D	4	2,3
17.	Bacterial transformation	1	D,I	4	2,3
18.	Mutation types, Repair mechanism, Selection of mutants	2	C,D	4	2,3
	Unit V: Genetics of Bacteriophage	**10**			

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
19.	Bacteriophages Classification, types	1	C,D,I	4	1,3
20.	Phage T4 – structure, gene expression and genome organization	2	C,D,I	4	2
21.	Lamda phage replication, lytic and lysogenic cycles	3	C,I	4	2
22.	Mechanisms of repressor synthesis and its control, auto regulation, one step growth curve	3	C,D,I	4	2
23.	Importance of bacteriophages	1	C,I	4	2,3
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Pelczar. M.J., Chan. E.C.S., Kreig. N.R., "*Microbiology*", McGraw Hill Publishers, 5th edition, 2001.
2.	Maloy.S.R.,Cronan.J.E., Freifelder.D., "*Microbial Genetics*", Narosa Book Distributors, 2nd edition, 2009.
	REFERENCE BOOKS/ OTHER READING MATERIALS
3.	Willey. J.M ., Sherwood.L.M ., Woolverton.C.J., "*Prescott's Microbiology*", McGraw Hill Publishers, 9th edition, 2013.

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
					End semester examination weightage :		**50%**

15GN203	**Molecular Techniques**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P Professional Core				
Course designed by	Department of Genetic Engineering				
Approval	32nd Academic Council Meeting held on 23rd July 2016				

PURPOSE	The course imparts the knowledge on the principles on nucleic acid isolation and purification and PCR application in genetic engineering. It also gives knowledge on history and latest methods of DNA sequencing. This course also deals with the protein – protein interaction and protein sequencing methods.

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Understand the principle of nucleic acid isolation.	b	c	d				
2.	Understand the principle of PCR and their uses in genetic engineering.	b	a	d				
3.	Gain a thorough knowledge about nucleic acid hybridization.	a	b	c	d			
4.	Learn history of DNA sequencing and current methods and gene synthesis	a	b	c	d			
5.	Analyze proteins and their interactions	b	c	d				

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Unit I: Nucleic Acid Isolation and Agarose Gel Electrophoresis	**9**			
1.	Conventional and kit methods for isolation of plasmid DNA	1	C,I,O	1	1
2.	Conventional and kit methods for isolation of Genomic DNA from bacterial cells, plant cells and animal cells	2	C,I,O	1	1
3.	RNA isolation and mRNA purification	2	C,I,O	1	1
4.	Agarose gel electrophoresis, Staining techniques	2	C,I,O	1	1
5.	Pulsed field gel electrophoresis (PFGE)	2	C,I,O	1	1
	Unit II: PCR Techniques	**10**			
6.	Principle of polymerase chain reaction (PCR) - Components of PCR reaction	1	C,I,O	2	1,3
7.	Optimization of PCR	1	C,D,I	2	1,3
8.	Chemistry of primer synthesis	1	C,D,I	2	1,3
9.	Gene specific and degenerate primers	1	C,D,I	2	1
10.	Hot-start PCR, ARMS-PCR	1	C,I,O	2	1,4
11.	LAMP-PCR	2	C,I,O	2	1,6
12.	Reverse transcription PCR	1	C,I,O	2	1,3
13.	Real time PCR.	2	C,I,O	2	1,3
	Unit III : Hybridization Methods	**8**			
14.	Introduction to probes	1	C,I,O	3	1
15.	Radioactive probe labeling	2	C,I,O	3	1
16.	Non-radioactive probe labeling	1	C,I,O	3	1
17.	Southern hybridization	2	C,I,O	3	1
18.	Northern hybridization	1	C,I,O	3	1
19.	Western blotting	1	C,I,O	3	1
	Unit IV: DNA Sequencing and Gene Synthesis	**9**			
20.	Automated DNA sequencing by Sanger's method	2	C,I,O	4	5
21.	Pyrosequencing	1	C,I,O	4	5
22.	Next generation sequencing methods- Illumina sequencing	1	C,I,O	4	5
23.	Single molecule real time (SMRT) sequencing	2	C,I,O	4	5
24.	Nanopore sequencing.	1	C,I,O	4	5
25.	Methods of gene synthesis	2	C,I,O	4	5
	Unit V: Protein Techniques	**9**			
26.	Denaturing SDS PAGE	1	C,I,O	5	2
27.	Native Non-denaturing PAGE	1	C,I,O	5	2
28.	2D gel electrophoresis	2	C,I,O	5	2
29.	ELISA	1	C,I,O	5	2
30.	Yeast one hybrid system	2	C,I,O	5	2
31.	Yeast two hybrid system	1	C,I,O	5	2
32.	Phage display.	1	C,I,O	5	2
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Frederick. M.A., Roger. B.R., David. D. M., Seidman. J. G., John A. S., Kevin. S., "*Current Protocols in Molecular Biology",* John Wiley and Son, Inc. 2003.
2.	Daniel. C.L., *"Introduction to Proteomics"***,** Humana Press. 2002.
	REFERENCE BOOKS/OTHER READING MATERIALS
3.	Valones et al., *Principles and applications of polymerase chain reaction in medical diagnostic fields: a review*Braz. J. Microbiol., 40, 1–11, 2009.
4.	Chen et al., *Amplification refractory mutation system, a highly sensitive and simple polymerase chain reaction assay, for the detection of JAK2 V617F mutation in chronic myeloproliferative disorders*Mol. Diagn., 9, 272–276, 2007.
5.	Shendure. J., Ji. H., *Next-generation DNA sequencing,*Nature Biotech., 26, 1135 – 1145, 2008.
6.	Notomi. T., et al., *Loop-mediated isothermal amplification of DNA*, Nucleic acids research, 28, E63, 2000.

Course nature				Theory			
Assessment Method – Theory Component (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
						End semester examination weightage :	**100%**

15GN204	**Molecular Biology of Gene**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P Professional core				
Course designed by	Department of Genetic Engineering				
Approval	32nd Academic Council Meeting held on 23rd July 2016				

PURPOSE	The course gives detailed knowledge on the structure of DNA and RNA. It gives complete understanding on the mechanisms of transcription and translation and an insight into the regulation of prokaryotic and eukaryotic gene regulation.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Understand the structure of nucleic acids and the DNA replication process	b	c	l				
2.	Learn about the process of transcription	b	c	l				
3.	Understand the mechanism of translation	b	c	l				
4.	Learn about gene regulation in prokaryotes	b	c	l				
5.	Learn about gene regulation in eukaryotes	b	c	l				

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Unit I: Nucleic Acid Structure and DNA Replication	**9**			
1.	Central dogma; structure of DNA and RNA	1	C	1	1
2.	DNA topology	1	C	1	1
3.	Replication in prokaryotes	2	C	1	1,2
4.	Replication in eukaryotes	1	C	1	1,2
5.	Types and functions of DNA polymerases; proof reading activity	1	C	1	1,2
6.	Exonuclease activity, topoisomerase activity, telomeric DNA replication	1	C	1	1
7.	Homologous recombination	1	C	1	1,2
8.	Site-specific recombination	1	C	1	1,2
	Unit II: Mechanisms of Transcription	**12**			
9.	Fine structure of prokaryotic gene	1	C	2	1,2
10.	Fine structure of eukaryotic gene	1	C	2	1
11.	Structure and function of the promoters	1	C	2	1,2
12.	RNA polymerases in prokaryotes - types and function	1	C	2	1,2
13.	RNA polymerases in eukaryotes – types and function	2	C	2	1,2
14.	Transcription of mRNA in prokaryotes	1	C	2	1,2
15.	Transcription of mRNA in eukaryotes	1	C	2	1,2
16.	Post transcriptional processing of mRNA – 5'capping	1	C	2	1,2
17.	Post transcriptional processing of mRNA – splicing (including different types)	1	C	2	1,2
18.	Polyadenylation	1	C	2	1,2
19.	RNA editing and mRNA transport	1	C	2	1,2
	Unit III: Genetic Code and Translation	**7**			
20.	Genetic code and Wobble hypothesis	1	C	3	1,2

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
21.	Rules governing the genetic code	1	C	3	1,2
22.	Translation in prokaryotes	2	C	3	1,2
23.	Translation in eukaryotes	1	C	3	1,2
24.	Post translational modifications	2	C	3	1,2
	Unit IV: Gene Regulation in Prokaryotes	**8**			
25.	Principles of transcriptional regulation	1	C	4	1,2
26.	Gene expression in *E coli*: positive and negative regulation	1	C	4	1,2
27.	*lac* operon	2	C	4	1,2
28.	*trp* operon	2	C	4	1,2
29.	Gene expression in phage - lambda lytic and lysogenic switch (genetic switch)	2	C	4	1,2
	Unit V: Gene Regulation in Eukaryotes	**9**			
30.	Gene regulation by DNA sequence elements – An introduction	1	C	5	1,2
31.	Short sequence elements – enhancers – locus control regions – activators	1	C	5	1,2
32.	Short sequence elements – repressors -insulators	1	C	5	1,2
33.	DNA protein interactions: zinc fingers – leucine zipper - basic helix loop helix – helix turn helix	1	C	5	1,2
34.	Epigenetic regulation: An introduction	1	C	5	1,2
35.	Histone modifications	1	C	5	1,2
36.	Chromatin remodeling	1	C	5	1,2
37.	DNA methylation and imprinting	1	C	5	1,2
38.	Role of RNA in gene regulation	1	C	5	1,2
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOK**
1.	Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M., Losick, R. *"Molecular Biology of Gene"*, 7th edition, Pearson, 2013.
	REFERENCE BOOK/ OTHER READING MATERIAL
2.	Krebs, J. E., Kilpatrick, S.T., Goldstein, E.S. *"Lewin's Genes XI"*, 11th revised edition, Jones and Bartlett Publishers Inc., 2013.

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
					End semester examination weightage:		**50%**

15GN205	Biochemical Engineering	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P Professional Core				
Course designed by	Department of Genetic Engineering				
Approval	32nd Academic Council Meeting held on 23rd July 2016				

PURPOSE	This subject puts emphasis on the basic principles of biochemical engineering. It helps the student to apply the engineering principles in their biotechnological process.

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Understand about the upstream processing of fermentation process such as medium formulation and sterilization	a	e	i	k			
2.	Gain knowledge about different type of bioreactors and mode of fermentation	a	e	i	k			
3.	Design the proper aeration system and scale up the reactors	a	e	i	k			
4.	Acquire knowledge on stoichiometry and energetics of cell growth and product formation	a	e	i	k			
5	Evaluate the kinetics and mechanism of recombinant culture cultivation	a	e	i	k			

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Unit I: Upstream Processing	**9**			
1.	Introduction of Biochemical engineering	1	C	1	2,3
2.	Isolation, preservation of industrial important microorganism	1	C	1	2,3
3.	Strain improvement of industrial important microorganism	1	C	1	2,3
4.	Types of media and media formulation	1	C	1	3
5.	Media optimization by Plackett Burman screening method and Response Surface Methodology (RSM)	2	C,D	1	3
6.	Thermal death kinetics of microorganisms	1	C,D,I	1	2,3
7.	Batch and continuous sterilization of liquid media	2	C,I	1	2,3
	Unit II: Bioreactor Design and Fermentation	**9**			
8.	Design and construction of bioreactor	1	C,D	2	2,3
9.	Monitor and control of parameter in bioreactor	1	C,D	2	2,3
10.	Type of bioreactor: Stirred tank reactor, Bubble column reactor, Fluidized bed reactor, Airlift reactor, Packed bed reactor and Surface wave bioreactor.	2	C	2	1,2
11.	Mode of fermentation: Batch, Fed-batch and Continuous fermentation	1	C,D,I	2	1,2
12.	Design equations for Batch, Fed-batch and Continuous fermentation	2	C,D,I	2	1,2
13.	Type of fermentation: Submerged and Solid state fermentations.	2	C,I	2	3
	Unit III: Aeration, Agitation and Scaleupof Bioreactor	**9**			
14.	Oxygen transfer in fermentation broth and rheological effects	2	C,D,I	3	1,2,4
15.	Regime analysis of bioreactor processes	2	C,D	3	1,2,4
16.	Correlations for oxygen transfer	1	C,I	3	1,2,4
17.	Scale-up criteria for bioreactors based on oxygen transfer	2	C,D,I	3	2,4
18.	Scale-up criteria for bioreactors based on power consumption	2	C,D,I	3	2,4
	Unit IV: Metabolic Stoichiometry	**9**			
19.	Stoichiometry of cell growth and product formation: elemental balances	1	C,I	4	1,2
20.	Degrees of reduction of substrate and biomass	2	C,I	4	1,2
21.	Electron balances	1	C,I	4	1,2
22.	Yield coefficient of biomass and product formation	2	C,I	4	1,2

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
23.	Maintenance coefficients, energetics analysis of microbial growth and product formation	2	C,I	4	1,2
24.	Oxygen consumption and heat evolution in aerobic cultures.	1	C,I	4	1,2
	Unit V: Fermentation of Recombinant Cultures	**9**			
25.	Recombinant cell culture processes - guidelines for choosing host - vector systems	2	C	5	1,4
26.	Plasmid stability and instability model	2	C,D	5	1,4
27.	Limits to over expression	1	C	5	1,4
28.	Modelling of recombinant bacterial cultures; Bioreactor configurations for cultivation of animal and plant cells	2	C,D	5	1,4
29.	Secondary metabolites from plant and animal cell cultures	2	C	5	1,4
	Total contact hours	**45**			

LEARNING RESOURCES	
	TEXT BOOKS
1.	Shuler.M.L., Kargi .F. , "*Bioprocess Engineering: Basic Concepts*" 2nd Edition. Pearson, 2002.
2.	Pauline M. Doran., " *Bioprocess Engineering Principles* "; 2nd Edition Academic Press, 2013
3.	Stanbury.P.F., Whitaker.A.,Hall.S.J., "*Principles of Fermentation Technology*", 2nd Edition, Butterworth– Heinemann, 1995.
	REFERENCE BOOK/OTHER READING MATERIAL
4.	Bailey.J.E., Ollis .D.F. , " *Biochemical Engineering Fundamentals*" , 2nd Edition, McGraw -Hill, 1986.

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
						End semester examination weightage :	**50%**

15GN206	**Molecular Cell Biology** (Applicable for students admitted from 2016-17 onwards)	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P Professional Core				
Course designed by	Department of Genetic Engineering				
Approval	32nd Academic Council Meeting held on 23rd July 2016				

PURPOSE	The course is aimed to make the students understand the structure and function of cell and its organelles. It also aims to introduce the role of cell cycle, cell death and the characteristics of cancer.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Know the basics about cell and its evolution	a	b	i				
2.	Learn about the structure and function of cell organelles involved in protein sorting and transport and bioenergetics and metabolism	a	b	i				
3.	Gain knowledge about the cytoskeletal organelles, plasma membrane, cell wall and cell-cell interactions	a	b	i				
4.	Understand the regulation of cell cycle	a	b	h	k	l		
5.	Gain knowledge on cell death, renewal and cancer	a	b	h	k	l		

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Unit I: Overview on Cell and Life	**7**			
1.	Diversity and commonality of cells,	1	C	1	4
2.	Historical perspectives of cytology	1	C	1	4
3.	The molecules of a cell - chemistry of cell, cell theory	1	C	1	4
4.	Investigating cells and their parts	2	C	1	4
5.	A genome perspective on evolution - origin, metabolism and evolution of life	1	C	1	4
6.	Prokaryotes and eukaryotes	1	C	1	4
	Unit II: Cell Organelles –I	**8**			
7.	Nucleus, nucleolus, ribosomes	1	C,D	2	1
8.	Protein Sorting and Transport- endoplasmic reticulum	2	C,D	2	1
9.	Golgi apparatus	1	C,D	2	1
10.	Lysosomes – structure and function	1	C,D	2	1
11.	Endocytic pathway	1	C	2	1
12.	Bioenergetics and metabolism- mitochondria, chloroplasts, peroxisomes	2	C,D	2	1
	Unit III: Cell Organelles- II	**8**			
13.	Cytoskeleton and cell movement, cytoskeletal motors	2	C	3	2
14.	Plasma membrane and cell wall	1	C	3	2
15.	Active and passive transport across membranes	1	C	3	2
16.	Extracellular matrix and interactions	2	C	3	3
17.	Cell junctions (adhesion, gap and tight)	1	C,D	3	3
18.	Plasmodesmata, desmosomes	1	C	3	3
	Unit IV: Regulation of Cell Cycle	**10**			
19.	Eukaryotic cell cycle	2	C,D	4	1
20.	Regulators of cell cycle progression – protein kinases and cyclin dependent kinases	2	C,D	4	1
21.	Regulators of cell cycle progression – growth factors and DNA damage check points	2	C,D	4	1
22.	Events of M phase	1	C,D	4	1
23.	Meiosis – regulation of oocyte meiosis	2	C,D	4	1
24.	Fertilization	1	C,D	4	1
	Unit V: Cell Death, Renewal and Cancer	**12**			
25.	Programmed cell death – events of apoptosis	2	C	5	1
26.	Executioners of apoptosis	2	C	5	1
27.	Stem cells – adult stem cells	1	C	5	1
28.	Embryonic stem cells	1	C	5	1
29.	Cancer – hallmarks of cancer	2	C,D	5	1
30.	The genetic basis of cancer	1	C,D	5	1
31.	Proto oncogenes	1	C,D	5	1
32.	Tumor suppressor genes	2	C,D	5	1
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOK**
1.	Geoffrey. M. Cooper, Robert. E. Hausman., "*The Cell – A Molecular Approach*", Sinauer Associates, Inc.; 6th Edition, 2013.
	REFERENCE BOOKS/ OTHER READING MATERIALS
2.	Rastogi.S.C, "*Cell biology*," New Age International publishers, 2005.
3.	Bruce Alberts, "*Molecular Biology of the Cell*", Garland Science, 6th Edition, 2014.
4.	H. Lodish. A. Berk. C. A., Kaiser, M. Krieger. M. P. Scott, A. Bretscher, H. Ploegh, and P. Matsudaira, W. H. "*Molecular Cell Biology*", Freeman and Company, New York, 6th Edition, 2007.

Course nature				Theory			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
End semester examination weightage :							**50%**

15GN207L	**Microbial Genetics Laboratory**	**L**	**T**	**P**	**C**
		0	**0**	**4**	**2**
Co-requisite:	15GN202 Microbial Genetics				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P Professional Core				
Course designed by	Department of Genetic engineering				
Approval	32nd Academic Council Meeting held on 23rd July 2016				

PURPOSE	To develop skills in isolation, identification characterization of microorganisms and to study the experiments related to gene transfer and mutagenesis.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1	Isolate and identify the bacterial species	a	b	c				
2	Conduct experiments to analyze the growth kinetics, generation time and markers	a	b	c				
3	Understand the gene transfer methods in bacteria	a	b	c				

Session	**Description of Experiments**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
1.	Staining of bacteria - simple, gram staining, and negative staining	4	C,I	1	1,2
2.	Culturing of bacteria using different types of medium - selective, differential, enriched	4	C,I	1	1,2
3.	Isolate pure colony using quadrant streaking and preservation of bacteria	4	C, I	1	1,2
4.	Biochemical characterization of bacteria -Fermentation test, catalase and oxidase test	8	C,D,I	1	1,2
5.	Biochemical and molecular characterization of bacteria- IMViC test, urease tests,16S rDNA sequence	8	C,D,I	1	1,2
6.	Bacterial growth curve analysis	8	C,D,I	2	1,2
7.	Analysis of genetic markers in bacteria- aminoacid and antibiotic	4	C,D,I	2	1,3
8.	Isolation of bacteriophage from sewage water	4	C,D,I	3	1,2
9.	Conjugation (Hfr, F^- mating)	8	C,D,I	3	1,4
10.	UV mutagenesis and lethal dose analysis	8	C,D,I	3	1,4
	Total contact hours	**60**			

LEARNING RESOURCES

S.No	**REFERENCES**
1.	Lab Manual
2.	Cappuccino.J.G., Sherman.N., " *Microbiology: A Laboratory Manual*", Pearson, 10th Edition, , 2014.
3.	Das.S., Dash.H.R., "*Microbial Biotechnology- A Laboratory Manual for Bacterial Systems* ", Springer; 1st Edition,2015.
4.	Miller. J.R., "*A Short Course in Bacterial Genetics: Lab Manual",* Cold Spring Harbor Laboratory Press. 1992.

Course nature				Practical		
Assessment Method (Weightage 100%)						
In-semester	**Assessment tool**	Experiments	Record	MCQ/Quiz/Viva Voce	Model examination	**Total**
	Weightage	**40%**	**5%**	**5%**	**10%**	**60%**
					End semester examination weightage :	**40%**

15GN208L	**Molecular Techniques Laboratory II**	**L**	**T**	**P**	**C**
		0	**0**	**4**	**2**
Co-requisite:	15GN203 Molecular Techniques				
Prerequisite:	15GN102L Molecular Techniqes Laboratory I				
Data Book / Codes/Standards	NIL				
Course Category	P Professional Core				
Course designed by	Department of Genetic Engineering				
Approval	32nd Academic Council Meeting held on 23rd July 2016				

PURPOSE	The course imparts practical knowledge on Nucleic acid isolation, digestion and ligation. This course also gives knowledge on Transformation and recombinant selection							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Learn basic instruments, DNA isolation and electrophoresis	a	b	c	d	f		
2.	Learn restriction digestion and ligation	b	a	d	f			
3.	Learn PCR and PCR optimization	a	b	c	d	f		
4.	Learn transformation and blue-white screening for recombinant clones	a	b	c	d	f		

Session	**Description of Experiments**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
1.	Introduction to micropipette handling	4	**C**	1	2
2.	Plasmid DNA isolation	4	C,I,O	1	1,2
3.	Agarose gel electrophoresis	4	C,I,O	1	1,2
4.	Quantification of plasmid DNA	4	C,I,O	1	1,2
5.	Restriction digestion of plasmid DNA	8	C,D,I, O	1	1,2
6.	Designing gene specific primers manually and using suitable software	4	C,I,O	2	1,2
7.	Polymerase Chain Reaction (PCR)	8	C,D,I, O	3	1,2
8.	Molecular diagnosis of SNPs using ARMS-PCR and PCR-RFLP	8	C,I,O	3	2
9.	Preparation of competent cells	8	C,I,O	4	1,2
10.	Transformation and blue-white screening for recombinant clones	8	C,I,O	4	1,2
	Total contact hours	**60**			

LEARNING RESOURCES	
Sl. No.	**REFERENCES**
1.	Michael, R. G., Sambrook. J., "*Molecular Cloning – A Laboratory Manual"*, 4th edition, Cold Spring Harbor Laboratory Press, 2012.
2.	Laboratory Manual

Course nature				Practical		
Assessment Method (Weightage 100%)						
In-semester	**Assessment tool**	Experiments	Record	MCQ/Quiz/Viva Voce	Model examination	**Total**
	Weightage	**40%**	**5%**	**5%**	**10%**	**60%**

End semester examination weightage :	40%

15GN209	Human Genetics	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	15GN201 Principles of Genetics				
Data Book / Codes/Standards	NIL				
Course Category	P Professional Core				
Course designed by	Department of Genetic Engineering				
Approval	32nd Academic Council Meeting held on 23rd July 2016				

PURPOSE	This course emphasizes on the current theories of mechanisms of inheritance and their implications for both basic knowledge on human diseases and its application in genetic mapping and genetic testing.

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Understand inheritance patterns in simple and complex genetic disorders.	a						
2.	Learn and gain knowledge on the human genome.	a	b	e				
3.	Understand the cause and effect of alterations in chromosome number and/or structure	a	b	e				
4.	Gain knowledge on identifying disease genes for new diseases using mapping techniques, linkage analysis and positional cloning.	a	b	e				
5.	Gain knowledge on genetic testing.	a	b	e				

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Unit I: Human Inheritance	**11**			
1.	History of Human Genetics	1	C	1	1
2.	Monogenic inheritance; multifactorial inheritance	1	C	1	1
3.	Mendelian pedigree patterns – five basic pedigree patterns	2	C,D	1	1
4.	X-inactivation, mosaicism due to X-inactivation	1	C	1	1,2,3
5.	Complications to basic Mendelian pedigree patterns – incomplete dominance, codominance, uniparentaldisomy, penetrance, expressivity, late-onset diseases, phenocopy	2	C	1	1,2,3
6.	Complications to basic mendelian pedigree patterns – anticipation, imprinting, pleiotropy, heterogeneity and its types, spontaneous mutations, mosaicism, consanguinity	2	C	1	1,2,3
7.	Polygenic theory for quantitative traits	1	C	1	1,2,3
8.	Hardy-Weinberg equilibrium – relating genotype and gene frequencies	1	C,D	1	1,2,3
	Unit II: Human Genome	**8**			
9.	Human genome organization – an overview	1	C	2	1,3
10.	Protein-coding genes	1	C	2	1,3
11.	RNAgenes and microRNA	1	C	2	1,3
12.	Heterochromatin and transposon repeats	1	C	2	1,3
13.	Variation between human genomes – Causes and types	2	C	2	1,3
14.	Pathogenic DNA variations and their effects	2	C	2	1,3
	Unit III: Chromosome Abnormalities in Humans	**7**			
15.	Human chromosomes – banding and cytogenetic analysis	1	C	3	1
16.	Polyploidy, aneuploidy and mixoploidy – clinical consequences	2	C	3	1
17.	Chromatid breaks and their consequences	1	C	3	1
18.	Chromosome translocations and their consequences	1	C	3	1
19.	Chromosomal disorders - Down syndrome, Turner syndrome, Klinefelter syndrome etc.	2	C	3	1

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Unit IV: Genetic Mapping and Disease Gene Identification	**12**			
20.	Role of recombination in genetic mapping	1	C	4	1,2
21.	Markers for human genetic mapping	1	C	4	1,2
22.	Linkage analysis – two point mapping and multi point mapping	3	C,D	4	1,2
23.	Positional cloning, Position dependent cloning strategies	3	C	4	1,2
24.	Position independent cloning strategies	2	C	4	1,2
25.	Genome-wide association studies to identify disease genes	2	C	4	1,2
	Unit V: Genetic Testing and Diagnosis	**7**			
26.	Genetic testing – an introduction	1	C	5	1,2,3
27.	Gene tracking	1	C	5	1,2,3
28.	Clinical tests, Personalized medicine	2	C	5	1,2,3
29.	Prenatal diagnosis of genetic disorders	1	C	5	1,2,3
30.	Congenital defects, construction of pedigree, proband	1	C,D	5	1,2,3
31.	Population screening	1	C	5	1,3
	Total Contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOK**
1.	Strachan, N.T., Read, A., "*Human Molecular Genetics*", 4th edition, Garland Science, 2010
	REFERENCE BOOKS/ OTHER READING MATERIALS
2.	Pasternak, J.,"*An Introduction to Human Molecular Genetics*", 2nd edition, John Wiley & Sons, Inc., 2005
3.	Korf, B.R., "*Human Genetics and Genomics*", 3rd edition, Blackwell Science Ltd, 2006

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
					End semester examination weightage :		**50%**

15GN210	**Recombinant DNA Technology**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
Co-requisite:	NIL				
Prerequisite:	15GN203 Molecular Techniques, 15GN204 Molecular Biology of Gene				
Data Book / Codes/Standards	NIL				
Course Category	P Professional Core				
Course designed by	Department of Genetic Engineering				
Approval	32nd Academic Council Meeting held on 23rd July 2016				

PURPOSE	The subject deals with different strategies of gene cloning and construction of genomic and cDNA library and applications of recombinant DNA technology. The students will learn about basic gene cloning methods, cloning vectors and design of a cloning experiment. They will gain knowledge in production of recombinant proteins and production of therapeutic proteins in transgenic plants and animals

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Understand the functions of several enzymes and vectors used in cloning	a	b	d				
2.	Devise their own cloning strategies for DNA and PCR products	a	b	d				

3.	Construct cDNA and genomic DNA libraries	a	d	e				
4.	Construct recombinant DNAs suitable for expression and purification of recombinant proteins in *E.coli* and yeast	a	b	e				
5.	Construct expression vectors for plants and animal cells	a	b	e				

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Unit I: Molecular Tools for Gene Cloning	**11**			
1.	Restriction enzymes – introduction and types with examples	2	C,D,I	1	1,2
2.	Methylation sensitivity of restriction enzymes Dam, Dcm and CpG methylases	1	C,D	2	1,2
3.	Star activity of restriction enzymes,	1	D,I	1	2,3
4.	Ligases – *E.coli* DNA ligase, T4 DNA ligase, T4 RNA ligase	1	D,I	2,3	1,2
5.	Polynucleotide kinase, phosphatases	1	D,I	2	2,3
6.	DNA and RNA polymerases, reverse transcriptase, terminal transferase	2	D,I	4	2,3
7.	DNAses-exonuclease I, exonuclease III, mungbean Nuclease	2	D,I	2	2,3
8.	RNases-RNaseI, RNaseA, RNaseH, Topoisomerase	1	D,I	2	2,3
	Unit II: Vectors for Gene Cloning	**10**			
9.	Introduction to cloning vectors	2	C,D	2,3,4	1,2
10.	Plasmid biology, plasmid vectors (high copy and low copy),	2	C,D,I	2,4	1,2
11.	Phage biology, phage vectors, cosmid vectors, phasmid vectors	3	C,D,I	4	1,2
12.	BAC vectors and YAC vectors	2	C,D,I	4	1,2
13.	Yeast vectors	1	C,D,I	4	2
	Unit III: Gene Cloning Techniques	**7**			
14.	Cloning after restriction digestion - blunt and cohesive end ligation	2	C,D,I	2,4	1,2
15.	Creation of restriction sites by PCR- cloning using linkers and adapters	2	C,D,I	4	1,2
16.	Cloning after homopolymer tailing	1	C,D,I	4	2,3
17.	Strategies for cloning PCR products – TA cloning -TOPO-TA cloning	1	C,D,I	4	1,2
18.	Ligation free cloning.	1	C,D,I	4	2,3
	Unit IV: Construction of Gene Libraries	**7**			
19.	Construction of cDNA library	1	C,D	2,4	2,3
20.	Construction subtractive cDNA library	2	C,D,	2,4	2
21.	Construction of genomic DNA library	2	C,D,	2	1,2
22.	Construction of BAC and YAC libraries	2	C,D,	2	2
	Unit V: Expression of Recombinant Protein	**10**			
23.	Construction of expression vectors for bacteria and yeast	2	C,D,I	2,5	2,3
24.	Promoters used in expression vectors	1	C,D,I	2,5	1,2
25.	Cloning of genes in correct reading frame in expression vector	1	C,D,I	2	2,3
26.	Purification of recombinant protein using histidine tag, GSTtag, chitin binding domain and intein	3	C,D,I	2,5	2,3
27.	Construction of expression vectors for plants and animal cells.	2	C,D	2,5	2,3
28.	Bias in codon use and codon optimization.	1	C	2	2,3
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. no.	**TEXT BOOKS**
1	Brown, T.A, "*Gene Cloning and DNA Analysis- An Introduction*, 6th edition, John Wiley&Sons, 2010.
2	Christopher Howe., "*Gene Cloning and Manipulation*, 2nd edition, Cambridge University Press, 2007.
	REFERENCE BOOK/ OTHER READING MATERIAL
3	Michael, R. G., Sambrook. J., "*Molecular Cloning – A Laboratory Manual"*, 4th edition, Cold Spring Harbor Laboratory Press, 2012.

Course nature				Theory			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
						End semester examination weightage :	**50%**

15GN211	**Ethical Issues and Intellectual Property Rights**	**L**	**T**	**P**	**C**
		1	**0**	**0**	**1**
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P Professional Core				
Course designed by	Department of Genetic Engineering				
Approval	32nd Academic Council Meeting held on 23rd July 2016				

PURPOSE	The course helps students understand the basics of ethical perspectives of animal and human research, publication and documentation of data

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Understand the ethical issues in animal research	g	j					
2.	Understand the ethical issues in Human research	g	j					
3.	Know the general, lab and publication ethics	j						
4.	Gain knowledge about intellectual property rights across the world	j						
5.	Know the procedure of filing patents	j						

Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
	Unit I: Ethical Issues in Research with Animals	**3**			
1.	Ethical consideration in conducting research with animal subjects	1	C	1	1
2.	Ethical committee regulations, guidelines for the use of animal subjects	1	C	1	1
3.	Alternatives to the use of animals in research	1	C,D	1	1
	Unit II: Ethical Issues in Research with Human	**3**			
4.	Ethical committee, regulations, guidelines for the collection and use of blood, tissue and other samples from human	1	C,D,I	2	1
5.	Obtaining consent for collection, transparency in handling the samples	1	C,D,I	2	1
6.	Use of human subjects in research and clinical trials, voluntariness, competence	1	C,D	2	4
	Unit III: Ethics in Research Documentation	**3**			
7.	Maintenance of good conduct both in research and with researchers - lab note book and maintenance – recording experimental data – importance of page numbers and dates – report loss of note book immediately – contents of each experimen	1	I	3	1
8.	Ethics in publications – plagiarism	1	C,D,I	3	1
9.	Ethics in publications - authorship and credits sharing and data protection	1	C,D	3	4
	Unit IV: Intellectual Property Rights	**3**			
10.	Intellectual property rights -WTO, TRIPS	1	C	4	2
11.	Intellectual property rights - GATT	1	C,D	4	2
12.	Farmer rights in India; PPVFR	1	C,D	4	2

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Unit V: Patents and Patent Law	**3**			
13.	Objectives of patent system, basic principles and requirements of patent law	1	C,D,I	5	3
14.	Patentable and non-patentable inventions	1	C,D,I	5	3
15.	Procedure for filing patent, patent infringement	1	C,I	5	3
	Total contact hours	**15**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Emanuel .E.J. et al. "*Ethical and Regulatory Aspects of Clinical Research*". Baltimore, MD: Johns Hopkins University Press. 2003.
2.	Singh. K., "*Intellectual property rights on Biotechnology"*, Springer, 2015
3.	*"The Patents Act"*, Government of India, 1970.
	REFERENCE BOOK/ OTHER READING MATERIAL
4.	European commission, "*European Textbook on Ethics in Research,"*- 2010

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	Assessment tool	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	Total
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
					End semester examination weightage :		**50%**

15GN212L	**Cytogenetics Laboratory**	**L**	**T**	**P**	**C**
		0	**0**	**4**	**2**
Co-requisite:	NIL				
Prerequisite:	15GN206 Molecular Cell Biology, 15GN204 Molecular Biology of Gene				
Data Book / Codes/Standards	NIL				
Course Category	P Professional Core				
Course designed by	Department of Genetic engineering				
Approval	32nd Academic Council Meeting held on 23rd July 2016				

PURPOSE	The course is aimed at making the students to observe the chromosomes at different stages and forms in different cells under the microscope through appropriate techniques.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1	Handle microscope effectively.	a	b	c				
2	Seperate and differentiate the cell organelles by sub cellular fractionation.	a	b	c				
3	Observe cell division in somatic and germinal cells	a	b	c				
4	Differentiate cytoplasm, nucleus, Barr bodies and chromosomes in a cell	a	b	c				

Session	Description of Experiments	Contact hours	C-D-I-O	IOs	Reference
1.	Introduction to different types of microscopes	4	C,D,I	1	1
2.	Sub cellular fractionation	8	C,D,I	2	1
3.	Observation of mitosis in onion roo**t** tip	8	C,D,I	3	1
4.	Observation of mitosis in human peripheral blood	4	C,D,I	3	1,2
5.	Observation of meiosis in pollen grains	8	C,D,I	3	1
6.	Observation of meiosis in grasshopper testis	4	C,D,I	3	1,2
7.	Observation of polytene chromosome	4	C,D,I	4	1,2
8.	Barr body identification from buccal smear	4	C,D,I	4	1
9.	Observation of budding and binary fission in yeast	8	C,D,I	4	1
10	Karyotyping	8	C,D,I	4	1,2

Session	Description of Experiments	Contact hours	C-D-I-O	IOs	Reference
	Total contact hours	**60**			

LEARNING RESOURCES	
S.No	**REFERENCES**
1.	Lab Manual
2	Arsham. M., Lawce H and Barch M. "*The AGT Cytogenetic Laboratory Manual*", Wiley-Blackwell, 2016.

Course nature				**Practical**		
Assessment Method (Weightage 100%)						
In-semester	**Assessment tool**	Experiments	Record	MCQ/Quiz/Viva Voce	Model examination	**Total**
	Weightage	**40%**	**5%**	**5%**	**10%**	**60%**
				End semester examination weightage :		**40%**

15GN213L	**Recombinant DNA Technology Laboratory**	**L**	**T**	**P**	**C**
		0	**0**	**4**	**2**
Co-requisite:	15GN210 Recombinant DNA Technology				
Prerequisite:	15GN208L Molecular Techniques Laboratory II				
Data Book / Codes/Standards	NIL				
Course Category	P Professional Core				
Course designed by	Department of Genetic engineering				
Approval	32nd Academic Council Meeting held on 23rd July 2016				

PURPOSE	This course offers an opportunity to practically learn all basic techniques of gene cloning right from DNA to verification of cloning by restriction digestion, Sanger sequencing and BLAST.

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1	Learn the preparation of insert and vectors for the cloning and PCR	a	d	i				
2	Learn restriction digestion and ligation of DNA	a	d	i				
3	Learn transformation, colony PCR and plasmid DNA isolation	a	d	i				
4	Learn DNA sequencing by Sanger chemistry and BLAST analysis.	a	d	i				

Session.	**Description of Experiments**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
1.	Plasmid DNA isolation for the vector and insert or PCR amplification of the insert	8	C, D	1	1,2,3
2.	Restriction digestion and quality checking on the agarose gel	8	C, D	2	1,2,3
3.	Gel elution of the vector, Gel/PCR purification of insert and setting up ligation	8	C, D	2	1,2,3
4.	Transformation of ligated DNA	8	C, D	3	1,2,3
5.	Verification of cloning by colony PCR and patching the positive colonies	4	C, D	3	1,2,3
6.	Plasmid isolation from PCR positive colonies	4	C, D	3	1,2,3
7.	Confirmation of cloning by restriction digestion	4	C, D	2	1,2,3
8.	DNA cycle sequencing	4	C, D	4	1,2,3
9.	Purification of cycle sequencing reaction product and automated DNA sequencing	8	C, D	4	1,2,3
10.	Sequence editing and BLAST analysis to identify the gene	4	C, D	4	1,4
	Total contact hours	**60**			

LEARNING RESOURCES	
Sl. No.	**REFERENCES**
1.	Laboratory manual
2.	Michael, R. G., Sambrook. J., "*Molecular Cloning – A Laboratory Manual"*, 4th edition, Cold Spring Harbor Laboratory Press, 2012.
3.	Frederick. M., Ausubel., Brent R., Kingston. R. E., Moore D.D., Seidman J. G., John A. Smith and Kevin Struhl, "*Current Protocols in Molecular Biology*", John Wiley& Son, Inc., 2003.
4.	http://blast.ncbi.nlm.nih.gov/Blast.cgi

Course nature				**Practical**		
Assessment Method (Weightage 100%)						
In-semester	**Assessment tool**	Experiments	Record	MCQ/Quiz/Viva Voce	Model examination	**Total**
	Weightage	**40%**	**5%**	**5%**	**10%**	**60%**
					End semester examination Weightage :	**40%**

15GN214L	**Basic Immunology Laboratory**	**L**	**T**	**P**	**C**
		0	**0**	**4**	**2**
Co-requisite:	15BT205 Immunology				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P Professional Core				
Course designed by	Department of Genetic Engineering				
Approval	32nd Academic Council Meeting held on 23rd July 2016				

PURPOSE	Provides an opportunity to experimentally verify the theoretical concepts already studied. It also helps in understanding the theoretical principles in a more explicit and concentrated manner.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Understand Isolation of antibodies	a	b					
2.	Know Purification of antibodies	a	b					
3	Detect antigen and Antibody by Immuno agglutination and Precipitation techniques	a	b					

Session	**Description of Experiments**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
1.	Enumeration of leucocytes and Giemsa staining of blood smear for differential counting.	4	C,D,I	3	1
2.	Isolation and enumeration of PBMC's from peripheral blood	4	C,D,I	3	1
3.	Preparation of particulate and soluble antigens	4	C,D,I	3	1
4.	Raising antisera in rabbits	4	C,D	1,2	1,2
5.	Blood grouping and Rh typing	4	C,D,I	3	1
6.	Agarose gel precipitation test (AGPT) and Counter immuno-electrophoresis	4	C,D,I	3	1,2
7.	Affinity purification of polyclonal antibodies using protein A coated sepharose beads	8	C,D	1,2	1
8.	DOT- ELISA	4	C,D	3	1
9.	SDS-PAGE of purified polyclonal antibodies to visualize the light and heavy chains of antibodies	8	C,D	1,2	1
10.	Western blotting	8	C,D	3	1,2
	Total Contact hours	**60**			

LEARNING RESOURCES	
Sl. No.	**REFERENCES**
1.	Laboratory manual
2.	G.P.Talwar andS.K.Gupta,*"A Handbook of Practical and Clinical Immunology Volume 1",* 2nd Edition, CBS Publishers, New Delhi. 2012.

Course nature				**Practical**		
Assessment Method (Weightage 100%)						
In-semester	**Assessment tool**	Experiments	Record	MCQ/Quiz/Viva Voce	Model examination	**Total**
	Weightage	**40%**	**5%**	**5%**	**10%**	**60%**
				End semester examination weightage :		**40%**

15GN301	**Enzyme Engineering**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P Professional Core				
Course designed by	Department of Genetic Engineering				
Approval	32nd Academic Council Meeting held on 23rd July 2016				

PURPOSE	The course should help the students to understand the basics of enzymes, mechanisms of enzyme action and its application in the various fields. This course facilitates the students to troubleshoot the real time industrial problems with the help of their knowledge acquired on enzyme kinetics and various purification methods.

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Understand about enzyme structure and its applications.	a						
2.	Acquire knowledge on the kinetics of single andmulti substrate enzymatic reactions.	a	l	m				
3.	Have the ability to understand the concepts of enzyme inhibition and regulation	a	l	m				
4.	Know about enzyme immobilization and its specialized application in the industry	a	l	m				
5.	Have the ability to assay the enzyme in the unknown samples.	a	l	m				

Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
	Unit I: Introduction to Enzymes	**7**			
1.	Introduction to enzyme - overview of syllabus	1	C	1	1
1.	Classification of enzymes, specificity of enzyme action	1	C	1	1
2.	Structural Components of Enzymes: active site and allosteric site	1	C	1	1,2
3.	Involvement of apoenzymes, prosthetic group	1	C	1	1,2
4.	Involvement of cofactors in activity of enzyme	1	C	1	1,2
5.	Factors affecting enzyme activity	1	C,I	1	1
6.	Application of enzyme in clinical diagnosis, enzyme therapy and in various industries	1	C	1	1
	Unit II: Enzyme Mechanism and Kinetics	**10**			
7.	Mechanism of enzyme action: concept of active site and energetic of enzyme	2	C	2	1,2
8.	Enzyme substrate complex formation: lock and key, induced fit and transition model	2	C	2	1,2
9.	Enzyme kinetics: Michaelis – Menten equations	1	C,D,I	2	1,3

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
10.	Lineweaver – Burk plots (single substrate enzyme catalysed reactions)	1	C,D,I	2	1,3
11.	Analysis of parabolic three hinged arch	1	C,D	2	1,3
12.	Ping-pong bi-bi mechanism	1	C,D	2	1,3
13.	Random order mechanism and compulsory order mechanism (multi-substrate enzyme kinetics)	2	C,D	2	1,3
	Unit III: Enzyme Inhibition and Kinetics	**10**			
14.	Enzyme Inhibition: type of Inhibition	2	C	3	1,3
15.	Kinetic model for different types of enzyme inhibition	2	C,D,I	3	1,3
16.	Competitive inhibition	1	C,D,I	3	1,3
17.	Uncompetitive and noncompetitive inhibition	1	C,D,I	3	1,3
18.	Enzyme deactivation kinetics	2	C,D	3	1,3
19.	Allosteric regulation of enzyme	1	C,D	3	1,3
20.	Current application of enzyme inhibitor in different fields	1	C	3	1,3
	Unit IV: Enzyme Immobilization	**10**			
21.	Types of enzyme immobilization-matrix entrapment, ionic and cross linking	2	C	4	1
22.	Column packing	1	C,D	4	1
23.	Analysis of mass transfer effects during enzyme reactions	2	C,D	4	1
24.	Kinetics of immobilized enzyme reactions	2	C,D	4	1
25.	Analysis of film and pore diffusion	1	C,D	4	1
26.	Calculation of Effectiveness Factors of immobilized enzyme systems	2	C,D	4	1
	Unit V: Enzyme Assay	**8**			
27.	Principle of Enzyme analysis: End point methods, kinetic methods	1	C,D,I	5	1,4
28.	Fixed time methods, fixed concentration methods	1	C,D,I	5	1,4
29.	High throughput assays	1	C,D,I	5	1,4
30.	Determination of molecular weight	1	C,D,I	5	1,4
31.	Detection Techniques: Photometry	1	C,I	5	1,4
32.	Electrochemical	1	C,I	5	1,4
33.	Radiochemical methods	1	C,I	5	1,4
34.	Immunoassay methods	1	C,I	5	1,4
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Trevor Palmer and Philip L Bonner, "*Enzymes: Biochemistry, BiotechnologyAnd Clinical Chemistry",* 2nd edition, Woodhead Publishing, 2007.
	REFERENCES/ OTHER READING MATERIALS
2.	Robert A. Copeland, "*Enzymes: A Practical Introduction to Structure,Mechanism, and Data Analysis",* 2nd edition, Wiley, John & Sons, 2001.
3.	Paul F. Cook, Cleland .W.W, "*Enzyme Kinetics and Mechanism",* GarlandScience, 2007.
4.	Robert Eisenthal and Michael J. Danson, "*Enzyme Assays: A PracticalApproach"*, 2nd edition, Oxford University Press, 2002.

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
					End semester examination weightage :		**50%**

15GN302	Animal Cell Culture And Transgenic Technology	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P Professional Core				
Course designed by	Department of Genetic Engineering				
Approval	32nd Academic Council Meeting held on 23rd July 2016				

PURPOSE	This course aims at making students to learn about the animal cell culture techniques and different application aspects of cell culture in various fields.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Know the properties and features of cultured animal cells	a	d	f	h	i	l	
2.	Learn the preservation and characterization of cell lines	a	d	f	h	i	k	l
3.	Analyse the methods involved in scaling up of animal cell culture and be aware of biosafety and biohazards involved in animal cell culture	a	b	d	i	j	l	
4.	Know the techniques in transgenic animal production	a	b	j	l			
5.	Understandthe applications of animal cell culture and transgenic animals	a	b	j	l			

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Unit I: Biology of Cultured Animal Cells	**8**			
1.	Cell culture - introduction, use, advantages and disadvantages	1	C,D	1	1,2
2.	Cell types and its characteristics, differentiation of cells	1	C,D	1	1,2
3.	Growth of cells in culture - importance of aseptic techniques	2	C,D,I	1	1,2
4.	Culture media and culture conditions	1	C,D,I	1	1,2
5.	Maintenance and storage of cell cultures	1	C,D,I	1	1,2
6.	Bio-safety and biohazards	2	C,D,I	1	1,2
	Unit II: Preservation and Characterization of Cell Lines	**9**			
7.	Primary culture, subculture	1	C,D	2	1,2
8.	Cloning and selection - conditions, suspension cloning, isolation of clones, interaction with substrates	2	C,D	2	1,2
9.	Cell separation - isopyknic sedimentation, centrifugation, antibody based techniques	1	C,D	2	1,2,
10.	Characterization and differentiation	2	C,D	2	1,2
11.	Transformation and immortalization-genetic instability, telomerase induced immortalization	2	C,D	2	1,2
12.	Contamination - routes, microbial,cryopreservation techniques - principles, freezing medium, liquid nitrogen freezers	1	C,D,I	2	1,2
	Unit III: Scaling up of Animal Cell Culture	**9**			
13.	Cell quantification methods - counting, automatic colony counting	1	C,D,I	3	1,2
14.	Cell quantification - growth curve analysis	1	C,D,I	3	1,2
15.	Cell viability measurements	1	C,D,I	3	1,2
16.	Growth kinetics	2	C,D	3	1,2
17.	Scale up of suspension and monolayer cultures	2	C,D,I	3	1
18.	Air lift bioreactors	2	C,D	3	1
	Unit IV: Production of Transgenic Animals	**9**			
19.	Methodology of production of transgenic animals - retroviral vector method	2	C,D	4	3,4
20.	Transposons - DNA micro injection, ICSI, antisense RNA's	2	C,D	4	3,4
21.	Engineered embryonic stem cell method, oocyte culture	2	C,D	4	3,4
22.	Dolly production	1	C,D,I	4	3,4
23.	Knockout mice generation - strains, procedure, chimera production, limitations	2	C,D,I	4	3,4

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Unit V: Applications of Animal Cell Culture and Transgenic Animals	**10**			
24.	Animal cells as bioreactors - properties, types, methods of cultivation	1	C,D,I	5	4
25.	Bioreactors-rotating cell culture system, methods, mechanical and biological evacuation	1	C,D,I	5	4
26.	Therapeutic proteins - enzymes, vaccines	2	C,D,I	5	4
27.	Applications of transgenic animals for the production of recombinant proteins, better nutrition	2	C,D,I	5	3
28.	Transgenic animals- transgenic cattle - transgenic goat and pigs - transgenic chicken	2	C,D,I	5	3
29.	Bioindicators - ornamental transgenic fish - applications of various cell lines	2	C,D,I	5	3
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOK**
1.	R.I. Freshney, "*Culture of Animal cells*", Wiley-Blackwell; 6th edition, 2010.
	REFERENCE BOOKS/ OTHER READING MATERIALS
2.	Sheelendra M Bhatt "*Animal Cell Culture Concept and Application*", Alpha Science International Limited. Oxford, U.K. 2005
3.	M.M. Ranga, "*Transgenic animals*", Agrobios (India), 2006.
4.	Srivastava., *"Animal Biotechnology",* Oxford and IBH Publishing, 2005.

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
					End semester examination weightage :		**50%**

15GN303	**Bioinstrumentation**	**L**	**T**	**P**	**C**
		2	**2**	**0**	**3**
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P Professional core				
Course designed by	Department of Genetic Engineering				
Approval	32nd Academic Council Meeting held on 23rd July 2016				

PURPOSE	This course helps the students to understand the working principles of various instruments used in life sciences. This improves the practical skills of the students when they use these instruments during their research. It also assists the students to interpret the result of the experiments carried out using these equipments.

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Analyze the results of different spectrophotometer and identify the chemical nature of the samples.	a	i	k				
2.	Analyze the results of NMR and MS spectrophotometer and able to calculate the mass by interpreting the results.	a	i	k				
3.	Understand the concept of various types of chromatographic techniques	a	i	k				
4.	Understand the differences in the application of different fluorescent and electron microscopic methods	a	i	k				

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Unit I: Spectroscopic Methods I	**12**			
1.	Principle and instrumentation of single, dual beam and scanning UV-Visible spectrophotometer	2	C	1	1
2.	Application of UV-Visible spectrophotometer	1	C	1	1
3.	Principle and instrumentation of Infra-Red spectrophotometer	1	C,I	1	1
4.	Instrumentation of IR spectrophotometer and its applications	2	C	1	1
5.	Analysis of sample IR spectrophotometer results and identifies the chemical nature of the sample (Tutorial)	6	I,O	1	1,6
	Unit II: Spectroscopic Methods II	**12**			
6.	Principle and instrumentation of Nuclear Magnetic resonance spectroscopy (NMR)	2	C	2	5
7.	Types of NMR	1	C	2	5
8.	Analysis of sample NMR chromatogram and identify the chemical nature of the sample (Tutorial)	3	I,O	2	5,6
9.	Principle and instrumentation of LC-MS	2	C	2	3
10.	Principle and instrumentation of MALDI –TOF	1	C	2	3
11.	Determination of mass of the sample using Mass Spectrophotometer results (Tutorial)	3	I,O	2	3,6
	Unit III: Chromatographic Methods	**12**			
12.	Instrumentation of HPLC	1	C	3	1,2
13.	Principle of different modes of HPLC: Gas chromatography, Gel filtration and Ion exchange chromatography	2	C, I	3	1,2
14.	Columns: Choice of column for different samples, Column packaging methods	2	C,D,I	3	1,2
15.	Factors affecting the efficiency of HPLC	2	C,I	3	1,2
16.	Determination of molecular weight of unknown protein using Gel filtration chromatogram (Tutorial)	2	C,I, O	3	1,2,6
17.	Methods to increase the resolution of chromatogram by optimizing the operating conditions: Explanation with sample chromatogram. (Tutorial)	3	C,I, O	3	1,2, 6
	Unit IV: Microscopic Methods I	**12**			
18.	Principles and instrumentation of Fluorescence microscopy	2	C	4	1
19.	Principle and application of Phase contrast microscopy	2	C	4	1
20.	Confocal microscopy :Instrumentation and types	2	C,I	4	1, 4
21.	Two photo excitation microscopy	1	C,I	4	1, 4
22.	Live cell imaging using Confocal microscopy	2	C	4	4
23.	Difference in the application of Fluorescence and Confocal microscopy with examples (Tutorial)	3	C,I	4	1,4
	Unit V: Microscopic Methods II	**12**			
24.	Fluorescence Recovery After Photo bleaching (FRAP) for dynamic studies	2	C	4	4
25.	Fluorescence Resonance Energy Transfer (FRET) for protein interaction studies	1	C	4	4
26.	Analysis of the sample FRET results for protein interaction studies	3	C,I,O	4	4
27.	Types of Electron Microscopy: TEM and SEM	2	C,I	4	1

28.	Difference in the application of TEM and SEM	1	C,I	4	1
29.	Identification of the sample using Emission finger printing sample result (Tutorial)	3	C,I, O	4	1
Total Hours		**60**			

LEARNING RESOURCES	
	TEXT BOOKS
1.	John G. Webster ., "*Bioinstrumentation"*, Wiley, 2003
	REFERENCES/OTHER READING MATERIALS
2.	Marrin C. McMaser., "*HPLC: Practical approach"*, 2nd edition, Wiley-Interscience, 2006
3.	Pedro R. Cutillas. , John F. Timms., "*LC-MS/MS in Proteomics: Methods and Applications (Methods in Molecular Biology)",* Humana Press, 2010
4.	Pawley. J, "*Handbook of Biological Confocal Microscopy",* Springer, 2006
5.	Cavanagh. J, Wayne. J, Fairbrother, A. G., Palmer. III ., Nicholas J. Skelton. , Rance. M, "*Protein NMR Spectroscopy, Second Edition: Principles and Practice"*, Academic Press, 2006
6.	Course material with sample results

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	**Cycle test I**	**Cycle test II**	**Cycle Test III**	**Surprise Test**	**Quiz**	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
					End semester examination Weightage :		**50%**

15GN304M	**Multi-Disciplinary Design**			**L**	**T**	**P**	**C**
				2	**2**	**0**	**3**
Co-requisite:	NIL						
Prerequisite:	NIL						
Data Book / Codes/Standards	NIL						
Course Category	P	PROFESSIONAL CORE					
Course designed by	Department of Genetic Engineering						
Approval	32nd Academic Council Meeting held on 23rd July 2016						

PURPOSE	Students of any specialization at an undergraduate level learn courses related to various sub-domains (Multi-disciplinary) of their specialization individually. They are not exposed to understanding how the various multi-disciplinary fields interact and integrate in real life situations. It is very common that an expert in a particular domain models and designs systems or products oblivious of the impact of other subsystems. This lack of multi-disciplinary thinking is very blatantly visible when the students take up their major project during their final year. This course aims to develop appropriate skills on systemic thinking on how to identify and formulate a problem, decompose the problem into smaller elements, conceptualize the design, evaluate the conceptual design by using scientific, engineering and managerial tools, select, analyze and interpret the data, consideration of safety, socio-politico-cultural, risks and hazards, disposal, regional and national laws, costing and financial model and undertake documentation and finally presentation.

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able								
1.	To subdivide a complex system into smaller disciplinary models, manage their interfaces and reintegrate them into an overall system model	a	b	c	d	i	l	m
2.	To rationalize a system architecture or product design problem by selecting appropriate design variables, parameters and constraints	a	b	c	d	e		
3.	To design for value and quantitatively assess the expected lifecycle cost of a new system or product	a	b	c	i	m		

4.	To take on the challenges of teamwork, prepare a presentation in a professional manner, and document all aspects of design work.	a	c	e	f	i	l	

Session.	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
1.	Introduction: Facilitating Multidisciplinary Projects		C,D,I,O	1,2,3,4	1,2,3
2.	Identifying and formulating a problem				
3.	System Modelling				
4.	Thinking perspectives: decomposition–Composition Thinking Hierarchical thinking, organizational Thinking, Life-Cycle thinking, safety thinking, risk thinking, Socio-politico-cultural thinking, Environment thinking				
5.	Decomposing a system – Identifying the major sub-systems				
6.	Mathematical Modeling and Governing equations for each sub systems				
7.	Objectives, Constraints and Design Variables				
8.	Conceptual Design				
9.	Collaborative Design – Disciplinary teams satisfy the local constraints while trying to match the global constraints set by the project coordinator.				
10.	Tools for modeling, designing, analysis, data interpretation, decision making etc				
11.	Design Analysis, evaluation and selection				
12.	Costing and Financial model				
13.	Documentation, reviewing and presentation				
	Total contact hours	**60**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	G. Maarten Bonnema, Karel T. Veenvliet, Jan F. Broenink, "*Systems Design and Engineering: Facilitating Multidisciplinary Development Projects"*, CRC Press, 2015.
2.	Ina Wagner , Tone Bratteteig , Dagny Stuedahl, "*Exploring Digital Design-Multi-Disciplinary Design Practices*" Springer-Verlag,2010.
	REFERENCE BOOK/ OTHER READING MATERIAL
3.	Michael, R. G., Sambrook. J., "*Molecular Cloning – A Laboratory Manual"*, 4th edition, Cold Spring Harbor Laboratory Press, 2012.

Course nature				**Predominantly Practice complimented by theory**		
Assessment Method (Weightage 100%)						
In-semester	**Assessment tool**	Review 1	Review 2	Review 3	Review 4	**Total**
	Weightage	**10%**	**25%**	**25%**	**40%**	**100%**
End semester examination weightage :						**0%**

Pedagogy:
Theme or major/broad domains will be announced by the department every semester. Multi-disciplinary designs will be made by the students in groups (group size may be decided by the course coordinator), with the topic of interest falling within the theme or major/broad domains as announced by the department, applying any combinations of the disciplines in engineering. 3D modelling and / or simulation must be used to validate the design.

In a combination of lecture and hands-on experiences, students must be exposed to understand and analyse engineering designs (or products) and systems, their realization process and project management. Analysis of the design criteria for safety, ergonomics, environment, life cycle cost and sociological impact is to be covered.

Periodic oral and written status reports are required. The course culminates in a comprehensive written report and oral presentation. If required guest lecturers from industry experts from the sub-domains may be arranged to provide an outside perspective and show how the system design is being handled by the industry. The Conceive Design Implement Operate (CDIO) principles must be taught to the students.

A full-scale fabrication is not within the purview /scope of this course. Of course this design, if scalable and approved by the department, can be extended as the major project work

This course is 100% internal continuous assessment.

15GN305L	**Enzyme Engineering Laboratory**	**L**	**T**	**P**	**C**
		0	**0**	**4**	**2**
Co-requisite:	15GN301 Enzyme Engineering				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P Professional core				
Course designed by	Department of Genetic engineering				
Approval	32nd Academic Council Meeting held on 23rd July 2016				

PURPOSE	To develop skills in isolation of microbial enzymes, enzyme characterization and conducting experiments related to applications of principles of Enzyme engineering							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1	Estimate the unknown concentration of the product using colorimeter	a	k	l				
2	Determine MichaelisMenten kinetic parameters	a	k	l				
3	Characterize the enzyme	a	k	l				
4	Estimate the deactivation kinetics of enzyme	a	k	l				
5	Immobilize and study the kinetics of immobilized enzyme	a	k	l				
6	Construct Native PAGE and zymography	a	k	l				

Session	**Description of Experiments**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
1.	Estimation of unknown concentration of the product using colorimeter	4	C,I	1	1,2
2.	Determination of Michaelismenten kinetic parameters of the enzyme	4	C,D,I	2	1,2
3	Analysis of enzyme activity and enzyme stability at different pH	8	C,D,I	3	1,2
4	Analysis of enzyme activity and enzyme stability at different temperature	8	C,D, I	3	1,2
5	Estimation of effect of metal ions and inhibitors in enzyme activity	8	C,D,I	3	1,2
6	Determination of enzyme inhibition kinetics	4	C,D,I	3	1,2
7	Determination of enzyme deactivation kinetics at different temperature	4	C,D,I	4	1,2
8	Immobilization of enzyme by calcium alginate method	4	C,D,I	5	1,2
9	Preparation of packed bed reactor for immobilized enzyme and estimation of enzyme activity for the immobilized enzyme	8	C,D,I	5	1,2
10	Native PAGE and zymography	8	C,D,I	6	1
	Total contact hours	**60**			

LEARNING RESOURCES	
Sl. No.	**REFERENCES**
1.	Lab Manual

2.	Trevor Palmer and Philip L Bonner., "*Enzymes: Biochemistry, Biotechnology And Clinical Chemistry",* 2nd edition, Woodhead Publishing, 2007.

Course nature				**Practical**		
Assessment Method (Weightage 100%)						
In-semester	**Assessment tool**	Experiments	Record	MCQ/Quiz/Viva Voce	Model examination	**Total**
	Weightage	**40%**	**5%**	**5%**	**10%**	**60%**
					End semester examination weightage :	**40%**

15GN306L	**Gene Expression Laboratory**	**L**	**T**	**P**	**C**
		0	**0**	**4**	**2**
Co-requisite:	NIL				
Prerequisite:	15GN210 Recombinant DNA Technology, 15GN213L Recombinant DNA Technology Laboratory				
Data Book / Codes/Standards	NIL				
Course Category	P Professional Core				
Course designed by	Department of Genetic engineering				
Approval	-- Academic Council Meeting -- 2016				

PURPOSE	To develop skills in isolation of total RNA and quantification of gene expression							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1	Perform isolation and quantification of total RNA	a	b		j			
2	Perform reverse transcription PCR and quantitative PCR	a	b		j			
3	Perform time course analysis of gene expression	a	b	d	j			

Session	**Description of Experiments**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
1.	Isolation of RNA	4	C,D,I	1	1,2
2.	Formaldehyde agarose gel electrophoresis of RNA	4	C,D,I	1	1,2
3.	RNA quantification	4	C,D,I	1	1,2
4.	cDNA synthesis	4	C,D,I	2	1,2
5.	Reverse transcription PCR	4	C,D,I	2	1,2
6.	Digital PCR	8	C,D,I	2	1,2
7.	Transformation of *E.coli* with expression vector	8	C,D,I	3	1,2
8.	Time course study of induction of gene expression with IPTG	8	C,D,I	3	1,2
9.	SDS-PAGE	8	C,D,I	3	1,2
10.	Western blotting	8	C,D,I	3	1,2
	Total contact hours	**60**			

LEARNING RESOURCES	
Sl.No.	**REFERENCES**
1.	Laboratory Manual
2.	Michael, R. G., Sambrook. J., "*Molecular Cloning – A Laboratory Manual"*, 4th edition, Cold Spring Harbor Laboratory Press, 2012.

Course nature				**Practical**		
Assessment Method (Weightage 100%)						
In-semester	**Assessment tool**	Experiments	Record	MCQ/Quiz/Viva Voce	Model examination	**Total**
	Weightage	**40%**	**5%**	**5%**	**10%**	**60%**

End semester examination Weightage :	**40%**

15GN307	**Stem Cell Biology**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
Co-requisite:	NIL				
Prerequisite:	15GN302 Animal Cell Culture and Transgenic Technology				
Data Book / Codes/Standards	NIL				
Course Category	P Professional Core				
Course designed by	Department of Genetic Engineering				
Approval	32nd Academic Council Meeting held on 23rd July 2016				

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**								
At the end of the course, student will be able to										
1.	Gain knowledge about embryogenesis, stem cells and its characteristics	a	b	d	f	h	j			
2.	Gain knowledge on embryonic stem cells, adult stem cells and transdifferentiation	a	b	d	f	h	j			
3.	Understand about cancer stem cells, iPSCs and cloning methods	a	b	c	f	h	i	j		
4.	Identify the role of signaling pathways and epigenetics in stem cell fate	a	b	f	h	j				
5.	Understand the application of stem cells in tissue engineering, treatment of different diseases and the recent advancements in the field of stem cell research	a	b	c	f	h	i	j	k	l

Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
	Unit I: Stem Cell Basics	**8**			
1.	Introduction to Stem Cells - overview of syllabus Origin of stem cells - Early development of embryo - Formation of stem cells - totipotent, pluripotent, multipotent cells - unique properties of stem cells. Types of stem cells - embryonic stem cells - adult stem cells - induced pluripotent stem cells - cancer stem cells - similarities and differences between embryonic and adult stem cells, lab tests to identify ESCs and ASCs.	1	C	1	1,2
2.	Early development of embryo	2	C	1	1
3.	Formation of stem cells and unique properties of stem cells	1	C,D	1	1,2
4.	Types of stem cells - ESCs, ASCs, iPSCs	1	C,D,I	1	2
5.	Germinal stem cells - Steven's experiment	1	C	1	1
6.	HSCs and tumor stem cells	1	C,I	1	1
7.	Similarities and differences, lab tests for ESCs and ASCs	1	C,D,I	1	2
	Unit II: Embryonic Stem Cells and Adult Stem Cells	**9**			
8.	Embryonic Stem Cells - mouse, primate, naïve and primed	1	C	2	1,4
9.	Isolation of hESCs	1	C,D,I	2	3
10.	Mouse embryo - derived cells - EC,ES,EG,TS, NTES cells	2	C,D,I	2	1
11.	Adult Stem Cells - properties and sources	1	C,D,I	2	2
12.	Plasticity and transdifferentiation	2	C,D	2	6
13.	Neural Stem Cells	2	C,D	2	7
	Unit III: Cancer Stem Cells and Induced Pluripotent Stem Cells and Therapeutic Cloning	**10**			
14.	Cancer stem cells - properties, origin and theory	1	C,D	3	8
15.	Cancer stem cell isolation, Heterogeneity	1	C,D,I	3	8
16.	Metastatic stem cells, Treatment and pathways	2	C,D	3	8
17.	iPSC's – production of iPSCs	2	C,D,I	3	9
18.	Safety for regenerative medicine and research	2	C,D	3	9
19.	Stem cells and Animal cloning - nuclear transfer method	1	C,D	3	1

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
20.	Molecular mechanisms in cloning	1	C	3	1
	Unit IV: Signalling Pathways and Epigenetic Regulation in Stem Cells	**8**			
21.	ESC pluripotency and signalling-JAK-STAT pathway	2	C,D	4	10
22.	HSC signaling pathways- Notch, Wnt	1	C,D,I	4	10
23.	TGF, SMAD	1	C,D,I	4	10
24.	Epigenetic control of stem cells- stem cells and epigenetics	2	C,D	4	11
25.	Transcriptional factors network, epigenetics in somatic and iPSCs	2	C	4	11
	Unit V: Applications of Stem Cells in Tissue Engineering and Regenerative Medicine	**10**			
26.	Tissue Engineering	2	C,D	5	5
27.	Stem cells in Parkinson's disease	2	C,D	5	12
28.	Stem cell treatment for burns	1	C,D	5	3
29.	Stem cell for spinal cord injury	2	C,D	5	3
30.	Stem cell treatment for diabetes	2	C,D	5	13
31.	Recent advances in stem cells (Recent Reviews and Research Articles)	1	C,D,I	5	
	Total Hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Stewart Sell., "*Stem Cells Handbook*" 2nd Edition, Humana Press, 2004.
2.	Stem Cell Information, National Institutes of Health, SC Primer 2009.
	REFERENCE BOOKS/ OTHER READING MATERIALS
3.	Robert Lanza, Edited by:Robert Lanza and Anthony Atala , "Essentials of Stem Cell Biology"3rd Edition, Academic Press,Copyright © 2014 Elsevier Inc. 4.
4.	Ann A. Kiessling, Scott Anderson, "*Human Embryonic Stem Cells*" 2nd Edition, Jones and Bartlett Publishers, 2007.
5.	Nancy E.Snow, " *Stem Cell Research-New Frontiers in Science and Ethics*", University of Notre Dame Press, 2000.
	Zech N. Plasticity of Stem Cells: Cell-fusion Versus Transdifferentiation. "*J. Reproduktionsmed. Endokrinol."* 2005; 2 (4), 239-245.
6.	Ma DK, Bonaguidi MA, Ming GL, So,Adult neural stem cells in the mammalian central nervous system. "*Cell Res"*. 2009, Jun;19(6):672-82.
7.	Neethan A. Lobo, YoheiShimono, Dalong Qian, and Michael F. Clarke. The Biology of Cancer Stem Cells. "*Annual Review of Cell and Developmental Biology".* 2007,Vol. 23: 675-699.
8.	Takahashi, K; Yamanaka, S. Induction of pluripotent stem cells from mouse embryonic and adult fibroblast cultures by defined factors. *"Cell".* 2006,**126** (4): 663–76.
9.	Huang G, Ye S, Zhou X, Liu D, Ying QL. Molecular basis of embryonic stem cell self-renewal: from signaling pathways to pluripotency network. "*Cell Mol Life Sci".* 2015, May;72(9):1741-57.
10.	Blank U, Karlsson G, Karlsson S. Signaling pathways governing stem-cell fate. "*Blood"*. 2008, Jan 15;111(2):492-503. Epub 2007.
11.	Victoria V. Lunyak, and Michael G. Rosenfeld. Epigenetic regulation of stem cell fate. "*Human Molecular Genetics.* 2008, Vol. 17, Review.
12.	Role of cell therapy in Parkinson disease. "*Neurosurg Focus."* 2002, Nov 15;13(5).
13.	Paras Kumar Mishra, Shree Ram Singh, Irving G. Joshua, and Suresh C Tyagi. Stem cells as a therapeutic target for diabetes Paras Kumar Mishra, Shree Ram Singh, Irving G. Joshua, and Suresh C Tyagi."*Front Biosci".* 2011, 15: 461–477.

Course nature		**Theory**					
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
End semester examination weightage :							**50%**

15GN308	Plant Genetic Engineering	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P Professional Core				
Course designed by	Department of Genetic Engineering				
Approval	32nd Academic Council Meeting held on 23rd July 2016				

PURPOSE	Today, the world population is growing at an alarming rate and hence agricultural production has to be increased to feed the growing population. Genetic engineering of plants offers new avenues in this regard by drastically enhancing the crop production through transformation of suitable genes. This course enlightens the students on how to create the transgenic crops and thus enhance productivity.

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Learn how to work in plant tissue culture lab.	b	c	d				
2.	Mass propagate the plants through tissue culture methods.	b	a	d				
3.	Gain knowledge on the production of transgenic plants through various methods.	a	b	c	d			
4.	Understand the applications of genetically modified crops in various fields.	a	b	c	d			
5.	Know about legal issues concerned with cultivation and commercialization of transgenic plants	m	j					

Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
	Unit I: Introduction to Plant Tissue Culture	**7**			
1.	History, tissue culture lab, establishing aseptic conditions	1	C	1	1
2.	Types of media and their preparation	1	C,I	1	1
3.	Plant hormones	2	C	1	1
4.	Organogenesis - Direct and Indirect	1	C,I,O	1	1
5.	Meristem /shoot apex culture, callus and suspension culture	2	C,I,O	1	1
	Unit II: Tissue Culture Methods and Theirapplications	**8**			
6.	Significance and application of anther culture	1	C	1,2	1
7.	Ovule culture	1	C	1,2	1
8.	Embryo culture	1	C	1,2	1
9.	Somatic embryogenesis	1	C	1,2	1
10.	Protoplast fusion	1	C	1,2	1
11.	Somaclonal variation	1	C	1,2	1
12.	Artificial seeds	1	C	1,2	1
13.	Micropropagation	1	C, I,O	1,2	1
	Unit III: Methods of Plant Transformation	**10**			
14.	Biology of *Agrobacterium tumefaciens*	**1**	C	3	2,3
15.	Agrobacterium mediated plant transformation	1	C,I,O	3	2,3
16.	Biolistic, PEG/liposome-mediated, electroporation mediated transformation	**3**	C	3	2
17.	Chloroplast transformation	1	C	3	2
18.	Protoplast transformation	1	C	3	2
19.	Site directed integration of transgene using zinc finger nucleases and CRISPR/Cas technology	3	C	3	4
	Unit IV: Plant Transformation Vectors	**10**			
20.	Binary and co-integrate vectors	2	C	3,4,5	2
21.	Gateway vectors - promoters	2	C	3,4,5	2

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
22.	Selectable and screenable markers	3	C	3,4,5	2
23.	Marker free transgenics-significance and applications	3	C	3,4,5	2
	Unit V: Transgenic Plants	**10**			
24.	Biotic and abiotic stress tolerant transgenic plants, Bt Cotton	2	C	3,4,5	2
25.	Roundup ready soybean	1	C	3,4,5	2
26.	Blue rose	1	C	3,4,5	2
27.	Vitamin A fortified rice	1	C	3,4,5	2
28.	Metabolic engineering - oil and secondary metabolite production	2	C	3,4,5	2
29.	Production of edible vaccines	1	C	3,4,5	2
30.	Biotech drugs production in transgenic plants	2	C	3,4,5	2
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Razdan. M.K., "*Introduction to plant tissue culture"* second edition, Science Publishers, 2003.
2.	Slater. A., Scott. N.W., Fowler. M.R., *"Plant biotechnology-the genetic manipulation of plants*" third edition, Oxford University Press, 2008.
	REFERENCE BOOKS/OTHER READING MATERIALS
3.	Gelvin. S., *Agrobacterium-mediated plant transformation: the biology behind the "gene-jockeying" tool*. Microbiol. Mol. Biol. Rev., 67, 16–37, 2003.
4.	Gaj. T., et al., *ZFN, TALEN and CRISPR/Cas-based methods for genome engineering*. Trends Biotechnol., 31, 397–405, 2013.

Course nature				**Theory**			
Assessment Method – Theory Component (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
						End semester examination weightage :	**100%**

15GN309	**Research Methodology**	**L**	**T**	**P**	**C**
		1	**0**	**0**	**1**
Co-requisite:	NIL				
Prerequisite:	15GN303 Bioinstrumentation				
Data Book / Codes/Standards	NIL				
Course Category	P Professional core				
Course designed by	Department of Genetic Engineering				
Approval	Academic Council Meeting -- , 2016				

PURPOSE	The course imparts knowledge and understanding about various research methodologies. This course helps in preparing students to perform research effectively. It also helps the students to gain knowledge on literature review and thesis writing.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Know about different types of research	a	i	l				
2.	Understand about research formulation	a						
3.	Know about research designs and methodology	a	i					
4.	Learn about presentations, thesis writing and publication of articles	a	i	l				

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Unit I: Objectives and Types of Research	**3**			

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
1.	Motivation and objectives of research, conceptual vs. empirical.	1	C	1	1
2.	Types of research, descriptive vs. analytical, applied vs. Fundamental, quantitative vs. qualitative	2	C	1	1
	Unit II: Research Formulation	**3**			
3.	Defining and formulating the research problem, selecting the problem, necessity of defining the problem, Importance of literature review in defining a problem	1	C,D,I	2	1
4.	Literature review, Primary and secondary sources ,reviews, monographs, patents	1	C,D,I	2	3
5.	Web as a source, searching the web, critical literature review, Identifying gap areas from literature review, development of working hypothesis	1	C,D	2	3
	Unit III: Research Design and Methods	**3**			
6.	Research design, Basic Principles, development of models. need of research design, features of good design sample, designs	1	C,D	3	1
7.	Determining experimental and sample designs, Important concepts relating to research design, observation and Facts	1	C,D	3	1
8.	Developing a research plan - exploration, description, diagnosis, Experimentation	1	C,D,O	3	1
	Unit IV: Presentation of Reseach Findings	**3**			
9.	How prepare and give effective and professional PowerPoint presentation	1	C	4	2
10.	Do's and Don'ts in PowerPoint presentation	1	C,D	4	1
11.	Poster presentation ,Methods and layout design using power Point and Photoshop	1	C,D,I	4	2
	Unit V: Writing Thesis and Research Papers	**3**			
12.	Structure and components of thesis and research articles	1	C,D,I	4	4,5
13.	Significance , different steps in the preparation, Layout, structure, illustrations, tables and bibliography-reference managers, Mendeley, EndNote	1	C,D,I	4	4,5
14.	Language correction -grammarly, plagiarism-iThenticate.	1	C,I	4	4,5
	Total contact hours	**15**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOK**
1.	Garg. B.L., Karadia R. Agarwal F., Agarwal, "*An Introduction to Research Methodology"*, RBSA Publishers. U.K., 2002.
	REFERENCES/ OTHER READING MATERIALS
2.	Watson.F.L.,Lom.B., "*More than a Picture: Helping Undergraduates Learn to Communicate through Scientific Images*", CBE Life Sci Educ. Spring; 7(1): 27–35.2008.
3.	Pautasso.M., "*Ten Simple Rules for Writing a Literature Review*", PLoSComput Biol. Jul; 9(7): e1003149. 2013.
4.	Dodson. B.T., "*Writing a Scientific Paper Is Not Rocket Science*!" J Oral MaxillofacSurg 73:S160-S169, 2015.
5.	Jha. K.N., "*How to Write Articles that Get Published*", J ClinDiagn Res. Sep; 8(9): XG01–XG03, 2014.

Course nature				**Theory**		
Assessment Method (Weightage 100%)						
In-semester	Assessment tool	Assessment I	Assessment II	Assessment III	Assessment IV	Total
	Weightage	**25% (Test -10%; Assignment-**	**25% (Test -10%; Assignment-**	**25% (Test -10%; Assignment-**	**25% (Test -10%; Seminar-**	**100%**

		15%)	**15%)**	**15%)**	**15%)**	
Endsemesterexamination weightage:						**0%**

15GN310L	**Animal Cell Culture Laboratory**	**L**	**T**	**P**	**C**
		0	**0**	**4**	**2**
Co-requisite:	NIL				
Prerequisite:	15GN302 Animal Cell Culture and Transgenic Technology				
Data Book / Codes/Standards	NIL				
Course Category	P Professional Core				
Course designed by	Department of Genetic engineering				
Approval	32nd Academic Council Meeting held on 23rd July 2016				

PURPOSE	The course is aimed at making students to learn culturing of animal cells from various sources. It also helps them to characterize the cultured cells through different techniques.

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1	Learn preparation of media and maintenance of animal cells	a	b	d	i	j	k	m
2	Isolate and culture cells from different sources	a	b	c	d	i	j	k
3	Perform various assays and staining procedures for characterization of cells	a	b	d	i	j	k	

Session.	**Description of experiments**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
1.	Introduction to animal cell culture lab and Equipments - biosafety cabinets, CO2 incubator and inverted microscope, sterilization techniques - autoclaving, dry heat, UV light, filtration	4	C,D	1	1,2
2.	Preparation of Media - DMEM, MEM, RPMI and preparation of serum from mammalian blood	8	C,D,I	1	1,2
3.	Lymphocyte isolation from human blood using Ficoll - Hypaque solution, cell counting and viability of lymphocytes	8	C,D,I	2	1,2
4.	Culturing of CHO and cancer cell Lines	4	C,D,I	2	1,2
5.	Trypsinization and subculturingof cell lines	8	C,D,I	1,2	1,2
6.	Cryopreservation, freezing and thawing of cultured cells	4	C,D,I	2	1,2
7.	Primary culture of chick embryo	4	C,D,I	2	1,2
8.	Isolation of hepatocytes from goat liver, counting and culturing of hepatocytes	4	C,D,I	1	1,2
9.	MTT assay of CHO and cancer cell lines	8	C,D,I	3	1,2
10.	Immunocytochemistry	8	C,D,I	3	1,2
	Total contact hours	**60**			

LEARNING RESOURCES	
Sl. No.	**REFERENCES**
1.	Laboratory Manual
2.	Freshney R.L, "*Culture of Animal cells*" Wiley-Blackwell, 6th Edition, 2010.

Course nature				**Practical**		
Assessment Method (Weightage 100%)						
In-semester	**Assessment tool**	Experiments	Record	MCQ/Quiz/Viva Voce	Model examination	**Total**
	Weightage	**40%**	**5%**	**5%**	**10%**	**60%**
				End semester examination weightage :		**40%**

15GN311L	Plant Genetic Engineering Laboratory	L	T	P	C
		0	0	4	2
Co-requisite:	15GN308 Plant Genetic Engineering				
Prerequisite:	15GN306L Gene Expression Laboratory				
Data Book / Codes/Standards	NIL				
Course Category	P Professional Core				
Course designed by	Department of Genetic Engineering				
Approval	32nd Academic Council Meeting held on 23rd July 2016				

PURPOSE	The objective of the course is to provide hands on training in engineering the transgenic plants and vectors for transformation. It has emerged as an important tool for crop improvement in agriculture. Biotechnology companies and research centres with crop improvement programs require expertise inrecombinant DNA technology and plant genetic engineering and this would be advantageous to the students.

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Learn how to work in plant tissue culture lab.	b	c	d	k			
2.	Grow the plants aseptically in lab.	b	a	d	k			
3.	Create a transgenic plant.	a	b	c	d	k		
4.	Confirm the transgenic plants with assays.	a	b	c	d	k		

Session	Description of Experiments	Contact hours	C-D-I-O	IOs	Reference
1.	Preparation of tissue culture media	4	C,I,O	1	1,4
2.	Aseptic germination of seeds	4	C,I,O	2	1,4
3.	Callus induction from leaf and seeds explants.	8	C,I,O	2	4
4.	Transformation of *Agrobacterium* with binary vector	8	C,D,I,O	3	2,3,4
5.	*Agrobacterium* - mediated transformation of tobacco leaf discs	8	C,I,O	3	2,3,4
6.	Co-cultivation, selection, and regeneration of transgenic plants	8	C,I,O	3	2,3,4
7.	Screening of transgenic plants by using GUS/GFP marker	4	C,I,O	4	2,3,4
8.	Screening of transgenic plants by PCR.	8	C,I,O	4	2,3,4
9.	Transient transformation by biolistic gene gun.	8	C,I,O	3	1,4
	Total contact hours	**60**			

LEARNING RESOURCES	
Sl. No.	**REFERENCES**
1.	Razdan. M.K., "*Introduction to plant tissue culture"* second edition, Science Publishers, 2003.
2.	Slater. A., Scott. N.W., Fowler. M.R., *"Plant biotechnology-the genetic manipulation of plants*", Third edition, Oxford University Press, 2008.
3.	Gelvin. S., *Agrobacterium-mediated plant transformation: the biology behind the "gene-jockeying" tool*. Microbiol. Mol. Biol. Rev., 67, 16–37, 2003.
4.	Laboratory Manual

Course nature				**Practical**		
Assessment Method (Weightage 100%)						
In-semester	**Assessment tool**	Experiments	Record	MCQ/Quiz/Viva Voce	Model examination	**Total**
	Weightage	**40%**	**5%**	**5%**	**10%**	**60%**
				End semester examination weightage :		**40%**

15GN375L	Minor Project I	L	T	P	C
		0	0	3	2
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P Professional				
Course designed by	Department of Genetic Engineering				
Approval	32nd Academic Council Meeting held on 23rd July 2016				

PURPOSE	To obtain an hands-on experience in converting a small novel idea / technique into a working model / prototype involving multi-disciplinary skills and / or knowledge and working in at team.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able								
1.	To conceptualise a novel idea / technique into a product	a	b	c	d			
2.	To think in terms of multi-disciplinary environment	i						
3.	To understand the management techniques of implementing a project	m						
4.	To take on the challenges of teamwork, prepare a presentation in a professional manner, and document all aspects of design work.	k						

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
1	An multidisciplinary project to be taken up by a team of maximum of ten students. Development of prototype product, a 3D model, simulation, blueprint for a larger project and any other development work are permitted. The contribution of the individuals in the project should be clearly brought out. A combined report is to be submitted. A presentation is to be made for the reviewers on the work done by the candidate.		C,D,I	1,2,3,4	
	Total contact hours				

Course nature		**Project – 100% internal continuous assessment**	
Assessment Method (Weightage 100%)			
In-semester	**Assessment tool**	Refer the table	**Total**
	Weightage	Refer the table below	**100%**
		End semester examination weightage :	**0%**

Assessment components

Assessment component	Expected outcome	Evaluators	Criteria or basis	Marks
Project proposal (Review – I)	A short presentation to be delivered on: • A brief, descriptive project title (2-4 words). This is critical! • The 3 nearest competitors (existing solutions) and price. • Team members name, phone number, email, department/degree program, and year. • A description of the product opportunity that has been identified. To include: Documentation of the market need, shortcomings of existing competitive products, and definition of the target market and its size.Proposed supervisor / guide	Panel of reviewers	Viability / feasibility of the project Extent of preliminary work done.	0

Assessment component	Expected outcome	Evaluators	Criteria or basis	Marks
Review II	• Mission statement / techniques • Concept sketches, design specifications / Modules and Techniques along with system architectureCoding	Panel of reviewers	Originality, Multi-disciplinary component, clarity of idea and presentation, team work, handling Q&A.	**20**
Review III	• Final Concept and Model / Algorithm/ Technique • Drawings, Plans / programme output • Financial Model / costing • Prototype / Coding Final Presentation and Demonstration	Panel of reviewers	Originality, Multi-disciplinary component, clarity of idea and presentation, team work, handling Q&A.	**50**
Final Technical report	A good technical report	Supervisor / Guide	Regularity, systematic progress, extent of work and quality of work	**30**
			Total	**100**

15GN376L	**Minor Project II**	**L**	**T**	**P**	**C**
		0	**0**	**3**	**2**
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P Professional				
Course designed by	Department of Genetic Engineering				
Approval	32nd Academic Council Meeting held on 23rd July 2016				

PURPOSE	To obtain an hands-on experience in converting a small novel idea / technique into a working model / prototype involving multi-disciplinary skills and / or knowledge and working in at team.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able								
1.	To conceptualise a novel idea / technique into a product	a	b	c	d			
2.	To think in terms of multi-disciplinary environment	i						
3.	To understand the management techniques of implementing a project	m						
4.	To take on the challenges of teamwork, prepare a presentation in a professional manner, and document all aspects of design work.	k						

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	An Multidisciplinary project to be taken up by a team of maximum of ten students. Development of prototype product, a 3D model, simulation, blueprint for a larger project and any other development work are permitted. The contribution of the individuals in the project should be clearly brought out. A combined report is to be submitted. A presentation is to be made for the reviewers on the work done by the candidate.		C,D,I	1,2,3,4	
	Total contact hours				

Course nature		**Project – 100% internal continuous assessment**	
Assessment Method (Weightage 100%)			
In-semester	**Assessment tool**	Refer the table	**Total**
	Weightage	Refer the table below	**100%**

End semester examination weightage :	0%

Assessment component

Assessment component	Expected outcome	Evaluators	Criteria or basis	Marks
Project proposal (Review – I)	A short presentation to be delivered on: • A brief, descriptive project title (2-4 words). This is critical! • The 3 nearest competitors (existing solutions) and price. • Team members name, phone number, email, department/degree program, and year. • A description of the product opportunity that has been identified. To include: Documentation of the market need, shortcomings of existing competitive products, and definition of the target market and its size. • Proposed supervisor / guide	Panel of reviewers	Viability / feasibility of the project Extent of preliminary work done.	**0**
Review II	• Mission Statement / Techniques • Concept Sketches, Design Specifications / Modules & Techniques along with System architecture • Coding	Panel of reviewers	Originality, Multi-disciplinary component, clarity of idea and presentation, team work, handling Q&A.	**20**
Review III	• Final Concept and Model / Algorithm/ Technique • Drawings, Plans / programme output • Financial Model / costing • Prototype / Coding • Final Presentation and Demonstration	Panel of reviewers	Originality, Multi-disciplinary component, clarity of idea and presentation, team work, handling Q&A.	**50**
Final technical Report	A good technical report	Supervisor / Guide	Regularity, systematic progress, extent of work and quality of work	**30**
			Total	**100**

15GN380L	Seminar I	L	T	P	C
		0	0	3	2
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P	Professional			
Course designed by	Department of Genetic Engineering				
Approval	32nd Academic Council Meeting held on 23rd July 2016				

PURPOSE	To enhance the disseminating skills of the student about the current and contemporary research work that are being carried out across the world.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able								
1.	To understand the research methodology adopted by various researchers	a						
2.	To mathematically model a problem, critically analyse it and adopt strategies to solve	a	b	c				
3.	To understand and present a well documented research	k						

Sl. No	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
1	**Guidelines for conducting 15GN380LSeminar for B.Tech** Upon registering for the course the student must identify a sub-domain of the degree specialization that is of interest to the student and start collecting research papers as many as possible.				
2	After collecting sufficient number of research papers the student must peruse all the papers, meet the course faculty and discuss on the salient aspects of each and every paper.				
3	The course faculty, after discussion with the student will approve TWO research papers that is appropriate for presentation.				
4	The student must collect additional relevant reference materials to supplement and compliment the two research papers and start preparing the presentation.				
5	Each student must present a 15-minute presentation on each of the approved research paper to the panel of evaluators.		C,D	1,2,3,4	
6	The presenter must present one research paper within the first half of the semester (6 weeks) and another research paper in the next half of the semester (6 weeks) as per the schedule.				
7	All other students registered for the course will form the audience.				
8	The audience as well as the evaluators will probe the student with appropriate questions and solicit response from the presenter.				
9	The presentation will be evaluated against 7 to 8 assessment criteria by 4 to 5 evaluators.				
10	The score obtained through the presentations of TWO research papers will be converted to appropriate percentage of marks. This course is 100% internal continuous assessment.				
	Total contact hours				

Course nature			Project – 100% internal continuous assessment	
Assessment Method (Weightage 100%)				
In-semester	**Assessment tool**	Presentation 1	Presentation 2	**Total**
	Weightage	**50%**	**50%**	**100%**
			End semester examination weightage :	**0%**

Department of Genetic Engineering

EVALUATION OF SEMINAR PRESENTATIONS

Name of the Student: Date:

Register Number: Degree and Branch:

Topic:

Sl. No.	Criteria for Assessment	Evaluator 1	Evaluator 2	Evaluator 3	Evaluator 4	Evaluator 5
1	Understanding of the subject					
2	Clarity of presentation					
3	Appropriate use of Audio visual aids					
4	Whether cross references have been consulted					
5	Ability to respond to questions on the subject					
6	Time scheduling					
7	Completeness of preparation					

Poor	1	Below	2	Average	3	Good	4	Very Good	5

Overall Grades:

Remarks:

Signature of Course Coordinator

15GN381L	SEMINAR II	L	T	P	C
		0	0	3	2
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P Professional				
Course designed by	Department of Genetic Engineering				
Approval	32nd Academic Council Meeting held on 23rd July 2016				

PURPOSE	To enhance the disseminating skills of the student about the current and contemporary research work that are being carried out across the world.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able								
1	To understand the research methodology adopted by various researchers	a						
2	To mathematically model a problem, critically analyse it and adopt strategies to solve	a	b	c				
3	To understand and present a well documented research	k						

	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Guidelines for conducting 15GN381L Seminar for B.Tech				
1.	Upon registering for the course the student must identify a sub-domain of the degree specialization that is of interest to the student and start collecting research papers as many as possible.				
2.	After collecting sufficient number of research papers the student must peruse all the papers, meet the course faculty and discuss on the salient aspects of each and every paper.				
3.	The course faculty, after discussion with the student will approve TWO research papers that is appropriate for presentation.				
4.	The student must collect additional relevant reference materials to supplement and compliment the two research papers and start preparing the presentation.				
5.	Each student must present a 15-minute presentation on each of the approved research paper to the panel of evaluators.		C,D	1,2,3,4	
6.	The presenter must present one research paper within the first half of the semester (6 weeks) and another research paper in the next half of the semester (6 weeks) as per the schedule.				
7.	All other students registered for the course will form the audience.				
8.	The audience as well as the evaluators will probe the student with appropriate questions and solicit response from the presenter.				
9.	The presentation will be evaluated against 7 to 8 assessment criteria by 4 to 5 evaluators.				
10.	The score obtained through the presentations of TWO research papers will be converted to appropriate percentage of marks.				
	This course is 100% internal continuous assessment.				
	Total contact hours				

Course nature				100% internal continuous assessment.
Assessment Method (Weightage 100%)				
In-semester	Assessment tool	Presentation 1	Presentation 2	Total
	Weightage	50%	50%	100%
End semester examination Weightage :				0%

Department of Genetic Engineering

EVALUATION OF SEMINAR PRESENTATIONS

Name of the Student: Date:

Register Number: Degree and Branch:

Topic:

Sl. No.	Criteria for Assessment	Evaluator 1	Evaluator 2	Evaluator 3	Evaluator 4	Evaluator 5
1	Understanding of the subject					
2	Clarity of presentation					
3	Appropriate use of audio visual aids					
4	Whether cross references have been consulted					
5	Ability to respond to questions on the subject					
6	Time scheduling					
7	Completeness of preparation					

Poor	1	Below Average	2	Average	3	Good	4	Very Good	5

Overall Grades:

Remarks:

Signature of Course Coordinator

15GN385L	Massive Open Online Courses (MOOCs) I	L	T	P	C
		0	0	3	2
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P Professional				
Course designed by	Department of Genetic Engineering				
Approval	32nd Academic Council Meeting held on 23rd July 2016				

PURPOSE	To offer students the opportunity to study with the world's best universities by integrating select MOOCs in a regular degree programme and providing students full credit transfer, as per university regulations, if they earn a "Verified / Completion Certificate" and take a proctored examination through a secure, physical testing center.

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able								
1.	To apply the concepts, theories, laws, technologies learnt herein to provide engineering solutions.	h	i	k	l			

Course nature		**Online - 100% internal continuous assessment.**				
Assessment Method (Weightage 100%)						
In-semester	**Assessment tool**	Quiz	Assignment	Non-proctored / Unsupervised Tests	Proctored / Supervised Test	**Total**
	Weightage	**25%**	**25%**	**10%**	**40%**	**100%**
End semester examination weightage :						**0%**

Registration process, Assessment and Credit Transfer:

1. Students can register for courses offered by approved global MOOCs platforms like edX, Coursera or Universities with which SRM partners specifically for MOOCs.
2. Annually, each department must officially announce, to the students as well as to the Controller of Examinations, the list of courses that will be recognised and accepted for credit transfer.
3. The department must also officially announce / appoint one or more faculty coordinator(s) for advising the students attached to them, monitoring their progress and assist the department in proctoring the tests, uploading the marks / grades, and collecting and submitting the graded certificate(s) to the CoE, within the stipulated timeframe.
4. Student who desires to pursue a course, from the above department-approved list, through MOOCs must register for that course during the course registration process of the Faculty of Engineering and Technology, SRM University.
5. The maximum credit limits for course registration at SRM will include the MOOCs course registered.
6. The student must periodically submit the marks / grades obtained in various quizzes, assignments, tests etc immediately to the Faculty Advisor or the Course Coordinator for uploading in the university's academic module.
7. The student must take the final test as a Proctored / Supervised test in the university campus.
8. The student must submit the "Certificate of Completion" as well as the final overall Marks and / or Grade within the stipulated time for effecting the grade conversion and credit transfer, as per the regulations. It is solely the responsibility of the individual student to fulfil the above conditions to earn the credits.
9. The attendance for this course, for the purpose of awarding attendance grade, will be considered 100% , if the credits are transferred, after satisfying the above (1) to (7) norms; else if the credits are not transferred or transferable, the attendance will be considered as ZERO

15GN386L	Massive Open Online Courses (MOOCs) II	L	T	P	C
		0	0	3	2
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL				
Course designed by	Department of Genetic Engineering				
Approval	32nd Academic Council Meeting held on 23rd July 2016				

PURPOSE	To offer students the opportunity to study with the world's best universities by integrating select MOOCs in a regular degree programme and providing students full credit transfer, as per university regulations, if they earn a "Verified / Completion Certificate" and take a proctored examination through a secure, physical testing center.

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able								
1.	To apply the concepts, theories, laws, technologies learnt herein to provide engineering solutions.	h	i	k	l			

Course nature		**Online - 100% internal continuous assessment.**				
Assessment Method (Weightage 100%)						
In-semester	**Assessment tool**	Quiz	Assignment	Non-proctored / Unsupervised Tests	Proctored / Supervised Test	**Total**
	Weightage	**25%**	**25%**	**10%**	**40%**	**100%**
End semester examination Weightage :						**0%**

Registration process, Assessment and Credit Transfer:

1. Students can register for courses offered by approved global MOOCs platforms like edX, Coursera or Universities with which SRM partners specifically for MOOCs.
2. Annually, each department must officially announce, to the students as well as to the Controller of Examinations, the list of courses that will be recognised and accepted for credit transfer.
3. The department must also officially announce / appoint one or more faculty coordinator(s) for advising the students attached to them, monitoring their progress and assist the department in proctoring the tests, uploading the marks / grades, and collecting and submitting the graded certificate(s) to the CoE, within the stipulated timeframe.
4. Student who desires to pursue a course, from the above department-approved list, through MOOCs must register for that course during the course registration process of the Faculty of Engineering and Technology, SRM University.
5. The maximum credit limits for course registration at SRM will include the MOOCs course registered.
6. The student must periodically submit the marks / grades obtained in various quizzes, assignments, tests etc immediately to the Faculty Advisor or the Course Coordinator for uploading in the university's academic module.
7. The student must take the final test as a Proctored / Supervised test in the university campus.
8. The student must submit the "Certificate of Completion" as well as the final overall Marks and / or Grade within the stipulated time for effecting the grade conversion and credit transfer, as per the regulations. It is solely the responsibility of the individual student to fulfil the above conditions to earn the credits.
9. The attendance for this course, for the purpose of awarding attendance grade, will be considered 100% , if the credits are transferred, after satisfying the above (1) to (7) norms; else if the credits are not transferred or transferable, the attendance will be considered as ZERO

15GN390L	Internship / Industrial Training I	L	T	P	C
		0	0	3	2
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P Professional Core				
Course designed by	Department of Genetic Engineering				
Approval	-32nd Academic Council Meeting held on 23rd July 2016				

PURPOSE	To provide short-term work experience in an Industry/ Company/ Organisation							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able								
1.	To get an inside view of an industry and organization/company	l	m					
2.	To gain valuable skills and knowledge	l						
3.	To make professional connections and enhance networking	k	j					
4.	To get experience in a field to allow the student to make a career transition	h						

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
1	It is mandatory for every student to undergo this course.				
2	Every student is expected to spend a minimum of 15-days in an Industry/ Company/ Organization, during the summer vacation.				
3	The type of industry must be NOT below the Medium Scale category in his / her domain of the degree programme.				
4	The student must submit the "Training Completion Certificate" issued by the industry / company / Organisation as well as a technical report not exceeding 15 pages, within the stipulated time to be eligible for making a presentation before the committee constituted by the department.				
5	The committee will then assess the student based on the report submitted and the presentation made. Marks will be awarded out of maximum 100. Appropriate grades will be assigned as per the regulations.		D, I,O	1,2,3,4	
6	Only if a student gets a minimum of pass grade, appropriate credit will be transferred towards the degree requirements, as per the regulations.				
7	It is solely the responsibility of the individual student to fulfill the above conditions to earn the credits. The attendance for this course, for the purpose of awarding attendance grade, will be considered 100%, if the credits are transferred, after satisfying the above (1) to (8) norms; else if the credits are not transferred or transferable, the attendance will be considered as ZERO.				
8	The committee must recommend redoing the course, if it collectively concludes, based on the assessment made from the report and presentations submitted by the student, that either the level of training received or the skill and / or knowledge gained is NOT satisfactory.				
	Total contact hours				

Course nature		Training – 100% internal continuous assessment		
Assessment Method (Weightage 100%)				
In-semester	**Assessment tool**	**Presentation**	**Report**	**Total**
	Weightage	**80%**	**20%**	**100%**
End semester examination weightage :				**0%**

15GN401	**Bioseparation Engineering**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P Professional Core				
Course designed by	Department of Genetic Engineering				
Approval	32nd Academic Council Meeting held on 23rd July 2016				

PURPOSE	The course provides a sound knowledge on the biomolecules separation from various biological systems. The detailed study with problematic approach on cell disruption of intracellular components, filtration, centrifugation. Determination of molecular weight of various methods, and protein structure prediction using mass spectrometry. Impart knowledge on recombinant protein purification strategies.

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Analyze the biological activity of the sample and calculate the purity of the protein	a	e	i	k			
2.	Design the centrifugation and filtration techniques	a	e	i	k			
3.	Understand the concept of precipitation and extraction methods	a	e	i	k			
4.	Choose suitable chromatographic techniques to purify the given protein sample	a	e	i	k			
5.	Design purification strategies for recombinant protein production.	a	e	i	k			

Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
	Unit I: Separation of Biomolecules - Introduction	**8**			
1.	Overview of unit operations involved in separation of biomolecules	1	C	1	1
2.	Problems and requirements of bioproduct purification	1	C,I	1	1
3.	Characteristics of biological mixtures	1	C	1	1
4.	Biological activity - analysis	2	C,I	1	1
5.	Purity of the products	2	C,I	1	1
6.	Process economics - capital and operating cost analysis	1	C,D	1	1
	Unit II: Cell Disruption and Product Separation	**10**			
7.	Cell disruption methods for intracellular products	2	C,I	2	1,2
8.	Flocculation	1	C,I	2	1,2
9.	Sedimentation	1	C,I	2	1,2
10.	Theory of filtration	1	C,D	2	1,2
11.	Batch and continuous filtration methods	2	C	2	1,2
12.	Theory of centrifugation techniques	1	C, D	2	1,2
13.	Continuous centrifugation: tubular and disc type centrifugation	2	C,I	2	1,2
	Unit III: Filtration, Precipitation and Extraction Techniques for Biomolecules	**10**			
14.	Membrane based separations - micro filtration and ultra-filtration theory	2	C	2	1,2
15.	Precipitation methods by salt and polymer	2	C,I	3	1,2
16.	Precipitation methods by organic solvent and isoelectric point	2	C,I	3	1,2

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
17.	Aqueous two-phase extraction	1	C	3	1,2
18.	Batch extraction	1	C,I	3	2
19.	Staged extraction	2	C,I	3	2
	Unit IV: Chromatographic and Electrophoretic Separation	**9**			1,2,4
20.	Working principle and application of SDS PAGE	1	C	4	1,3
21.	2D PAGE profiling for gene expression and gene silencing studies	2	C	4	1,3
22.	Ion exchange chromatography	1	C	4	1,3
23.	Gel filtration chromatography- molecular weight determination	2	C,I	4	1,3
24.	Hydrophobic and reverse phase chromatography	1	C	4	1,3
25.	FPLC: Instrumentation and analysis of result	2	C	4	3
	Unit V: Recombinant Protein Purification	**8**			
26.	Affinity taqs used for recombinant protein purification	1	C	5	3
27.	Choice of Affinity taqs: $(His)_6$Taq, GST, MBP, Strep-tag II	2	C	5	3
28.	Removal of taq using by enzymatic cleavage	1	C,I	5	3
29.	Problems of recombinant protein purification: Inclusion bodies and membrane bound proteins	2	C	5	3
30.	Refolding of solubilized recombinant proteins	2	C,I	5	3
	Total Hours	**45**			

LEARNING RESOURCES	
Sl.No.	**REFERENCES**
1.	Roger. G. Harrison. , Paul. W. Todd., Scott. R. Rudge. , Demetri Petrides, "*Bioseparation Science and Engineering",* 1st edition, Oxford University Press, 2003
2.	Belter. P.A., Cussler. E., "*Bioseparations",* New York : John Wiley, 1988
3.	Daniel. C. Liebler., "*Introduction to Proteomics – A tools to New biology",* Humana Press, 2007

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
					End semester examination weightage :		**50%**

15GN402	**Bioinformatics**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P Professional Core				
Course designed by	Department of Genetic Engineering				
Approval	32nd Academic Council Meeting held on 23rd July 2016				

PURPOSE	This course imparts fundamental knowledge of bio informatics, algorithms, tools and their applications. The study and learning on PERL, R and Python would enable the students to understand the scripting and programming which help in executing day- to- day research in biological data analysis and interpretations.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1	Know about databases and their use	a	c	i	l			
2	Understand sequence alignment and programming	a	c	i				
3	Analyze the protein sequence using bioinformatics tools	a	c	i				

4	Understand the use of PERL, Python in programming	a	c	i				
5	Gain exposure to R and learn to use in day- to- day research	a	c	i				

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Unit I: Biological Databases	**6**			
1.	Biological databases - primary sequence databases- Composite sequence databases - Secondary databases composite protein pattern databases - structure classification databases	3	C	1	1,5,7
2.	Genome Information Resources: DNA sequence databases - specialized genomic resources	2	C	1	1.5,7
3.	Gene prediction - tools and principles	1	C	1	1,5,7
	Unit II: Sequence Alignment	**10**			
4.	Database searching-algorithms and programs-comparing two sequences identity, similarity, gap penalties, edit distance	2	C	2	1,3,4,7
5.	BLAST -Variants	1	C	2	1,3,4,7
6.	Global alignments: Needleman - Wunsch Algorithm, local alignments: Smith Waterman Algorithm, PAM and BLOSUM scoring matrices	2	C	2	1,3,4,7
7.	Goal of multiple sequence Alignment - Computational complexity - manual Methods-Simultaneous methods progressive methods - viewing MSA	2	C	2	1,3,4,7
8.	Phylogenetic analysis: Concepts of trees, distance matrix methods, character based methods, construction of dendrogram - rooted and un - rooted tree representation - Phylogenetic trees - PHYLIP	3	C	2	1,3,4,7
	Unit III: Protein Analysis	**10**			
9.	Conserved domain analysis, Protein visualization tools	1	C	3	1,3,4,7
10.	Prediction of protein structure and function-secondary and tertiary structure, motifs and patterns	3	C	3	1,3,4,7
11.	Ramachandran plot - validation of the predicted structure using- Ramachandran plot and other stereochemical properties	3	C	3	1,3,4,7
12.	Study of protein - ligand interactions, docking with examples	2	C	3	1,3,4,7
13.	Protein target prediction, identification of active sites and functional domain	1	C	3	1,3,4,7
	Unit IV: Bioperl and Biopython	**12**			
14.	Using PERL to facilitate biological analysis - strings, numbers, variables- scalar, arrays and hashes.	3	C	4	6
15.	Basic input and output- File handles- Conditional Blocks and loops- Pattern matching- Arrays-Hashes.	3	C	4	6
16.	Bioperl scripts, examples with various applications.	2	C	4	6
17.	Biopython- variables, programming structure, scripts, examples with various applications.	4	C	4	6
	Unit V: Introduction to R	**7**			
18.	Introduction about R, Vectors, Matrices, Arrays, Lists, Data frames, factors and tables	2	C	5	2
19.	R programming structure, input output, string manipulation, doing math and simulations in R	2	C	5	2
20.	Introduction to Bioconductor R packages- use of different R packages for various applications- examples.	3	C	5	2
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Attwood.T.K., Parry-Smith D.J., "*Introduction to Bioinformatics*", 1st Edition, 11th Reprint, Pearson Education. 2005.
2.	Matloff. N., "*The Art of R Programming"*, No Starch Press, 2011.
3.	Murthy .C.S.V., "*Bioinformatics*", 1st Edition, Himalaya Publishing House.2003.
4.	Rastogi .S.C., Namita., M., Parag,R., "*Bioinformatics- Concepts, Skills, and Applications*", CBS Publishing. 2009.
	REFERENCE BOOKS/ OTHER READING MATERIALS
5.	Barnes. M. R., Gray I.C., "*Bioinformatics for Geneticists*", John Wiley. 2007.
6.	Online Sources: https://wiki.python.org/moin/BeginnersGuide/Programmers; https://en.wikibooks.org/wiki/Perl_Programming
7.	Mount D., "*Bioinformatics: Sequence and Genome Analysis"*, 2nd Edition, Cold Spring Harbor Laboratory Press, New York. 2004.

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
End semester examination weightage:							**50%**

15GN403	**Gene Therapy**	**L**	**T**	**C**	**P**
		2	**0**	**0**	2
Co-requisite:	NIL				
Prerequisite:	15GN307 Stem Cell Biology				
Data Book / Codes/Standards	NIL				
Course Category	P Professional Core				
Course designed by	Department of Genetic Engineering				
Approval	32nd Academic Council Meeting held on 23rd July 2016				

Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
	Unit I: Principles of Gene Therapy	**6**			
1.	Gene therapy – overview	1	C	1	1, 2
2.	Types of gene therapy - somatic and germ line, methods of gene therapy - Ex vivo and In vivo	1	C	1	1, 2
3.	Vectors for gene therapy - viral and non viral	1	C	1	1, 2
4.	Diseases with recessive heredity	1	C	1	1, 2
5.	Ex vivo gene therapy with case study - SCID	1	C	1	1,2
6.	In vivo gene therapy with case study - cystic fibrosis	1	C	1	1, 2
	Unit II: Somatic and Germline Gene Therapy	**6**			
7.	Embryo somatic gene therapy - reproductive cloning and therapeutic cloning	1	C	2	3, 4
8.	Preimplantation genetic diagnosis	1	C	2	3, 4
9.	Prenatal/fetal gene therapy with case study -Taysachs disease	1	C	2	3, 4
10.	Post natal somatic gene therapy, Germline gene therapy - methods and drawbacks	1	C	2	3, 4
11.	Suicide gene therapy	1	C	2	3, 4
12.	Secretion gene therapy	1	C	2	3, 4
13.	**Unit III: Gene Delivery Systems**	**6**			
	Methods for gene delivery - Physical, Chemical and Viral vectors-Briefly	1	C, D	3	2, 3
14.	Retroviral vectors	1	C, D	3	2, 3

15.	Adenoviral vectors	1	C, D	3	2, 3
16.	Adeno associated viral vectors	1	C, D	3	2, 3
17.	Herpes simplex viral vectors	1	C, D	3	2, 3
18.	Non viral vectors	1	C, D	3	2, 3
	Unit IV: Genome Editing in Gene Therapy	**6**			
19.	Zinc Finger Nucleases-ZNFs as gene editing tools	1	C, D	4	5
20.	TALENs as gene editing tools	1	C, D	4	5
21.	CRISPR/Cas9 as gene editing tools	2	C, D	4	5
22.	Types of therapeutic genome modifications-Gene disruption, Non homologous end joining - NHEJ gene correction	1	C, D	4	5
23.	Types of therapeutic genome modifications - Homology directed repair - HDR gene correction and HDR gene addition	1	C, D	4	5
	Unit V: Applications of Gene Therapy	6			
24.	Stem cells in gene therapy-gene therapy of haematopoietic stem cells	1	C	5	2, 3
25.	Treatment of genetic diseases - gene therapy of cancer	1	C	5	2, 3
26.	Treatment of genetic diseases - neurodegenerative disorders	1	C	5	2, 3
27.	Treatment of genetic diseases - eye diseases	1	C	5	2, 3
28.	Treatment of genetic diseases - cardiovascular disorders	1	C	5	2, 3
29.	Bone regeneration	1	C	5	2, 3
Total Hours		**45**			

LEARNING RESOURCES	
Sl.No.	**TEXT BOOKS**
1.	Evelyn B. Kelly, "*Gene Therapy*", Greenwood Press, 2007.
2.	Mauro Giacca, "*Gene Therapy*", Springer Milan, 2010.
	REFERENCE BOOKS/OTHER READING MATERIALS
3.	Peter J. Quesenberry, "*Stem cell biology and gene therapy*",John Wiley & Sons, 1998.
4.	Roland W. Herzog, "*A Guide to Human Gene Therapy*",World Scientific Publishing Co Pte Ltd, 2010.
5.	David Benjamin Turitz Cox et al "*Therapeutic genome editing: prospects and challenges*" Nature Medicine, Vol 21(2): 121-131, 2015.

Course nature		**Theory**					
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
End semester examination weightage :							**50%**

15GN404L	**Bioseparation Engineering Laboratory**	**L**	**T**	**P**	**C**
		0	**0**	**4**	**2**
Co-requisite:	15GN401 Bioseparation Engineering				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P Professional Core				
Course designed by	Department of Genetic engineering				
Approval	32nd Academic Council Meeting held on 23rd July 2016				

PURPOSE	This course should provide adequate hands on training on the techniques used to purify the proteins. It will help the students to choose proper methods to release the intracellular product. The students will acquire the knowledge on different types of chromatographic methods used for recombinant protein purification							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1	Choose proper cell disruption methods to release the intracellular product	a	b	i	e	k		

2	Concentrate the protein from the cell lysate	a	b	i	e	k		
3	Analyze the molecular weight of unknown protein using electrophoretic techniques	a	b	i	e	k		
4	Determine the molecular weight of unknown protein using electrophoretic and chromatographic techniques	a	b	i	e	k		

Session.	Description of Experiments	Contact hours	C-D-I-O	IOs	Reference
1.	Cell disruption by mechanical methods: Ultra sonication	4	C- I	1	1,2
2.	Cell disruption by mechanical methods: Homogenizer or glass beads	4	C- I	1	1,2
3.	Cell disruption – chemical or enzymatic methods	4	C- I	1	1,2
4.	Protein precipitation using salts and dialysis	8	C- I	2	1,2
5.	Protein precipitation using organic solvents	4	C- I	2	1,2
6.	Gel filtration chromatography: separation of proteins based on its size	8	C- I	3, 4	1,2
7.	Separation of proteins based on its charge using Ion exchange chromatography and chromotofocussing	8	C- I	4	1,2
8.	Purification of recombinant protein using affinity chromatography	8	C- I	4	1,2
9.	Separation of compounds using gas chromatography	4	C- I	4	1,2
10.	Separation and identification of compounds using HPLC	8	C- I	4	1,2
	Total contact hours	**60**			

LEARNING RESOURCES	
	REFERENCES
1.	Laboratory Manual
2.	Roe. S., "*Protein Purification Techniques: A Practical Approach (Practical Approach Series*", 2nd edition, Oxford publications, 2001

Course nature				**Practical**		
Assessment Method (Weightage 100%)						
In-semester	**Assessment tool**	Experiments	Record	MCQ/Quiz/Viva Voce	Model examination	**Total**
	Weightage	**40%**	**5%**	**5%**	**10%**	**60%**
				End semester examination weightage :		**40%**

15GN405L	**Bioinformatics Laboratory**	**L**	**T**	**P**	**C**
		0	**0**	**4**	**2**
Co-requisite:	15GN402 Bioinformatics				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P Professional core				
Course designed by	Department of Genetic engineering				
Approval	32nd Academic Council Meeting held on 23rd July 2016				

PURPOSE	This course imparts knowledge to the students on the practical use of bioinformatics tools to analyze nucleic acids and proteins.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1	Retrieve biological sequences from public databases and format conversions	a	i	l				
2	Perform Contig assembly and sequence alignments	a	i	l				
3	Subject the DNA sequences for the Reverse complement, ORF finding and	a	i	l				

	translation							
4	Efficiently use different types of BLAST for the research	a	i	l				
5	Learn protein structure prediction and molecular docking	a	i	l				

Session	Description of Experiments	Contact hours	C-D-I-O	IOs	Reference
1.	DNA and Protein sequence retrieval from public databases (NCBI, DDBJ and EBI)	4	C	1	1,2
2.	DNA Sequence formats and conversions: FASTA, FASTQ	4	C, D	1	1,3
3.	Basic DNA Sequence analysis: reverse complement, ORF Finder, Nucleotide sequence translation	4	C, D	3	1,3
4.	DNA Sequence assembly using Codon Code Aligner	8	C, D	2	1,4
5.	Variants of BLAST: BLASTn, BLASTx, BLASTp, psi-BLAST, tBLASTn, tBLASTx	8	C, D	4	1,5
6.	Multiple Sequence alignment and phylogenetic tree	8	C,D	2	1,6
7.	Protein secondary structure prediction methods: PSIPRED, Chou-Fasman, JPred and GOR	4	C,D	5	1,7
8.	Protein tertiary structure prediction methods using Homology modelling: Easy modeller and Swiss - Model	8	C,D	5	1,7
9.	Validation of predicted 3D structures: Ramachandran plot and RMSD	4	C,D	5	1,7
10.	Protein-ligand molecular docking: Rosetta and Swiss -Dock.	8	C,D	5	1,7
	Total contact hours	60			

LEARNING RESOURCES	
Sl. No.	**REFERENCES**
1.	Laboratory manual.
2.	http://www.ncbi.nlm.nih.gov/, http://www.ebi.ac.uk/, http://www.ddbj.nig.ac.jp/
3.	http://www.bioinformatics.org/sms2/
4.	http://www.codoncode.com/aligner/
5.	http://blast.ncbi.nlm.nih.gov/Blast.cgi
6.	http://www.ebi.ac.uk/Tools/msa/clustalo/
7.	Mount. D., "*Bioinformatics: Sequence and Genome Analysis"*, 2 nd Edition, Cold Spring Harbor Laboratory Press, New York, 2004.

Course nature			**Practical**			
Assessment Method (Weightage 100%)						
In-semester	**Assessment tool**	Experiments	Record	MCQ/Quiz/Viva Voce	Model examination	**Total**
	Weightage	**40%**	**5%**	**5%**	**10%**	**60%**
				End semester examination weightage :		**40%**

15GN490L	**Industry Module I**	**L**	**T**	**P**	**C**
		0	**0**	**3**	**2**
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P Professional Core				
Course designed by	Department of Genetic Engineering				
Approval	32nd Academic Council Meeting held on 23rd July 2016				

PURPOSE	To impart an insight into the current industrial trends and practices							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able								
1.	To obtain an insight into the current industrial trends and practices	1	m					

2.	To obtain an insight into the technologies adopted by industries	1	m					
3.	To obtain an insight into the technical problems encountered by the industries and the scope for providing solutions.	g						
4.	To network with industry	k						

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
1.	The department will identify and shortlist few emerging topics that are trending in industry.				
2.	The department will identify experts from industry who are willing to deliver modules on the shortlisted topics.				
3.	The identified expert will assist the department in formulating the course content to be delivered as a 30-hour module, prepare lectures notes, ppt, handouts and other learning materials.				
4.	The department will arrange to get the necessary approvals for offering the course, from the university's statutory academic bodies well before the actual offering.				
5.	The department must officially announce, to the students as well as to the Controller of Examinations, the list of courses that will be offered as industry module.				
6.	The department must also officially announce / appoint one or more faculty coordinator(s) for advising the students attached to them, monitoring their progress and assist the department in proctoring/supervising/assessment the quizzes, assignments, testsetc, uploading the marks, attendance etc, within the stipulated timeframe.		C,D,I,O	1,2,3,4	
7.	The student who desires to pursue a course, from the above department-approved list, must register for that course during the course registration process of the Faculty of Engineering and Technology, SRM University.				
8.	The maximum credit limits for course registration at SRM will include the Industry Module also.				
9	All academic requirements of a professional course like minimum attendance, assessment methods, discipline etc will be applicable for this Industry Module.				
10	The course will be conducted on weekends or beyond the college regular working hours.				
	Total contact hours	**30**			

Course nature				**100% internal continuous assessment.**			
Assessment Method – Theory Component (Weightage 50%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
End semester examination weightage :							**50%**

15GN491L	Industry Module II	L	T	P	C
		0	0	3	2
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL				
Course designed by	Department of Genetic Engineering				
Approval	32nd Academic Council Meeting held on 23rd July 2016				

PURPOSE	To impart an insight into the current industrial trends and practices							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able								
1.	To obtain an insight into the current industrial trends and practices	1	m					
2.	To obtain an insight into the technologies adopted by industries	1	m					
3.	To obtain an insight into the technical problems encountered by the industries and the scope for providing solutions.	g						
4.	To network with industry	k						

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
1	The department will identify and shortlist few emerging topics that are trending in industry.				
2	The department will identify experts from industry who are willing to deliver modules on the shortlisted topics.				
3	The identified expert will assist the department in formulating the course content to be delivered as a 30-hour module, prepare lectures notes, ppt, handouts and other learning materials.				
4	The department will arrange to get the necessary approvals for offering the course, from the university's statutory academic bodies well before the actual offering.				
5	The department must officially announce, to the students as well as to the Controller of Examinations, the list of courses that will be offered as industry module.		C,D,I,O	1,2,3,4	
6	The department must also officially announce / appoint one or more faculty coordinator(s) for advising the students attached to them, monitoring their progress and assist the department in proctoring/supervising/assessment the quizzes, assignments, tests etc, uploading the marks, attendance etc, within the stipulated timeframe.				
7	The Student who desires to pursue a course, from the above department-approved list, must register for that course during the course registration process of the Faculty of Engineering and Technology, SRM University.				
8	The maximum credit limits for course registration at SRM will include the Industry Module also.				
9	All academic requirements of a professional course like minimum attendance, assessment methods, discipline etc will be applicable for this Industry Module.				

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
10	The course will be conducted on weekends or beyond the college regular working hours.				
	Total contact hours	**30**			

Course nature		**100% internal continuous assessment.**					
Assessment Method – Theory Component (Weightage 50%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
End semester examination Weightage :							**50%**

15GN496L	**Major Project/ Practice School**	**L**	**T**	**P**	**C**
		0	**0**	**24**	**12**
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P	PROFESSIONAL CORE			
Course designed by	Department of Genetic Engineering				
Approval	32nd Academic Council Meeting held on 23rd July 2016				

PURPOSE	The major project experience is the culminating academic endeavor of students who earn a degree in their undergraduate Programs. The project provides students with the opportunity to explore a problem or issue of particular personal or professional interest and to address that problem or issue through focused study and applied research under the direction of a faculty member. The project demonstrates the student's ability to synthesize and apply the knowledge and skills acquired in his/her academic program to real-world issues and problems. This final project affirms students' ability to think critically and creatively, to solve practical problems, to make reasoned and ethical decisions, and to communicate effectively.

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able								
1.	To provide students with the opportunity to apply the knowledge and skills acquired in their courses to a specific problem or issue.	a	b	c	d	e	f	g
2.	To allow students to extend their academic experience into areas of personal interest, working with new ideas, issues, organizations, and individuals.	a	b	c	d	m	l	j
3.	To encourage students to think critically and creatively about academic, professional, or social issues and to further develop their analytical and ethical leadership skills necessary to address and help solve these issues.	a	b	c	d	j		
4.	To provide students with the opportunity to refine research skills and demonstrate their proficiency in written and/or oral communication skills.	a	b	c	d	h	k	
5.	To take on the challenges of teamwork, prepare a presentation in a professional manner, and document all aspects of design work.	i	k					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
1.	The Major project is a major component of our engineering curriculum: it is the culmination of the program of study enabling the students to showcase the knowledge and the skills they have acquired during the previous four years, design a product/service of significance, and solve an open-ended problem in engineering.		C,D,I,O	1,2,3,4, 5	
2.	Each student must register to the project course related to his or her program				
3.	Major Project course consists of one semester and would be				

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	allowed to register only during the final year of study.				
4.	The Major Project may be initiated during the pre-final semester but will be assessed and credits transferred only during the last semester of study, upon completion of all other degree requirements. Generally the undergraduate major project is a team based one.				
5.	Each team in the major project course will consist of maximum of 5 students.				
6.	Each project will be assigned a faculty, who will act as the supervisor.				
7.	The project shall be driven by realistic constraints like that related to economic, environmental, social, political, ethical, health & safety, manufacturability and sustainability.				
8.	Each group must document and implement a management structure. Group leadership roles must be clearly identified including who has responsibility for monitoring project deliverables and group coordination.				
9.	A group project may be interdisciplinary, with students enrolled in different engineering degrees, or in Engineering plus other faculties such as Management, Medical and Health Sciences, Science and Humanities.				
10.	Each student team is expected to maintain a log book that would normally be used to serve as a record of the way in which the project progressed during the course of the session.				
11.	Salient points discussed at meetings with the supervisor (i.e., suggestions for further meetings, changes to experimental procedures) should be recorded by the student in order to provide a basis for subsequent work.				
12.	The logbook may be formally assessed;				
13	The contribution of each individual team member will be clearly identified and the weightage of this component will be explicitly considered while assessing the work done.				
14.	A project report is to be submitted on the topic which will be evaluated during the final review.				
15.	Assessment components will be as spelt out in the regulations.				
16.	The department will announce a marking scheme for awarding marks for the different sections of the report.				
17.	The project report must possess substantial technical depth and require the students to exercise analytical, evaluation and design skills at the Appropriate level				
	Total contact hours				

Course nature		Project – 100 % Internal continuous Assessment			
Assessment Method (Weightage 100%)					
In-semester	Assessment tool	Review 1	Review 2	Review 3	Total
	Weightage	10%	15%	20%	45%
End semester examination	Assessment Tool	Project Report	Viva Voce		
	Weightage :	25%	30%		55%

LIST OF DEPARTMENT ELECTIVES

15GN314E	Human Physiology	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P Professional Elective				
Course designed by	Department of Genetic Engineering				
Approval	32nd Academic Council Meeting held on 23rd July 2016				

INSTRUCTIONAL OBJECTIVES		STUDENT OUTCOMES						
At the end of the course, student will be able to								
1.	Know the importance of experimental principles, blood clotting and physiology of circulation	a	b	c	j	l		
2.	Learn about the digestive and metabolic processes of macromolecules	b	d	l				
3.	Understand the major elements and concepts that constitute nervous and muscular systems	b	l					
4.	Gain knowledge on the working of endocrine hormones and their regulation	b	l					
5.	Gain knowledge on the excretory system and the physiological processes of reproduction	b	l					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Unit I: Blood and Circulatory System	**8**			
1.	Introduction to Physiology blood-composition and its functions	1	C	1	1,4
2.	Blood grouping and its significance	1	C,D,O	1	1,4
3.	Blood clotting mechanism – intrinsic pathway and extrinsic pathways	1	C	1	3
4.	Bleeding and clotting disorders	1	C,D	1	3
5.	Intra and extracellular fluids	1	C	1	1,2,3
6.	Interstitial fluid and odema	1	C,D	1	1,2,3
7.	Circulatory system – arteries, veins, blood capillary	1	C,D	1	1
8.	Structure of heart, systemic and pulmonary circulation	1	C,D	1	1
9.	Cardiac cycle, blood pressure – systolic and diastolic pressure.	1	C,D,O	1	2,4
10.	ECG and its significance	1	C,D,O	1	2,4
	Unit II: Gastrointestinal System	**6**			
11.	Alimentary system –accessory organs	1	C	2	1,2
12.	Structure and functions of the digestive organs	1	C	2	1,2
13.	Salivary secretions and its functions	1	C,D,O	2	1,2
14.	Gastrointestinal secretions	2	C,D,O	2	3
15.	Digestion and absorption of nutrients	1	C,D	2	3
	Unit III: Nervous and Muscular System	**12**			
16.	Nervous system – structure of a nerve cell, nerve fibre	1	C	3	2
17.	Central nervous system- brain and spinal cord, structure and function of different parts of brain	1	C	3	2
18.	Autonomic and sympathetic nervous system and their functions	2	C,D	3	2
19.	Neurotransmitters	2	C,D	3	2
20.	Membrane excitation and nerve impulse transmission	2	C	3	2,3
21.	Muscular system – striated, non-striated and cardiac muscle	2	C,D	3	2
22.	Muscular contraction	2	C,D	3	3
	Unit IV: Endocrine System	**10**			
23.	Introduction to endocrinology-hormones	2	C,D	4	1,3
24.	Pituitary gland	2	C,D	4	1,3

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
25.	Parathyroid glands	1	C	4	1,3
26.	Endocrine function of pancreas	2	C,D	4	1,3
27.	Adrenal cortex and medulla	1	C,D	4	1,3
28.	Endocrine function of other organs	1	C,D	4	1,3
29.	Local hormones	1	C,D	4	1,3
	Unit V: Renal and Reproductive System	**9**			
30.	Excretory organs, structure and functions of kidney	1	C	5	1,2
31.	Structure of nephron	1	C	5	1,2
32.	Formation of urine and normal and abnormal constituents of urine	2	C	5	1,2
33.	Male reproductive system	1	C	5	1,2,3
34.	Female reproductive system	1	C	5	1,2,3
35.	Menstruation, menopause and fertilization	2	C,D	5	1,2,3
	Total Hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Sembulingam P., Sembulingam K,*"Essentials of Medical Physiology"* , Jaypee Publications, 6th Edition. 2010.
2.	Jain A.K. "*Textbook of Physiology*", Avichal Publishing Company, 4th Edition, 2009.
	REFERENCE BOOKS/OTHER READING MATERIALS
3.	Guyton A.C. and Hall J.E., *"Medical Physiology",* Saunders Publications, 11thEdition, 2005.
4.	Muthayya, N.M., *"Human Physiology",* 4th edition, Jaypee Publications, 2010.

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
					End semester examination weightage :		**50%**

15GN315E	**Medical Biochemistry**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	E Professional Elective				
Course designed by	Department of Genetic Engineering				
Approval	32nd Academic Council Meeting held on 23rd July 2016				

PURPOSE	To make the students understand the clinical aspects of plasma enzymes and their diagnostic importance in several disorders. The course would give them a detailed idea about the biochemical and hormonal basis of metabolic disorders and inborn errors of metabolism.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Gain fundamental understanding of biological fluids and their biochemical functions.	a	b					
2.	Acquire knowledge on hormones and their biochemical functions.	a	b	c				
3.	Understand the mechanism of drug metabolism	a	b	c				
4.	Understand about the biochemical basis of some metabolic disorders and its diagnosis	a	b	c	f			

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Unit I: Body Fluids and Components	**8**			
1.	Introduction –overview of the course	1	C	1	1, 3
2.	Composition of blood and plasma components	1	C	1	3
3	Collection of blood, anticoagulants and preservatives	1	C,D,I, O	1	3
4	Transport of oxygen and carbon dioxide in blood and body fluids	2	C	1	1, 3
5	Acid-base balance of the body	2	C	1	1, 3
6	Renal mechanisms for regulation of acid-base balance	1	C	1	1, 3
	Unit II: Disorders of Metabolism	**12**			
7	Disorders of carbohydrate metabolism - Diabetes mellitus	2	C	4	1
8	Glucose tolerance test	1	C,D,I, O	4	1
9	Glycogen storage diseases	1	C	4	1
10	Disorders of lipid metabolism- physiologic importance of lipid and lipoproteins, sphingolipidosis	2	C	4	1
11	Multiple sclerosis	1	C	4	1
12	Apo lipoproteins and familial hypercholesteremia	1	C	4	1
13	Disorders of aminoacid metabolism- phenylalanemia, homocystinuria	1	C,D,I	4	1
14	Tyrosinemia, MSUD	1	C,D,I	4	1
15	Phenylketonuria, alkaptonuria	1	C,D,I	4	1
16	Albinism and animoacidurias	1	C,D,I	4	1
	Unit III: Xenobiotics and Drug Metabolism	**7**			
17	Metabolic transformation of Xenobiotics	**1**	C	3	1, 4
18	Drug metabolizing enzymes	2	C	3	1, 4
19	Mechanism of drug action. Phases of detoxification–phase I-oxidation, reduction, hydrolysis	1	C	3	1, 4
20	Phase II- conjugation, phase III- excretion	2	C	3	1, 4
21	Factors that affects drug metabolism	1	C	3	1, 4
	Unit IV: Endocrine Hormones and Disorders	**9**			
22	General mechanism of action of hormones	2	C	2	1,2
23	Chemistry, functions of hormones	2	C	2	1,2
24	Disorders of Growth hormone- pituitary dwarfism. Gigantism and acromegaly	1	C	2	1,2
25	Disorders of thymusgland-DiGeorge syndrome	1	C	2	1,2
26	Disorders of thyroid hormone – Myxoedema and Grave’s disease	1	C	2	1,2
27	Disorders of adrenalsteroids- Addison'sdisease and Cushing's syndrome	1	C	2	1,2
28	Hypo and hyper secretion of PTH, insulin and glucagon	1	C	2	1,2
	Unit V: Clinical Diagnosis	**9**			
29	Function of liver	1	C	4	1
30	Liver function tests -test based on the abnormalities of bile pigment metabolism and excretory function of liver.	1	C,D,I	4	1
31	Renal disorders, kidney function tests –urea clearance test and creatine clearance test.	2	C,D,I	4	1
32	Gastric function tests-Resting contents, fractional gastric analysis, stimulation test.	1	C,D,I	4	1
33	Principles of diagnostic enzymology, Clinical significance of diagnostic enzymes – Aspartate amino transferase, alanine amino transferase	2	C,D,I	4	1
34	Creatine kinase,aldolase	1	C,D,I	4	1

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
35	Lactate dehydrogenase	1	C,D,I	4	1
	Total Contact hours	**45**			

LEARNING RESOURCES	
Sl.No.	**TEXT BOOK**
1.	Chatterjee. M.N., Rana Shinde, "*Textbook of Medical Biochemistry"*, 7th Edition, Jaypee Brothers, Medical Publishers Pvt. Limited, New Delhi,2007.
	REFERENCE BOOKS/OTHER READING MATERIALS
2.	Bhagavan.N.V, "*Medical Biochemistry"* 4th Edition, Academic Press Publishers, 2001.
3.	Burtis. C.A., Ashwood. E.R., *"Tietz Fundamentals of Clinical Chemistry"*, 5th Edition, St. Louis : Saunders Elsevier,2001.
4.	Gibson. G.G., Paul SkettFil.,"*Introduction to Drug Metabolism*", 1st Edition, Chapman and Hall ,1986.

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
						End semester examination weightage :	**50%**

15GN316E	**Plant Physiology**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P Professional Elective				
Course designed by	Department of Genetic Engineering				
Approval	32nd Academic Council Meeting held on 23rd July 2016				

PURPOSE	This course introduces the fundamentals of plant physiology. It discusses the basic activities of a plant like transpiration, photosynthesis, respiration, photoperiods and its interaction with environment.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Gain knowledge on basic physiological aspects of transpiration, respiration and photosynthesis	a	b	c				
2.	Acquire knowledge on the applied aspects of plant stress physiology	a	b	c				
3.	Gain a holistic approach on research related to plant genetic manipulation and plant - environment interaction	a	b	c				

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Unit I: Absorption of Water and Transpiration	**8**			
1.	Terms-colloids, permeability, diffusion, osmosis, water potential, imbibitions and plasmolysis	1	C	1	3
2.	Water absorption by plants-mechanism of water absorption	2	C	1	1,3
3.	Transpiration, evaporation and guttation	1	C	1	1,3
4.	Mechanism of transpiration; kinds of transpiration; stomata-diffusion through stomata, theory of starch glucose interconversion, Stomata opening and closing theory of photosynthesis in guard cells, theory of glycolate metabolism, Theory of proton transport and hormonal regulation;	3	C	1	1,3

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
5.	Anti transpirants	1	C	1	3
	Unit II: Growth and Mineral Nutrition	**10**			
6.	Growth regions and phases	1	C	1	3
7.	Role of auxin-apical dominance and cell division, shoot and root growth, xylem differentiation	2	C	1,2	2
8.	Gibberellins-biosynthesis and translocation, mechanism of action	2	C	1,2	2
9.	Cytokinins- biosynthesis and translocation, applications of cytokinins	2	C	1,2	2
10.	Biosynthesis, translocation and role of abscisic acid, Introduction to ethylene	1	C	1,2	2
11.	Mineral nutrition- solution, sand and hydrophonics culture and Mechanism of mineral salt absorption.	2	C	1,2,3	3
	Unit III: Photosynthesis and Nitrogen Metabolism	**10**			
12.	Structure of chloroplast, photosynthetic pigments C2 cycle	2	C	1	1,2,3
13.	C3 cycle	2	C	1	1,2,3
14.	C4 cycle	2	C	1	1,2,3
15.	CAM cycle, Respiration-significance of photorespiration	2	C	1	1,2,3
16.	Nitrogen fixation symbiotic and asymbiotic nitrogen fixation.	2	C	1,2,3	1,2,3
	Unit IV: Photobiology and Photoperiodism	**8**			
17.	Principles of Photoperiodism and photoperiodic response groups	1	C	3	5
18.	Photoperiodic timekeeping – Circadian rhythms	1	C	3	5
19.	Photoperiodic photoreceptors	1	C	3	5
20.	Day length perception in short day and long day plants	1	C,D	3	5
21.	Photoperiodic control of development – floral development bud dormancy	2	C,D	3	5
22.	Genetic approaches to photoperiodism	2	C	3	5
	Unit V: Stress Physiology	**9**			
23.	Reactive oxygen species and oxidative stress in plants	2	C	2	4
24.	Salinity stress	1	C,D	2	4
25.	Chilling stress	1	C	2	4
26.	Heat stress	1	C	2	4
27.	Heavy metal toxicity in plants	2	C	2	4
28.	Biotic stress tolerance.	2	C,D	2	4
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOK**
1.	Varma.V.K and Mohit Varma, "*Text book of plant physiology, biochemistry and biotechnology*", S Chand ltd 2008.
	REFERENCE BOOKS/ OTHER READING MATERIALS
2.	Frank Salisbury and Cleon Ross, "*Plant Physiology*", Brooks Cole; 4thedition ,1991.
3.	S N Pandey and B K Sinha, "Plant Physiology" Vikas Publishing House Pvt Ltd, 4th Edition 2005.
4.	Sergey Shabala, "Plant Stress Physiology" CAB International, 2012.
5.	Brain Thomas and Daphne Vince-prue, "Photoperiodism in plants" Academic Press, 2nd edition, 1975.

Course nature			**Theory**				
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
					End semester examination Weightage :		**50%**

15GN317E	Plant Systematics	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P Professional Elective				
Course designed by	Department of Genetic Engineering				
Approval	32nd Academic Council Meeting held on 23rd July 2016				

PURPOSE	The course should help the students to understand the basics of plant systematics like diversity of plants, DNA barcoding, and databases. This course facilitates the students to troubleshoot the real time problems in identifying the plants with the help of their knowledge acquired on plant classification.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Understand about plant systematics and its applications.	a	b	c				
2.	Acquire knowledge on diversity of plants	a						
3.	Have the ability to understand the concepts of DNA barcoding	a	b	c				
4.	Know about various resources in plant systematics	a	b					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Unit I: Introduction to Plant Systematics	**9**			
1.	Two kingdom system	1	C	2	1,2
2.	Five kingdom system	1	C	2	1,2
3.	Overview of plant systematics, basic components of systematics	2	C	1-2	1,2
4.	Systems of classification – artificial, natural and phylogenetic	2	C	1,2	1,2
5.	Botanical nomenclature: The international code of botanical nomenclature	2	C	4	1,2
6.	Principles, rules and recommendations.	1	C	4	1,2
	Unit II: Evolution and Diversity of Plants	**8**			
7.	Evolution and diversity of green and land plants	1	C	1,2	1,2
8.	Vascular plants, woody, seed plants, flowering plants	2	C	1,2	1,2
9.	Diversity and classification of flowering plants: amborellales, nymphaeales	2	C	1,2	1,2
10.	Austrobaileyales, magnoliids, ceratophyllales	2	C	1,2	1,2
11.	Monocots and eudicots	1	C	1,2	1,2
	Unit III: Systematic Evidence and Descriptive Terminology	**8**			
12.	Plant morphology	1	C	1,2	1,2
13.	Plant anatomy	2	C	1,2	1,2
14.	Physiology	1	C	1,2	1,2
15.	Plant embryology	1	C	1,2	1,2
16.	Plant reproductive biology	2	C	1,2	1,2
17.	Plant molecular systematics	1	C	1,2	1,2
	Unit I: Resources in Plant Systematics	**10**			
18.	Floras, monographs, manuals, herbaria,	2	C,D	1,2,4	1,2
19.	Bibliographies, catalogues, taxonomic index, keys for	2	C	1,2,4	1,2

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	identification.				
20.	Introduction to flora of India	1	C	1,2,4	1,2
21.	Endemic and end dangered species, Red data Book	2	C	1,2,4	1,2
22.	Role of botanical survey of India.	2	C	1,2,4	1,2
23.	Botanical garden.	1	C	1,2,4	1,2
	Unit V: Molecular Taxonomy	**10**			
24.	Molecular approaches to plant taxonomy	1	C	1,3	1,2
25.	DNA markers in plant taxonomy	2	C	1,3	1,2
26.	DNA Barcoding, the concept of DNA barcoding	2	C	3	3,4
27.	Chloroplast and nuclear markers for DNA barcoding	2	C	3	3,4
28.	Barcoding gap, species discrimination ability	1	C	3	3,4
29.	DNA barcoding databases, applications of DNA barcoding in authentication	1	C,D	3	3,4
30.	Cryptic species discovery	1	C	1,3	3,4
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOK**
1.	Michael G. Simpson., "*Plant Systematics*", Academic Press, 2 nd Edition, 2010.
	REFERENCE BOOKS/ OTHER READING MATERIALS
2.	Gurcharan Singh., "*Plant Systematics: An Intergrated Approach*". CRC Press, 3rd Edition 2010.
3.	John Kres.,W .and David L. Erickson "*DNA Barcodes: Methods and Protocols"*. Humana Press, 2012.
4.	Frederic P. Miller, Agnes F. Vandomeand John McBrewster. "*DNA Barcoding: Taxonomy, Species, Molecular Phylogenetics, Consortium for the Barcode of Life, Identification (biology), Eukaryote, Mitochondrion"*. VDM Publishing, 2009.

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
					End semester examination weightage :		**50%**

15GN318E	**Microbial Physiology**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P Professional Elective				
Course designed by	Department of Genetic Engineering				
Approval	32nd Academic Council Meeting held on 23rd July 2016				

PURPOSE	This course introduces the fundamentals of microbial genetics through the study of the characteristics of microorganisms, multiplication, growth kinetics, gene transfer methods, mutation and phage life cycle.						
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**					
At the end of the course, student will be able to							
1.	Study about the structure and organization of microbes	a					
2.	Study about energy generation pathways in microbes	a	b	e			
3.	Gain knowledge about microbial communication	a	b	e			
4.	Study about metabolic pathways in microbes	a	b	e			

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Unit I: Introduction to Microbial Physiology	**4**			
1.	Factors affecting microbial growth – nutrient availability	1	C,D	1	1,3
2.	Gaseous requirements	2	I,O	1	3
3.	Growth of microbes in extreme conditions	1	C,D,I	1	3
	Unit II: Cell Structure and Function	**11**			
4.	Bacterial nucleus and its organization	2	C	1	1
5.	Capsules and biofilms	2	C,D,I	1	1
6.	Cell wall organization of Gram positive, Gram negative bacteria and archea	6	C,D,I	1	1
7.	Quorum sensing and chemotaxis, outer membrane proteins and antigens	1	C,D	1	1
	Unit III: Energy Production Pathways and Metabolite Transport	**10**			
8.	Aerobic and anaerobic bioenergetics	1	C,I	2	1
9.	Structural organization of membrane transporters	2	C,D,I	1,2	1
10.	Mechanisms of metabolite transport – Facilitated diffusion, ABC transporters, ion channels involved in transport	2	C,D	1	1
11.	Transport systems for uptake of iron, phosphoenol pyruvate transporters	3	D,I,O	1	1,3
12	Proton pumps, and efflux pumps	2	D,I	2	
	Unit IV: Metabolic Regulation	**10**			1,2
12.	Mechanisms of regulation on enzyme synthesis	2	C,D	3	1,2
13.	Catabloite repression	2	C,D	3	1
14.	Two component systems and regulator proteins	2	C,D,I	3	1,3
15.	Autogenous regulation	2	C,D,I	3	2
16.	Global regulation and secondary metabolites	2	C,I	3	2
	Unit V: Microbial Stress Responses	**10**	C,D,I		
17.	Heat stress, osmotic stress, oxidative stress	3	C,I	4	1,2
18.	pH stress and acid tolerance, ethanol stress proteins	3	C,D,I	4	1,2
19.	Nutrient stress and starvation stress response	2	D,I	4	1,2
20.	Stress adaptation mechanisms	2	D,I	4	1,2
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Moat, A.G, Foster, J.W, Spector, J.P "*Microbial Physiology*" 4th edition, Wiley Liss Publishers, 2003.
2.	Kim, B. H, Gadd , G.M "*Bacterial Physiology and Metabolism*",1st edition, Cambridge University Press, 2008.
	REFERENCE BOOK/ OTHER READING MATERIAL
3.	Sherwood. L, Joanne, M.W, Woolverton. C "*Prescott's Microbiology*, 9th edition, McGraw Hill Education, 2010.

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
					End semester examination weightage :		**50%**

15GN319E	Microbial Systematics	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P Professional Elective				
Course designed by	Department of Genetic Engineering				
Approval	32nd Academic Council Meeting held on 23rd July 2016				

PURPOSE	This course introduces the fundamentals of classification of microorganisms through the study of the characteristics of microorganisms, genetic relatedness, biochemical and antigenic characteristics

INSTRUCTIONAL OBJECTIVES	**STUDENT OUTCOMES**						
At the end of the course, student will be able to							
1. Understand about the classification scheme of microbes	a						
2. Identify unknown microbes and classify them	a	b	e				
3. Study different forms of microbes and its distribution	a	b	e				
4. Use molecular methods used to classify microbes	a	b	e				

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Unit I: Introduction to Microbial Classification	**11**			
1.	Classification scheme for bacteria	1	C	1	1,2
2.	Concepts of taxonomy, characterization	1	C,D	1	1,2
3.	Concepts of classification and nomenclature	2	C,D	2	1,2
4.	Classification of microorganisms -three domain and six kingdom systems	2	C,D	1,3	1,2
5.	Classifcation based on phenotypic characters- morphology, biochemical tests	2	C,I	2	1,2
6.	Classification of microorganisms based on API, BIOLOG	2	C,D	2	1,2
7.	Bacteriphage typing and serotyping	1	C	2	1,2
	Unit II: Methods Used in Microbial Classification	**10**			
8.	Chemotaxonomic markers-cell wall components, lipid composition	2	C	2,4	1
9.	Cellular fatty acid (FAME), isoprenoid and quinolone analysis	2	C,D,I	2,4	1
10.	Protein profile analysis using MALDI-TOF, cytochrome composition	2	C,D,I	2,4	1
11.	Nucleic acid based techniques (GC content), DNA hybridization	2	C,D	2,4	1
12.	16 S rRNA gene sequencing and phylogenetic analysis	2	C,D	2,4	1
	Unit III: Classification of Bacteria	**10**			
13.	Concept of species, numerical and polyphasic taxonomy	2	C	1,3	1,2
14.	Salient features, phylum ,class and orders of Archea	2	C,D,I	1,3	2,4
15.	Salient features of Eubacteria and Actinomycetes	2	C,D	2	2,4
16.	Salient features Gram negative, rod shaped aerobic bacteria	2	D,I,O	2	4
17.	Salient features Gram positive endospore forming rod shaped bacteria	2	I,O	2	4
	Unit IV: Structure and Classification of Viruses	**8**			
18.	Salient features, classification of viruses	1	C	1	3
19.	Nomenclature, morphology and chemical composition	2	C,D	2,3	3
20.	Classification of DNA viruses, RNA viruses	2	C,D	2,3	3
21.	Satellites, viriods and prions	2	C,I	1	3
22.	Diagnosis methods of viruses	1	C,D,I	2,4	3
	Unit V: Classification of Fungi , Algae and Cyanobacteria	**6**			
23.	Taxonomy of fungi	2	C,D,I	1	1,2
24.	Salient features of fungi	1	C,D,I	1	1,2
25.	Classification of microalgae	1	C,I	2,3	1,2

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
26.	Classification of macroalgae	1	C,D,I	2,3	1,2
27.	Classification of cyanobacteria	1	C,I	2,3	1,2
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Sherwood. L, Joanne, M.W, Woolverton. C "*Prescott's Microbiology"*, 9th edition, McGraw Hill Education, 2010.
2.	Pelczar, M.J, Chan, E.C.S, Kreig, N.R "*Microbiology*", 5th edition, McGraw Hill Publishers, 1998.
3.	Dimmock, N.J, Easton, A.J, Leppard, K.N, "*Introduction to Modern Virology*", 7th edition, Wiley Blackwell, 2015.
	REFERENCE BOOK/ OTHER READING MATERIAL
4.	Holt, J.G, Kreig, N.R, Sneath, P.H.A, Stanley, J.T, Williams, S.T , " *Bergey's Manual of Determinative Bacteriology* " 9th edition, Lippincott Williams & Wilkins publishers, 1994.

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
					End semester examination weightage :		**50%**

15GN320E	**Genes and Diseases**			**L**	**T**	**P**	**C**
				3	**0**	**0**	**3**
Co-requisite:	NIL						
Prerequisite:	NIL						
Data Book / Codes/Standards	NIL						
Course Category	P	Professional Elective					
Course designed by	Department of Genetic Engineering						
Approval	32nd Academic Council Meeting held on 23rd July 2016						

PURPOSE	The course should help the students to understand about the genes that control or influence the heritable human diseases and the pattern of inheritance of heritable diseases. It will help them to learn about the different types of metabolic disorders and help them to obtain knowledge on genetic counseling and genetic databases.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Understand about genetic factors responsible for different type of heritable diseases.	b						
2.	Learn about the genetics and treatment options of diseases related to autosomal disorder.	a	b					
3.	Learn about the genetics and treatment options for allosomal and mitochondrial disorders.	a	b					
4.	Learn about the genetics and treatment options for different chromosomal disorders.	a	b					
5.	Acquire knowledge on genetics database and genetic counseling to prevent genetic disorders	a	b					

Session	Description of topic	Contact hours	C-D-I-O	IOs	Reference
	Unit I: Introduction	**8**			
1.	Introduction to genetic versus non-genetic diseases. Importance of the genetics of heritable diseases	1	C	1	2
2.	Dominance, recessive and co-dominance	1	C	1	2
3.	Autosomal and sex-linked, multifactorial and polygenic (complex) disorders.	2	C	1	2
4.	FINDbase (the Frequency of Inherited Disorders Database). Genetic epidemiology	2	C	1	2
5.	Human gene mutation database, Single Nucleotide Polymorphisms (dbSNP) database	2	C	1	2
	Unit II: Autosomal Diseases	**12**			
6.	Blood - Thalassemia, Sickle cell disease	3	C	2	1
7.	Inborn errors of Metabolism - Phenylketonuria, Maple syrup urine disease	2	C	2	1
8.	Respiratory system - Cystic fibrosis, Alpha-1 antitrypsin deficiency	2	C	2	1
9.	Nervous System – Huntington's disease, Parkinson's disease, Alzheimer's disease	2	C	2	1
10.	Eye Disorders – Glaucoma, Retinoblastoma, Best disease	3	C	2	1
	Unit III: Allosomal & Mitochondrial Diseases	**8**			
11.	X –Linked **:** Hemophilia, G6PD deficiency, Fragile X syndrome, Rettsyndrome,Duchene muscular dystrophy Y Linked**:** Male Infertility	4	C	3	1
12.	Mitochondrial diseases - Leber's hereditary optic neuropathy	1	C	3	1
13.	Mitochondrial diseases - Deafness, Diabetes mellitus	3	C	3	1
	Unit IV: Chromosomal Disorders	**8**			
14.	Turner's syndrome, Down syndrome, Klinefelter's syndrome	3	C	4	1
15.	Prader -willi syndrome, Angelman syndrome, Williams syndrome	2	C	4	1
16.	Edward's syndrome , Patau syndrome, Cri-du-chat syndrome	2	C	4	1
17.	XYY Syndrome, X-Trisomy	1	C	4	1
	Unit V: Genetic Diseases – Information and Counseling	**9**			
18.	Genetic Testing, Genetic diseases prevention, Genetic Counseling.	2	C,D,I	5	3
19.	Pharmacogenomics, Genetic and rare disease information center.	3	C,D.I	5	3
20.	OMIM - online Mendelian Inheritance in Man, a catalog of human genes and genetic disorders.	2	C,D,I	5	3
21.	Genetic disease information from the human genome project. Global genes project, Genetic and rare diseases organization.	2	C,D,I	5	3

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Genes and Diseases, NCBI Bookselfhttp://www.ncbi.nlm.nih.gov/books/bookres.fcgi/gnd/tocstatic.html
2.	Tom S., and Andrew P. R., "*Human Molecular Genetics*", 2nd Edition NewYork ; Willy: Liss, 1999
	REFERENCE/ OTHER READING MATERIAL
3.	Pagon R.A. *et al.*,"*GeneReviews*™ [Internet]".Seattle (WA): University of Washington, Seattle; 1993-2016. Available from:http://www.ncbi.nlm.nih.gov/books/NBK1116/.

Course nature				Theory			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
						End semester examination weightage :	**50%**

15GN321E	**Developmental Genetics**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	E Professional elective				
Course designed by	Department of Genetic Engineering				
Approval	32nd Academic Council Meeting held on 23rd July 2016				

PURPOSE	The course gives detailed knowledge on animal embryology and developmental genetics. It gives complete understanding on the patterning of the body plan, organogenesis, sex determination, regeneration and ageing.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Learn about basics of developmental genetics	b	c	l				
2.	Learn about body patterning in *Drosophila* and *Xenopus*	b	c	l				
3.	Gain detailed understanding of morphogenesis and organogenesis	b	c	l				
4.	Learn about sex determination and regeneration	b	c	l				
5.	Learn about growth and ageing in animals	b	c	l				

Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
	Unit I: Introduction to Developmental Genetics	**5**			
1.	History of Developmental Biology	1	C	1	1
2.	Cellular basis of development	2	C	1	1
3.	Embryological origins of gene theory	1	C	1	1
4.	Genomic equivalence	1	C	1	1
	Unit II: Early Development in Drosophila	**10**			
5.	Drosophila life cycle	1	C	2	1,2
6.	Fertilization, cleavage and gastrulation	2	C	2	1,2
7.	Axis formation during oogenesis	1	C	2	1,2
8.	Role of maternal factors in development	1	C	2	1,2
9.	Generating dorsal-ventral pattern in the embryo	2	C	2	1,2
10.	Segmentation and anterior-posterior body plan	2	C	2	1,2
11.	Segmentation genes	1	C	2	1,2
	Unit III: Early Development in Xenopus	**10**			
12.	Fertilization, cortical rotation and cleavage	2	C	3	1,2
13.	Gastrulation in *Xenopus*	2	C	3	1,2
14.	Determination of Amphibian axis	2	C	3	1,2
15.	Molecular mechanism of amphibian axis formation	2	C	3	1,2
16.	Organizer and epidermal inducers	2	C	3	1,2
	Unit IV: Organogenesis	**10**			
17.	Formation of the neural tube	1	C	4	1
18.	Differentiation of the neural tube	1	C	4	1
19.	Neuronal diversity and axonal specificity	2	C	4	1
20.	Formation of the somites	1	C	4	1
21.	Differentiation of the somites	1	C	4	1
22.	Development of kidney tissue	1	C	4	1

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
23.	Heart development	1	C	4	1
24.	Digestive tube and its derivatives	1	C	4	1
25.	Development of respiratory tube	1	C	4	1
	Unit V: Growth and Ageing	**10**			
26.	Stem cells and stem cell niches	2	C	5	1,2
27.	Amphibian metamorphosis	1	C	5	1,2
28.	Insect metamorphosis	1	C	5	1,2
29.	Epimorphic regeneration	1	C	5	1
30.	Morphallactic regeneration	1	C	5	1
31.	Regeneration in mammals	1	C	5	1
32.	Biology of senescence	1	C	5	1
33.	Genetic causes of ageing	2	C	5	1
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOK**
1.	Gilbert, S.F., "*Developmental Biology*", 10th edition, Sinauer Associates, 2013.
	REFERENCE BOOK/ OTHER READING MATERIAL
2.	Wolpert, L., Tickle, C., Arias, A.M., "*Principles of Development*", 5th edition, Oxford University Press, 2015.

Course nature			**Theory**				
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
					End semester examination weightage :		**50%**

15GN322E	**Plant Biochemistry**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	E Professional elective				
Course designed by	Department of Genetic Engineering				
Approval	32nd Academic Council Meeting held on 23rd July 2016				

PURPOSE	To make the students understand the clinical aspects of plasma enzymes and their diagnostic importance in several disorders. The course would give them a detailed idea about the biochemical and hormonal basis of metabolic disorders and inborn errors of metabolism.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Gain knowledge on the metabolite function and biogenesis.	a	b					
2.	Provide a platform for students to investigate metabolic pathways in plants.	a	b	c				
3.	Help students to manipulate a pathway for any desired product	a	b	c	d			

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Unit I: Carbohydrate Metabolism	**8**			
1.	Biosynthesis and functions of sucrose	2	C	1,2,3	1
2.	Biosynthesis and functions of trehalose and other oligosacharides	2	C	1,2,3	1
3.	Fructans metabolism	1	C	1,2,3	1
4.	Starch metabolism , other reserve polysaccharides	1	C	1,2,3	1
5.	Plant cell wall polysaccharides	2	C	1,2	1
	Unit II: Nitrogen Metabolism	**10**			
6.	Nitrogen fixation	1	C	1,2,3	1
7.	Nitrate uptake and reduction	1	C	1,2,3	1
8.	Ammonia assimilation – asparagine metabolism – aspartate family	2	C	1,2,3	1
9.	Branched chain amino acids	1		1,2,3	1
10.	Biosynthesis of proline and arginine	1	C	1,2,3	1
11.	Sulfur amino acids and histidine	1	C	1,2,3	1
12.	Non-protein amino acids	1	C	1,2,3	1
13.	Cyanogenic glycosides and glucosinolates, auxins, cytokinins and ethylene	2	C	1,2,3	1
	Unit III: Lipid Metabolism	**8**			
14.	Fatty acid biosynthesis	2	C	1,2,3	1
15.	Triacylglycerol synthesis	2	C	1,2,3	1
16.	Membrane lipid biogenesis	2	C	1,2,3	1
17.	Lipid catabolism	1	C	1,2,3	1
18.	Cutins, suberins and waxes	1	C	1,2,3	1
	Unit IV: Alkaloid and Terpenoid Metabolism	**10**			
19.	General pathway of alkaloid	2	C	1,2,3	1,2
20.	Mono terpenoid indole alkaloids	1	C	1,2,3	1,2
21.	Tropane alkaloids – benzyl isoquinoline alkaloids – bisbenzyl isoquinoline alkaloids	2	C	1,2,3	1,2
22.	General pathway of terpenoid biosynthesis – monoterpenoids	1	C	1,2,3	1,2
23.	Sesqui terpenoids – diterpenoids – triterpenoids	2	C	1,2,3	1,2
24.	Carotenoids – polyterpenoids – minor classes of terpenoids – control and compartmentation of isoprenoid biosynthesis	2	C	1,2,3	1,2
	Unit V: Metabolism of Flavanoid, Lignins and Quinones	**9**			
25.	Shikimate/arogenate pathway	1	C	1,2,3	1,2
26.	Phenylalanine/hydroxycinnamate pathway	1	C	1,2,3	1,2
27.	Phenylpropanoid pathways	1	C	1,2,3	1,2
28.	Hydroxy cinnamate conjugates – Hydroxycoumarins – Hydroxybenzoates	2	C	1,2,3	1,2
29.	Flavonoids	2	C	1,2,3	1,2
30.	Lignins – lignans and neolignans	1	C	1,2,3	1,2
31.	Tannins – quinones	1	C	1,2,3	1,2
	Total Contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOK**
1.	P.M. Dey, J.B. Harborne , "*Plant Bio Chemistry*" 1st Edition Academic Press, 1997
	REFERENCE BOOK/ OTHER READING MATERIAL
2.	Michael Wink, "*Biochemistry of plant secondary metabolism*" Annual plant reviews, volume 40, Black well Publishing Ltd. 2 ndEdition 2010.

Course nature				Theory			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
						End semester examination weightage :	**50%**

15GN323E	**Plant Developmental Genetics**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P Professional Elective				
Course designed by	Department of Genetic Engineering				
Approval	32nd Academic Council Meeting held on 23rd July 2016				

PURPOSE	This course introduces the fundamentals of plant developmental genetics. It discusses the basic aspects of signal transduction, induction and genetics of embryo, shoot and root and seed development.

INSTRUCTIONAL OBJECTIVES	**STUDENT OUTCOMES**						
At the end of the course, student will be able to							
1. Gain knowledge on basic developmental aspects of plant that can be transformed into research application.	a	b	c				
2. Apply the modular approach and regulatory networks present in a cell.	a	b	c				
3. Possess requisites for plant signal transduction research.	a	b	c				

Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
	Unit I: Principles of Plant Development	9			
1.	Novel features of plant growth and development	1	C	1-3	1
2.	Concept of plasticity in plant development	1	C	1-3	1
3.	Signal transduction –receptors and G-proteins	2	C	1-3	1
4.	cyclic AMP cascade	2	C	1-3	1
5.	Phospholipid and Ca^{2+}-calmodulin cascade, MAP kinase cascade	2	C	1-3	1
6.	Two component sensor-regulator system	1	C	1-3	1
	Unit II: Light and Hormonal Control	9			
7.	Light and hormonal control of plant development	1	C,D	1-3	1,2
8.	Phytochromes and cryptochromes	1	C	1-3	1,2
9.	Molecular mechanisms of light perception	2	C	1-3	1,2
10.	Signal transduction and gene regulation	2	C	1-3	1,2
11.	Biological clocks - genetic and molecular determinants	1	C	1-3	1,2
12.	Hormone signal perception, transduction and gene regulation	2	C	1-3	1,2
	Unit III: Embryogenesis	9			
13.	Embryogenesis - microsporangium and microsporogenesis	1	C	1-3	1,2
14.	Megasporangium and megasporogenesis	2	C	1-3	1,2
15.	Fertilization- apomixes, parthenocarpy	1	C	1-3	1,2
16.	Embryogenesismolecular and genetic determinants	1	C	1-3	1,2
17.	Male sterility- cell lineages and positional information	2	C	1-3	1,2
18.	Seed dormancy and germination	1	C,D	1-3	1,2
19.	Meristem establishment and maintenance	1	C	1-3	1,2
	Unit IV: Shoot, Leaf and Root Development	9			
20.	Shoot, leaf and root development –organization of Shoot Apical Meristem (SAM)	2	C	1-3	1,2

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
21.	Cell to cell communication	1	C	1-3	1,2
22.	Molecular analysis of SAM	1	C	1-3	1,2
23.	Leaf development and differentiation	2	C,D	1-3	1,2
24.	Organization of Root Apical Meristem (RAM);	2	C	1-3	1,2
25.	Root hair and trichome development.	1	C	1-3	1,2
	Unit V: Floral Development and Senescence	9			1
26.	Floral induction and development	1	C	1-3	1,2
27.	Inflorescence and floral determination	1	C	1-3	1,2
28.	Molecular genetics of floral development and floral organ differentiation	2	C	1-3	1,2
29.	Sex determination	1	C	1-3	1,2
30.	Senescence and programmed cell death (PCD)	1	C	1-3	1,2
31.	Senescence and its regulation	1	C	1-3	1,2
32.	Hormonal and environmental control of senescence	1	C	1-3	1,2
33.	PCD in the life cycle of plants	1	C		1,2
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOK**
1.	Stephen H. Howell, *"Molecular genetics of plant development",* Cambridge University press, 2000.
	REFERENCE BOOK/ OTHER READING MATERIAL
2	Chong Pua E and Davey M R *"Plant developmental biology – biotechnological perspectives*", Springer, 2010

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
					End semester examination weightage :		**50%**

15GN324E	**Medical Microbiology**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P Professional Elective				
Course designed by	Department of Genetic Engineering				
Approval	Academic Council Meeting -- , 2016				

PURPOSE	This course introduces the various microbial disease's, based on the symptoms, route of entry, cultural characteristics, pathogenicity and laboratory diagnosis and control							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Understand the normal microflora and microbiome	a	b	c	h			
2.	Uunderstand the pathogenicity of microbial diseases	a	b	c				
3.	Know about laboratory diagnosis of diseases	a	b	c	l			

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Unit I: Microbiome and Drug Resistance	**8**			
1.	Human microbiome, normal microbial flora	2	C	1	1,4
2.	Probiotic organisms, nosocomial Infection	2	C	1	1,4
3.	Drug resistance, MRSA, MDRTB, NDM 1	2	C	1	1,4
4.	Mechanisms of multiple drug resistance	2	C	1	1,4
	Unit II: Bacterial Diseases - Gram Positive Organisms	**11**			
5.	Morphology, cultural characteristics, pathogenicity and laboratory diagnosis of *Staphylococcus aureus*, *Streptococccus pyogenes*,	2	C,D,I	2	2,3
6.	Morphology, cultural characteristics, pathogenicity and laboratory diagnosis of *Bacillus anthracis*, *Corynebacterium diphteriae*	2	C,D,I	2	2,3
7.	Morphology, cultural characteristics, pathogenicity and laboratory diagnosis of *Clostridium tetani*, *Clostridium botulinum*	2	C,D,I	2	2,3
8.	Morphology, cultural characteristics, pathogenicity and laboratory diagnosis of *Mycobacterium tuberculosis*, *Mycobacterium leprae*	2	C,D,I	2	2,3
9.	Morphology, cultural characteristics, pathogenicity and laboratory diagnosis of Spirochaetes , *Treponema pallidium* and *Leptospira*	3	C,D,I	2	2,3
	Unit III: Bacterial Diseases - Gram Negative Organisms	**11**			
10.	Morphology, cultural characteristics, pathogenicity and laboratory diagnosis of *E.coli*, *Klebsiella* sp.	2	C,D,I	2	2,3
11.	Morphology, cultural characteristics, pathogenicity and laboratory diagnosis of *Salmonella typhi*, *Shigelladysenteriae*	2	C,D,I	2	2,3
12.	Morphology, cultural characteristics, pathogenicity and laboratory diagnosis of *Pseudomonas aeroginosa*, *Vibrio cholerae*,	3	C,D,O	2	2,3
13.	Morphology, cultural characteristics, pathogenicity and laboratory diagnosis of *Bordetella pertusis*, *Yersinia pestis*	2	C,D,O	2	2,3
14.	Morphology, cultural characteristics, pathogenicity and laboratory diagnosis of *Neiserria gonorrhea*, *Neiserriameningitidis*	2	C,D,O	2	2,3
	Unit IV: Viral Diseases	**7**			
15.	Approaches to viral diagnosis, serological and molecular techniques	1	I,O	3	1,3
16.	Pathogenicity and laboratory diagnosis of viral infections , Hepatitis, Polio	1	I,O	3	1,3
17.	Pathogenicity and laboratory diagnosis of viral infections Rabies, Influenza	1	I,O	3	1,3
18.	Pathogenicity and laboratory diagnosis of viral infections Measles, Mumps, Rubella	2	I,O	3	1,3
19.	Pathogenicity and laboratory diagnosis of viral infections Dengue virus and HIV	2	I,O	3	1,3
	Unit V: Fungal and Parasitic Diseases	**8**			
20.	Mycosis : superficial, subcutaneous and systemic infections – Cryptococcosis, Madura mycosis, Histoplasmosis, *Candida allbicans*, Aspergillosis.	2	C,D,I	2	3,4
21.	Parasitology: Pathogenicity and laboratory diagnosis of *Leishmaniadonovani* and *Trichomonas vaginalis*.	2	C,D,I	2	3,4
22.	Parasitology: Pathogenicity and laboratory diagnosis of *Entamoeba histolytica*, *Taeniasolium*,	2	C,D,I	2	3,4
23.	Parasitology: Pathogenicity and laboratory diagnosis of *Plasmodium vivax*, *Wucherariabancrofti*,	2	C,D,I	2	3,4
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1	Greenwood.D., Slack R.C.B., Barer M.R., Irving W.L., "*Medical Microbiology*", Churchill Livingstone Publications, 18 th Edition, 2007.
2	Rajan.R., "*Medical Microbiology*", MJP Publishers, 1st edition ,2007.
3	Ananthanarayan and Paniker, **"***Textbook of Microbiology*", Orient BlackSwan; 9th edition, 2013.
	REFERENCE BOOK/ OTHER READING MATERIAL
4	Melnick.J, Adelbergs, "*Medical Microbiology*",McGraw Hill Education, 26th Edition, 2013.

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
						End semester examination weightage :	**50%**

15GN325E	**Food Microbiology**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	E Professional Elective				
Course designed by	Department of Genetic Engineering				
Approval	32nd Academic Council Meeting held on 23rd July 2016				

PURPOSE	To provide students an understanding of relation between food and microorganisms, the methods to detect the presence of microbes and their products in food, the food spoilage and causes, the food preservation principles, the food safety and food quality measures and the food borne diseases							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Know the relationship between food and microorganisms	a	b	c				
2.	Understand the food spoilage and contamination sources	a	b	c				
3.	Understand the principles of food preservation	a	b	c				
4.	Know the measures of food safety and quality	a	b	c				
5.	Gain knowledge about food borne pathogens	a	b	c				

Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
	Unit I: Food and Microorganisms	**9**			
1.	Food as a source of microorganism	1	C	1	2
2.	Factors affecting growth of microorganisms - extrinsic parameters	1	C	1	2
3.	Intrinsic parameters	1	C	1	2
4.	Nutrient content and antimicrobial contents	2	C	1	2
5.	Determination of microorganisms and their products in foods	4	C,D,I	1	2
	Unit II: Microorganism and Food Spoilage	**7**			
6.	Fresh meats and poultry, processed meats and sea foods	2	C,D	2	2
7.	Fermentation and fermented dairy products	2	C,D	2	2
8.	Fruit and vegetable products - whole, fresh-cut and fermented	2	C,D	2	2
9.	Miscellaneous food products	1	C,D,I	2	2
	Unit III: Food Preservation	**10**			
10.	Food preservation with chemicals and food preservation with modified atmospheres	2	C,D,I	3	1
11.	Radiation preservation of foods and nature of microbial radiation resistance	2	C,D,I	3	1

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
12.	Low-temperature food preservation and characteristics of psychrotrophic microorganisms	2	C,D,I	3	1
13.	High-temperature food preservation and characteristics of thermophilic microorganisms	2	C,D,I	3	1
14.	Preservation of foods by drying	2	C,D,I	3	1
	Unit IV: Food Safety and Quality	**9**			
15.	The HACCP system and food safety	2	I,O	4	4
16.	Hazard analysis critical control point system	3	I,O	4	4
17.	Good manufacture practices	2	D,I,O	4	3
18.	Basic principles of food industry sanitations	2	D,I,O	4	3
	Unit V: Food Borne Diseases	**10**			
19.	Introduction to food borne pathogens, food illness - staphylococcal gastroenteritis (caused by *Escherichia coliSalmonella* and *Shigella*)	4	C	5	1
20.	Food poisoning caused by gram - positive spore forming bacteria	3	C	5	1
21.	Food borne listeriosis, food intoxication and mycotoxins	3	C	5	1
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOK**
1.	Frazier, W.C., "*Food Microbiology"* 4th Edition, , McGraw Hill Companies, 1995
	REFERENCE BOOKS/ OTHER READING MATERIALS
2.	Jay, JM., "*Modern Food Microbiology",* 6th Edition. An Aspen Publication - 2000
3	Bibek Ray, ArunBhunia , "*Fundamental Food Microbiology"*, 5th Edition, ,CRC Press.
4	Carol Wallace, Sara Mortimore, "*HACCP: A Practical Approach"*, 3rd Edition, Springer, 2003

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	**Cycle test I**	**Cycle test II**	**Cycle Test III**	**Surprise Test**	**Quiz**	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
					End semester examination weightage :		**50%**

15GN413E	**Genetic Counseling**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
Co-requisite:	NIL				
Prerequisite:	15 GN209 Human Genetics				
Data Book / Codes/Standards	NIL				
Course Category	E Professional Elective				
Course designed by	Department of Genetic Engineering				
Approval	32nd Academic Council Meeting held on 23rd July 2016				

PURPOSE	The aim of this course is to enable students to learn the basic principles of genetic counseling. This course will also help them learn how to perform a genetic risk assessment in a clinical setting, particularly based on risk factors in a patient's personal and family history.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Discuss the principles of genetic counseling	g	m					
2.	Learn pedigree construction with standard symbols and intake questions	j	k					
3.	Learn about common genetic disorders	f	j	k				
4.	Learn the significance of genetic testing on the individual and family	f	h	j	k			

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Unit I: Introduction to Genetic Counseling	**7**			
1.	Historical overview, Definition	1	C	1	1
2.	Models of genetic counseling	2	C	1	1,3
3.	Components of genetic counseling interaction	1	C	1	1,3
4.	Providers of genetic counseling	1	C	1	1,3
5.	Professional and educational landmarks in Genetic Counseling	2	C	1	1
	Unit II: Pedigree Analysis	**10**			
6.	Interpretation of genetic case - Pedigree analysis	2	C,D	2	1,2,4
7.	Consent form, Family history	3	C,D	2	1,2,4
8.	Risk assessment, Verbal and nonverbal communication	2	C	1,2	1,3,4
9.	Psychological aspects of patient- Case documentation	3	C,D	2, 3	1,3,4
	Unit III: Strategies for Counseling	**6**			
10.	Characteristics and systems of family	2	C	1,2	1,3,4
11.	Comparison of family therapy – Medical therapy	2	C	1,2	1,3,4
12.	Structuring the genetic counseling session.	2	C	1,2	2,3
	Unit IV: Genetic Counseling for Specific Diseases	**16**			
13.	Case study for genetic counseling: Huntington's disease	3	C,D,I	3	5
14.	Case study for genetic counseling: Beta Thalassemia	2	C,D,I	3	5
15.	Case study for genetic counseling: Fragile X syndrome	2	C,D,I	3	5
16.	Case study for genetic counseling: Duchenne muscular dystrophy	2	C,D,I	3	5
17.	Case study for genetic counseling: Down syndrome	2	C,D,I	3	5
18.	Case study for genetic counseling: Leukemia.	2	C,D,I	3	5
19.	Case study for genetic counseling: Breast cancer.	3	C,D,I	3	5
	Unit V: Ethics of Genetic Testing	**6**			
20.	Genetic testing issues.	2	C,D	4	1,4
21.	Criteria for prenatal diagnosis.	2	C	4	1,4
22.	Ethics and legal issues of genetic testing	2	C	4	1,4
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOK**
1.	Wendy R. Uhlmann, Jane L. Schuette, Beverly Yashar, "*A Guide to Genetic Counseling*", 2nd Edition, Wiley-Blackwell, 2009
	REFERENCE BOOKS/ OTHER READING MATERIALS
2.	Bonnie S. LeRoy, Patricia M. Veach, Dianne M. Bartels "*Genetic Counseling Practice: Advanced Concepts and Skills".* Wiley-Blackwell, 2010
3.	Patricia McCarthy Veach, Bonnie S. LeRoy, Dianne M. Bartels "*Facilitating the Genetic Counseling Process: A Practice Manual*", Springer, 2003
4.	Peter S. Harper *"Practical Genetic Counselling"* 7th Edition. Taylor & Francis group, 2011
5.	Andrew Read, Dian Donnai "*New Clinical Genetics*" 2nd Edition. Scion Publishing Ltd., 2010

Course nature			**Theory**				
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
End semester examination weightage :							**50%**

15GN414E	Molecular Medicine	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	E Professional elective				
Course designed by	Department of Genetic Engineering				
Approval	32nd Academic Council Meeting held on 23rd July 2016				

PURPOSE	The course imparts advanced knowledge on use of biological molecules as medicine in human health care sector employing biotechnology. A brief outline on drug discovery and pharmacological aspects, and importance on the molecular aspects of infectious diseases and gene therapy will be focused.

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Focus and impart advanced knowledge on the molecular basis of diseases.	c	f	h	l			
2.	Know the protein functional defects in diseases	c	f	h	i	l		
3.	Obtain a brief knowledge on molecular pharmacology	h	j	l				
4.	Understand about molecular aspects of infectious diseases and molecular Therapeutics	c	f	h	j			
5.	Gain awareness about molecular level of drug delivery system and gene therapy	f	h	i	j	l		

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Unit I: Introduction	**7**			
1.	Introduction to molecular medicine	1	C	1	1
2.	Molecular mechanisms in development and differentiation	3	C	1	2
3.	Ageing – introduction (theories of ageing)	1	C	1	3
4.	Factors affecting ageing	1	C,D	1	3
5.	Genetic aspects of ageing	1	C,D	1	3
	Unit II: Gene and Protein Defects And Diseases	**10**			
6.	Abnormal protein function and diseases	1	C,D	2	1,4
7.	Diseases of DNA repair and genomic instability, RNA processing and disease	2	C,D	2	1
8.	Chromosomal translocations and leukemia	1	C,D	2	1
9.	Skin cancer	1	C	2	1
10.	Renal carcinoma	1	C	2	1
11.	Coagulation and haemophilia	1	C,D	2	1
12.	Gene defects and drug action in atherosclerosis	1	C,D	2	1
13.	Gene defects and drug action in cystic fibrosis	1	C,D	2	1
14.	Gene defects and drug action in Alzheimer's disease and Huntinton’s disease	1	C,D	2	1
	Unit III: Molecular Pharmacology	**10**			
15.	Drug discovery	1	C	3	6
16.	Drug design and development	1	C,D	3	6
17.	Clinical trials	1	C,D	3	6
18.	Molecular pharmacology – Pharmacokinetics (absorption and distribution)	2	C,D	3	6
19.	Molecular pharmacology – Pharmacokinetics (metabolism and excretion)	1	C,D	3	6
20.	Pharmacodynamic studies (drug – dose relationship)	1	C,D	3	6
21.	Effect of drugs (therapeutic, safety and toxicity)	1	C,D	3	6
22.	Drug elimination kinetics	2	C,D	3	6
	Unit IV: Molecular Aspects of Infectious Diseases	**10**			
23.	Virulence – Introduction	1	C	4	5

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
24.	Virulence factors and virulence associated factors	1	C,D	4	5
25.	Molecular mechanism of infection	1	C,D	4	5
26.	Intracellular pathogens: Bacillary dysentery	2	C,D	4	5
27.	Extracellular pathogens: Botulism	1	C,D	4	5
28.	Extracellular pathogens: Tetanus	1	C,D	4	5
29.	Viral pathogens: Dengue hemorrhagic fever	2	C,D	4	5
30.	Effects of drugs in infectious diseases	1	C,D	4	5
	Unit V: Molecular Biotechnology	**8**			
31.	Antibodies - Introduction	2	C	5	7
32.	Antibodies - design production, engineering	2	C,D	5	7
33.	Peptides and derivatives as therapeutic agents (anti microbial peptides)	2	C,D	5	8
34.	Nanotechnology and pharmaceuticals, drug delivery systems	2	C,D	5	9
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Robert A. Meyers "*Encyclopedia of Molecular Cell Biology and Molecular Medicine*" (Ed) – Vol I, II ed. VCH, 1996
2.	Leon W. Browder, Carol A. Erickson, William R. Jeffery, " *Developmental biology",* 3RD EDITION, Saunders College Publishing, Philadelphia, 1996.
3.	Barry Halliwell "*Free Radicals in Health and Disease*", Oxford, 2007.
4.	Gary Walsh "*Proteins – Biochemistry and Biotechnology*" Wiley, 2002
	REFERENCES/ OTHER READING MATERIALS
5.	Eduardo.A, Groisman, "*Principles of Bacterial pathogenesis*", Academic press, 2001
6.	John Dickenson, Fiona Freeman, Chris Lloyd Mills, Christian Thode, Shiva Sivasubramaniam "*Molecular Pharmacology: From DNA to Drug Discovery*", Wiley-Blackwell, 2012.
7.	Sang Jick Kim, Youngwoo Park, and Hyo Jeong Hong, "*Antibody engineering for the development of Therapeutic Antibodies*", Mol. Cells, Vol. 20, No. 1, pp. 17-29, 2005.
8.	Min-DukSeo , Hyung-Sik Won, Ji-Hun Kim, TsogbadrakhMishig-Ochir and Bong-Jin Lee, "*Antimicrobial Peptides for Therapeutic Applications: A Review",* Molecules 2012, 17, 12276-12286
9.	Suwussa Bamrungsap; Zilong Zhao; Tao Chen; Lin Wang; Chunmei Li; Ting Fu; Weihong Tan, "*Nanotechnology in Therapeutics - A focus on nanoparticles as a drug delivery System",* 2012.

Course nature			**Theory**				
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
					End semester examination weightage :		**50%**

15GN415E	**Cancer Genetics**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
Co-requisite:	NIL				
Prerequisite:	15GN201 Principles of Genetics				
Data Book / Codes/Standards	NIL				
Course Category	P Professional Elective				
Course designed by	Department of Genetic Engineering				
Approval	32nd Academic Council Meeting held on 23rd July 2016				

PURPOSE	This course will help the students to understand the genetic basis of cancer development and growth. It will help them to understand the hallmarks of cancer progression and genetic alterations observed in various types of cancer.

INSTRUCTIONAL OBJECTIVES	STUDENT OUTCOMES						
At the end of the course, student will be able							
1. To understand various types of cancer and tumor viruses.	b	c	l				
2. To learn about oncogenes and tumor suppressor genes.	b	c	l				
3. To understand the salient features of cancer phenotype.	b	c	l				
4. To gain knowledge on genetic instability of various cancers.	b	c	l				
5. To gain knowledge on cancer treatment.	b	c	l				

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Unit I: Nature of Cancer	**9**			
1.	Cancer types based on tissue of origin	1	C	1	1
2.	Properties and salient features of cancer cell	1	C	1	1
3.	Progression of cancer	1	C	1	1
4.	Monoclonal growth in tumors	1	C	1	1
5.	Causes of cancer – carcinogens and mutagens	2	C	1	1
6.	Tumor viruses	2	C	1	1,2
7.	Rous sarcoma virus and cell transformation	1	C	1	1
	Unit II: Genetics of Cancer	**9**			
8.	Cellular oncogenes	1	C	2	1
9.	Oncogenes and transforming retroviruses	2	C	2	1
10.	Role of growth factors and their receptors	2	C	2	1
11.	Tumor suppressor genes	1	C	2	1,2
12.	Loss of heterozygosity – the *Rb* gene	1	C	2	1,2
13.	Role of tumor suppressor genes and proteins	2	C	2	1,2
	Unit III: Hallmarks of Cancer Phenotype	**9**			
14.	Cancer cell immortality	1	C	3	1
15.	Decreased dependence on growth factors for proliferation	1	C	3	1
16.	Loss of anchorage dependent growth	1	C	3	1,2
17.	Loss of cell cycle control	1	C	3	1,2
18.	Reduced sensitivity to apoptosis	1	C	3	1
19.	Angiogenesis	2	C	3	1
20.	Role of microRNA's in cancer	2	C	3	1
	Unit IV: Genomic Instability and Cancer	**9**			
21.	Aneuploidy in cancer cells	1	C	4	1
22.	Multiple forms of genetic instability in cancer	1	C	4	1,2
23.	Defects in nucleotide excision repair	1	C	4	1
24.	Defects in mismatch repair	1	C	4	1
25.	Defects in DNA cross-link repair	1	C	4	1
26.	Genetic alterations in common cancers - lung cancer, prostate cancer, breast cancer, bladder cancer, ovarian cancer	2	C	4	1
27.	Genetic alterations in common cancers – lymphoma, melanoma, intestinal cancer, liver cancer, pancreatic cancer	2	C	4	1
	Unit V: Cancer Genetics in the Clinic	**9**			
28.	Altered genes as biomarkers of cancer	1	C	5	1
29.	Identifying carriers of germ line cancer genes	2	C	5	1
30.	Detecting early cancer via gene based assays	2	C	5	1
31.	Chemotherapy, radiotherapy and gene therapy	2	C	5	1,2
32.	Molecularly targeted therapy – *BCR-ABL* and Imatinib	2	C	5	1
	Total Contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOK**
1.	Bunz, F. "*Principles of Cancer Genetics*", 1st edition, Springer, 2008
	REFERENCE BOOK/ OTHER READING MATERIAL
2.	Weinberg, R.A. "*The Biology of Cancer*", 2nd edition, Garland Science, Inc., 2013

Course nature				Theory			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
					End semester examination weightage :		**50%**

15GN416E	**Pharmacogenomics and Personalized Medicine**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	E Professional elective				
Course designed by	Department of Genetic Engineering				
Approval	32nd Academic Council Meeting held on 23rd July 2016				

PURPOSE	The course provides fundamental knowledge in pharmacogenomics and implementation of pharmacogenomic studies in personalized medicine. The detailed study on human drug response, drug metabolizing enzymes and research activities carried out so far in the field of personalized medicine will be focused

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Apply knowledge on current challenges of health care landscape through personalized medicine.	f	g	h	i	j	l	
2.	Understand the drug dose response relationships with pharmacogenetics	c	f	g	h	i	j	l
3.	Obtain a broad education necessary to understand the pharmacogenomics in drug is metabolizing and non-drug metabolizing variants	c	f	g	h	i	j	l
4.	Know about application of pharmacogenomics in personalized medicine	f	g	h	i	j	l	
5.	Update knowledge from research papers in personalized medicine	g	h	l				

Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
	Unit I: Introduction	**6**			
1.	Introduction to pharmacogenomics and historical perspectives	1	C	1	1
2.	Basic principles of pharmacogenomics and personalized medicine	1	C,D	1	1
3.	Personalized medicine - Introduction	2	C	1	1
4.	The current challenges of healthcare landscape driving the pharmaceutical industry to personalized medicine	2	C	1	1
	Unit II: Human Drug Response	**10**			
5.	Pharmacological profile of Human drug response	1	C,D	2	2
6.	Pharmacokinetics in pharmacogenetics	1	C,D	2	2
7.	Drug-dose response relationships in pharmacogenetics	1	C,D	2	2
8.	The genetic profile of Human drug response	2	C,D	2	2
9.	Twin studies in pharmacogenomics	1	C,D	2	2
10.	Pharmacokinetic variability of anticancer agents (drug absorption and drug metabolism)	2	C,D	2	3
11.	Pharmacokinetic variability of anticancer agents (drug excretion and dose individualization)	1	C,D	2	3
	Unit III: Drug Metabolizing Enzyme Variants	**10**			
12.	Alcohol intolerance and alcohol metabolism	1	C,D	3	2
13.	Cyclophosphamide polymorphic biotransformation (anti cancer drug)	1	C,D	3	2

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
14.	Glucose – 6 – phosphate dehydrogenase deficiency	1	C,D	3	2
15.	Parathion poisoning	1	C,D	3	2
16.	Paraoxan polymorphism	1	C,D	3	2
17.	Acetylation polymorphism	1	C,D	3	2
18.	Fish odor syndrome	1	C,D	3	2
19.	Glucocorticoid remediable aldosteronism	1	C,D	3	2
20.	Lactose intolerance	1	C,D	3	2
21.	Pyridoxine responsive anaemia	1	C,D	3	2
	Unit IV: Application of Pharmacogenomics	**10**			
22.	Pharmacogenetic applications in Epilepsy	1	C	4	1
23.	Alzheimer's disease	1	C	4	1
24.	Psychiatric disorders	2	C	4	1
25.	Human immune deficiency virus	1	C	4	1
26.	Cardiovascular diseases, Obesity	2	C	4	1
27.	Inflammatory bowel syndrome	1	C	4	1
28.	Cancer pharmacogenomics	2	C	4	4
	Unit V: Research in Personalized Medicine	**9**			
29.	Impact of Genetic polymorphism on clinical response to antithrombotics	2	C,D	5	5
30.	Pharmacogenomics of drug metabolizing enzymes: Implication for cancer therapy	2	C,D	5	6
31.	Pharmacogenomics of drug transporters in cancer therapy	2	C,D	5	6
32.	Individualization of antiretroviral therapy	2	C,D	5	7
33.	Personalized medicine in mycobacterial diseases	1	C,D	5	8
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl.No.	TEXT BOOKS
1.	Nadine Cohen., "*Pharmacogenomics and personalized medicine*", Humana press, 2010
2.	Wendell W Weber, "*Pharmacogenetics*", Oxford University Press, 2008
3.	Samir D. Undevia; Gonzalo GomezAbuin; Mark J. Ratain., *"Pharmacokinetic Variability of Anticancer Agents"*, Nat Rev Cancer. Jun;5 (6):447-58, 2005.
4	R. Stephanie Huang, and Mark J. Ratain., "*Pharmacogenetics and Pharmacogenomics of Anticancer Agents"* CA Cancer J Clin.; 59(1): 42–55, 2009.
5	Kena J Lanham et al, "*Impact of Genetic polymorphism on clinical response to antithrombotics, Pharmacogenomics and personalized medicine*", Dove press; 3: 87-89, 2010.
	REFERENCE BOOKS/ OTHER READING MATERIALS
6.	Jing li et al, "*Pharmacogenomics of drug metabolizing enzymes and transporters: Implication for cancer therapy, Pharmacogenomics and personalized medicine*", Dove press; 4:11-33, 2011.
7.	Rebecca Pavlos et al, "*Individualization of antiretroviral therapy, Pharmacogenomics and personalized medicine*", Dove press; 5: 1-17, 2012.
8	Mehdi Mirsaeidi ,*Personalized medicine approach in mycobacterial disease*, Int J Mycobacteriol. 1(2): 59–64, 2012.

Course nature		**Theory**					
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
					End semester examination weightage :		**50%**

15GN417E	Environmental Microbiology	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P Professional Elective				
Course designed by	Department of Genetic Engineering				
Approval	32nd Academic Council Meeting held on 23rd July 2016				

PURPOSE	To help students to know about enumeration of microbes from environmental samples. The students will be taught about microbial distributions, waste water treatments and biodegradation using microbes

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Study the distribution of microbes in different environments	a						
2.	Study about isolation and characterization of microbes from different environments	a	b	c				
3.	Gain knowledge about adaptation of microbes to different environments	a	c	e				
4.	Study about diseases caused by environmental microbes	a	b	c				
5.	Gain knowledge on biodegradation of pollutants using microbes	a	e					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Unit I: Microbiology of Air	**8**			
1.	Introduction to environmental microbiology	1	C	1	1
2.	Composition of air, significance of air flora	2	C,D,I	1	1
3.	Enumeration of microorganisms in air, sampling techniques	1	D,I	2	1,2
4.	Air borne infections and pathogenesis	2	C	4	1,2
5.	Air sanitation techniques, assessment of air quality	2	D,I	1	1,2
	Unit II: Microorganisms in Aquatic Environments	**13**			
6.	Microbes in aquatic environments – fresh water environment, marine environment	3	C,D	2	1
7.	Nutrient cycling in aquatic environments, eutrophication	3	C	2	1,2
8.	Microbial communities in aquatic environments	1	C	2	1
9.	Microbiological tests for water quality control	2	C,D	2	2
10.	Water purification systems, waste water treatment processes	2	C,D	2	1,2
11.	Waterborne diseases and transmission	2	C,D	4	2
	Unit III: Microorganisms in Extreme Environments	**7**			
12.	Microbes in low and high temperature environments	1	C	3	1
13.	Microbes in chemolithotrophic environments	1	C	3	1
14.	Microbial growth under radiation	1	C	3	1
15.	Mechanism of microbial metal resistance and detoxification	2	C,D	3	1
16.	Bioremediation and bioaugumentation.	2	D,I	3	1,2
	Unit IV: Microbial Communities in Natural Ecosystems	**7**			
17.	Bacterial communities	1	C	1	1
18.	Microbial diversity of soil and water	2	D,I	1,2	1
19.	Soil bacterial communities, soil-plant-microbe interactions	2	C,D	1	1
20.	Microbial diversity and natural products	2	C,I	1	1
	Unit V: Applications of Environmental Microbiology	**10**			
21.	Hydrocarbon degradation and petroleum composting	2	C,D,I	5	1,2
22.	Vermiform composting, silage, Pyrolysis and saccharification;	2	C,D,I	5	1,2
23.	Treatment of liquid wastes, degradation of liquid industrial wastes; Degradation of pesticides and detergents	3	C,D,I	5	1
24.	Degradation of lignin; synthetic polymers and xenobiotics	3	D,I	5	1,2
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOK**
1.	Pepper, I.L, Gerba, C.P, Gentry, T.J *"Environmental Microbiology*", 3rd edition, Academic Press, 2014.
	REFERENCE BOOK/ OTHER READING MATERIAL
2.	Sherwood. L, Joanne, M.W, Woolverton. C "*Prescott's Microbiology"*, 9th edition, McGraw Hill Education, 2010.

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
End semester examination weightage :							**50%**

15GN418E	**Industrial Microbiology**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P Professional Elective				
Course designed by	Department of Genetic Engineering				
Approval	32nd Academic Council Meeting held on 23rd July 2016				

PURPOSE	This course introduces the fundamentals of microbial genetics through the study of the characteristics of microorganisms, multiplication, growth kinetics, gene transfer methods, mutation and phage life cycle.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Understand about different types of food fermentations	a						
2.	Gain knowledge about production of antibiotics, vitamins and enzymes	a	b	e				
3.	Study about biofuel production	a	b	e				
4.	Gain knowledge on strain improvement techniques	a	b	e				

Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
	Unit I: Introduction to Industrial Microbiology	**8**			
1.	Historical developments, basic concepts, scope and importance,	1	C	1	1,3
2.	Genetic manipulation of microorganisms, screening techniques	4	C	4	3
3.	Strain development, preparation of inoculum for fermentation	2	C,D	1	3
4.	Preservation of microorganisms	1	C	1	1
	Unit II: Microbiological Bioconversions and Assay Methods	**11**			
5.	Types of microbial bioconversions with examples	2	C	2,3	1
6.	Microbiological assay of antibiotics	2	C,D	2	1
7.	Microbiological assay of trace elements	6	C,D	2	1
8.	Microbiological assay of aminoacids, vitamins	1	C,D	2	1
	Unit III: Production of Industrially Important Products Using Microbes	**9**			
9.	Production of antibiotics	1	C	2	1
10.	Production of enzymes	3	C,D	2	1
11.	Production of solvents	2	C,D	2	1
12.	Production of amino acids and vitamins	3	C,D,I	2	1,3
	Unit IV: Production of Single Cell Proteins	**7**			
13.	Production of bacterial and yeast proteins	3	C	2	1,2

14.	Algal and fungal protein production	2	C,D	2	1,2
15.	Economic aspects and applications of single cell protein production	2	C,D	4	1
	Unit V: Production of Fermented Foods	**10**			
16.	Lactic acid fermentation of cabbage and cucumber	2	C,D,I	2	1,3
17.	Production of baked foods ,	2	C,D,I	2	2
18.	Production of oriental foods, cheese	2	C,I	2	2
19.	Production of alcoholic beverages	2	C,D,I	2	2
20.	Food preservation techniques	2	C,I	2	2,3
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Patel A.H., "*Industrial Microbiology*" 2nd edition, Laxmi Publications, 2016.
2.	Reed G., "*Prescott and Dunn's Industrial Microbiology*" 4th edition, CBS publishers and distributors, 2004.
	REFERENCE BOOK/ OTHER READING MATERIAL
3.	Sherwood. L, Joanne, M.W, Woolverton. C "*Prescott's Microbiology*, 9th edition, McGraw Hill Education, 2010.

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
					End semester examination weightage :		**50%**

15GN419E	**Genome Informatics**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P Professional Elective				
Course designed by	Department of Genetic Engineering				
Approval	32nd Academic Council Meeting held on 23rd July 2016				

PURPOSE	This course imparts advanced knowledge on the methods and strategies involved in the generation and analysis of high throughput next generation sequencing data and its application in analysing the genome and transcriptome of life. This course will help to learn all the techniques related to NGS (Next Generation Sequencing) data pre-processing, *de novo* and reference sequence assembly, variant calling, analysing whole genome, exome and transcriptome data, and other methods and, strategies involved in designing and executing the study using NGS.

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Know about the methodology and strategy, and quality control of big data generation in genomics.	a	c	i	l			
2.	Learn and perform the DNA sequence assembly using different strategies and to improve the assembly	a	c	i	l			
3.	Learn and perform the genome sequencing in prokaryotes using NGS and analysis	a	c	i	l			
4.	Learn and perform the genome sequencing in eukaryotes using NGS and analysis	a	c	i	l			
5.	*Learn and perform the transcriptome sequencing and analysis using NGS*	a	c	i	l			

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Unit I: Big Data from Next Generation Sequencing	**7**			
1.	Introduction to high throughput DNA sequencing methods for large data generation and analysis	2	C	1	1,2, 3
2.	Strategy in choosing NGS methods in biological study	1	C	1	1,2, 3
3.	Strategy for the preparation of DNA and RNA samples for Next generation sequencing	1	C	1	1,2, 3
4.	Sequencing data types, quality assessment of sequencing data.	1	C,D	1	1,2, 3
5.	Strategies to improve the quality. Tools for the quality trimming of NGS data. Pre-processing for the single end and paired end sequencing data	2	C,D	1	1,2, 3
	Unit II: DNA Sequence Assembly	**12**			
6.	Introduction to assembly of DNA sequencing data from NGS, Assembly algorithms	1	C	2	1,2, 3
7.	De novo assembly, Reference guided assembly	3	C	2	1,2, 3,4
8.	Assembly using single end and paired end reads	3	C,D	2	1,2, 3,4
9.	Large scale genome assembly- tools and challenges	2	C	2	1,2, 3,4
10.	Different types of assemblers, Assembly Errors, Evaluation of different assembly methods and assemblers	3	C,D	2	1,2, 3,4
	Unit III: Genome Sequencing and Analysis in Prokaryotes	**7**			
11.	Introduction to genome sequencing. Genome nature of prokaryotes, sequencing of prokaryotic genomes	1	C	3	1,2, 3
12.	Assembly of prokaryotic genomes	2	C,D	3	1,2, 3,4
13.	Gene prediction and Annotation of prokaryotic genomes	2	C,D	3	1,2, 3,4
14.	Comparative genome analysis in prokaryotes	2	C,D	3	1,2, 3,4
	Unit IV: Genome Sequencing and Analysis in Eukaryotes	**9**			
15.	Introduction to genome sequencing. Genome nature of Eukaryotes, Sequencing of Eukaryotic genomes	1	C	4	1,2, 3
16.	*De novo* assembly of genome from eukaryotic non-model species. Gene prediction. Annotation	3	C,D	4	1,2, 3,4
17.	Reference guided genome assembly and variants (SNP, INDEL) identification	3	C,D	4	1,2, 3,4
18.	Exome sequencing and analysis	2	C,D	4	1,2, 3,4
	Unit V: Transcriptome Sequencing and Analysis	**10**			
19.	Introduction to transcriptome sequencing. Designing strategy for RNA Sequencing study. Global transcriptome analysis	3	C	5	1,2, 3
20.	*De novo* and reference guided transcriptome assembly and annotation	3	C,D	5	1,2, 3,4
21.	RNA sequencing to study gene expression	2	C,D	5	1,2, 3,4
22.	Small RNA sequencing and analysis. Applications of transcriptome sequencing	2	C	5	1,2, 3
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOK**
1.	Wang. X., " *Next-Generation Sequencing Data Analysis* ", CRC Press. 2016.
	REFERENCE BOOKS/ OTHER READING MATERIALS
2.	http://www.personal.psu.edu/iua1/courses/2014-BMMB-852.html
3.	https://en.wikibooks.org/wiki/Next_Generation_Sequencing_%28NGS%29
4.	https://usegalaxy.org/

Course nature		Theory (100% internal continuous assessment)				
Assessment Method (Weightage 100%)						
In-semester	Assessment tool	Assessment I	Assessment II	Assessment III	Assessment IV	Total
	Weightage	**25% (Test -10%; Assignment-15%)**	**25% (Test -10%; Assignment-15%)**	**25% (Test -10%; Assignment-15%)**	**25% (Test -10%; Assignment-15%)**	**100%**
End semester examination weightage:						**0%**

15GN420E	**Functional Genomics and Proteomics**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P Professional Elective				
Course designed by	Department of Genetic Engineering				
Approval	32nd Academic Council Meeting held on 23rd July 2016				

PURPOSE	This course imparts advanced knowledge on the methods to study gene expression at the genome and proteome levels using traditional methods to latest RNA sequencing technology. The detailed analysis of the techniques involved for quantifying gene and protein expression will enable students to perform the assays for detection of gene expression. Additionally, they would be able to study genome organization, comparison and the application of the genomic and proteomic techniques in various fields.

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Know about the functional organization of the genomes, genetic elements control on gene expression and functional genetics	a	b	c	i	l		
2.	Understand the nature of the genomes and their comparisons	a	b	c	i	l		
3.	Understand and apply the classical and largescale techniques in gene expression study	a	b	c	i	l		
4.	Learn the techniques used in the proteome analysis	a	b	c	i			
5.	Understand the application of functional genomics and proteomics	a	b	c	i			

Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
	Unit I: Genome Organization, Gene Expression and Functional Genetics	**8**			
1.	Introduction, genome organization, genetic elements and their control on gene expression	3	C	1	3
2.	Constitutive and inducible gene expression	2	C	1	3
3.	Correlation between mRNA and protein abundance, functional genomic analysis using forward genetics and reverse genetics	3	C	1	3
	Unit II: Comparative Genomics	**8**			
4.	Genome size, content, and gene order, Orthologs and paralogs	1	C	2	1,5
5.	Comparative genomics of bacteria and horizontal gene transfer	3	C	2	1,5
6.	Comparative genomics of mitochondrial genomes, plastids and nuclear genomes of eukaryotes	3	C	2	1,5
7.	Applications of comparative genomics	1	C	2	1,5
	Unit III: Transcriptome Analysis	**11**			
8.	Introduction to transcriptome and gene expression studies with mRNA	1	C	3	3
9.	Traditional approaches for the analysis of gene expression – Semi quantitative RT PCR, quantitative PCR (real time PCR), differential display PCR, Northern hybridization	4	C	3	3

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
10.	Genome wide analysis of gene expression – SAGE, RNA Sequencing using NGS methods	4	C	3	3
11.	Gene expression analysis using Microarrays	2	C	3	3
	Unit IV: Proteome Analysis	**10**			
12.	Introduction to proteome, protein databases	1	C	4	2,4
13.	2D gel electrophoresis, MALDI-TOF and ESI analysis with applications in proteomics, MASCOT analysis Mass spectroscopy	3	C	4	2,4
14.	Peptide mass fingerprinting, peptide sequence analysis by tandem mass spectrometry, SELDI protein chip technology	3	C	4	2,4
15.	Proteomic analysis of post translational modifications, Experimental approaches for protein-protein interaction mapping	2	C	4	2,4
16.	Differential and quantitative proteomics	1	C	4	2,4
	Unit V: Applications of Functional Genomics and Proteomics	**8**			
17.	Introduction, applications of genomics in understanding basis of monogenic and polygenic disorders	3	C	5	1,2,3,4
18.	Pharmacogenomics, Medical proteomics-biomarker discovery and its importance	2	C	5	1,2,3,4
19.	Pharmaceutical proteomics-role of proteomics in drug development, applications of proteomics for the analysis of genetically modified plants	3	C	5	1,2,3,4
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Pevsner. J., "*Bioinformatics and Functional Genomics*", 2nd edition, Wiley-Blackwell. 2009.
2.	Liebler. D.C., "*Introduction to Proteomics***"** Humana Press, 2002
3.	Mount. D, "*Bioinformatics: Sequence and Genome Analysis*", 2nd Edition, Cold Spring Harbor Laboratory Press, New York. 2004.
	REFERENCE BOOKS/ OTHER READING MATERIALS
4.	Twayman. R.M., "*Principles of Proteomics*" *(Advanced text series)*, 1st edition, Taylor and Francis. 2004.
5.	Primrose. S.B., Twayman. R.M., "*Principles of Gene Manipulation and Genomics*" 7th edition, Blackwell publishing. 2006.

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
End semester examination weightage:							**50%**