BT– 502 MS BIOINSTRUMENTATION

M. Sc Semester -II (Biotechnology)

L	P	Credits			
4	--	4	Class Work	:	50 Marks
			Examination	:	100 Marks
			Total	:	150 Marks
			Duration of Examination	:	3 Hours

OBJECTIVES:

- To study different techniques of microscopy and ultracentrifugation
- To identified the applications of electrophoresis and chromatography
- To develop an understanding for spectrophotometry technique
- To study the nature and properties of radioisotopes

OUTCOME:

- Able to know different techniques of microscopy and ultracentrifugation
- Students will understand the applications of electrophoresis and chromatography
- They will learn spectrophotometry technique
- Understanding the nature and properties of radioisotopes

Text Books/References:

- Biological spectroscopy: Campbell and Durek
- Physical Biochemistry, ed. by D. Friefelder, W.H. Freeman and Company, USA.
- Introduction to instrumental analysis, ed. Robert. D. Braun, 1987. McGraw Hill, UK.
- Analytical Chemistry for techniques, ed. John Kenkel, 1994, Lewis Publishers. Boca Raton, USA.
- Principles and Techniques of practical Biochemistry, ed. K. Willson and J. Walker, 1994, Cambridge University Press, Cambridge.
- Biophysical Chemistry: Principles and techniques, ed. A Upadhyay, K. Upadhyay and N. Nath, 1998, Himalya Publication House, Delhi.
- Physical Biochemistry, ed. K.E. Vanholde, 1985, Prentice Hall Inc., New Jersey.

LECTUREWISE PROGRAMME: (from 08.01.18 to 27.04.18)

UNIT – I

Microscopy (08.01.18 to 16.01.18)

Light, electron (scanning & transmission)	2
Phase contrast, fluorescence microscopy, freeze–fracture techniques	2
Specific staining of organelles or marker enzymes.	2

Ultracentrifugation (17.01.18 to 31.01.18)

Sedimentation of macromolecules	3
Centrifugation techniques and their applications	2
Differential centrifugation, zonal, density gradient and ultracentrifugation techniques.	2

UNIT – II

Electrophoresis (02.02.18 to 23.02.18)

Paper and gel electrophoresis, immunoelectrophoresis	3
Enzyme linked Immunosorbent assay (ELISA), Isoelectric focusing	4
2-D electrophoresis, capillary electrophoresis	3

Chromatography (26.02.18 to 14.03.18)

Paper chromatograp hy and thin layer chromatography, (TLC)	4
Adsorption, partition, ion -exchange, reverse phase, gel filtration, affinity	3

Gas chromatography, High pressure liquid chromatography (HPLC) 3

UNIT – III

Spectrophotometry (16.03.18 to 05.04.18)

Basic concepts and brief description of application of U.V./ Visible, IR, NMR, ESR 3
Fluorescence, Raman, Mass spectroscopy in structure determination of organic and biomolecules 4
X-ray diffraction (diffraction by fibrous proteins, globular proteins and molecular crystals) 2
CD and ORD 2

UNIT – IV

Radioisotope Techniques (06.04.18 to 27.04.18)

Nature of radioactivity, properties of a, ß and Ɣ rays 2
Measurement of radioactivity, use of radioisotopes in research 3
In vivo and in vitro labelling techniques, double labelling, instruments for monitoring radioactivity 2
Quenching, internal standard channel ratio, external standard ratio 2
Emulsion counting radioactive decay, auto radiography, radioimmunoassay. 3

Home Assignments : 4 –5 assignments are given during the semester.

Evaluation Procedure

1.	Assignment / Project / Performance in the Class	10Marks
2.	Minor Tests (Two tests having equal weightage) Minor Test I : 14-16 Feb, 2018 Minor Test II : 4 -6 April, 2018	20 Marks
3.	Major test (University Examination)	100 Marks

Award of Grades Based on Absolute Marks: The University is following the system of grading based on absolute marks (after applying moderation if any). Following grading will be done based on the % of marks obtained in all the components of evaluation part of the subject.

A+ (90% - 100 %), A (80% - 89%), B+ (70% - 79%) , B(62% - 69%), C+ (55% - 61%),C (46% - 54%), D (40% - 45), F (Less than 40 %)

For F grade, a candidate shall be required to appear in the major test of concerned course only in the subsequent examination(s) to obtain the requisite marks/grade.

Attendance Record – Candidate should attend at least75% attendance of the total classes held of the subject

Chamber consultation hour: Any vacant period.

Note:

1. In the semester examination, the examiner will set 08 questions in all selecting two from each unit (1 & 2 from unit I, 3 & 4 from unit II, 5 &6 from unit III and 7 & 8 from unit IV). The students will be required to attempt only 5 questions selecting at least one question from each unit. All questions will carry equal marks.
2. The use of scientific calculator will be allowed in the examination. However, programmable calculator and cellular phone will not be allowed.
3. The use of properties (water, air, steam etc) tables, heat transfer tables, charts is permitted

(Anjali Dahiya)

BT– 504 MS IMMUNOLOGY-I

M. Sc. Semester - II (Biotechnology)

L	P	Credits	
4	**--**	**4**	**Class Work : 50Marks**
			Examination : 100 Marks
			Total : 150 Marks
			Duration of Examination: 3 Hours

LECTUREWISE PROGRAMME: (from 08.01.18 to 27.04.18)

Introduction of the subject (08.01.18)	1
UNIT- I	
The Components of Immunity **(09.01.18 to 31.01.18)**	
Concept of Innate Immunity.	1
Concept of Acquired Immunity.	1
Cells of immune System,	2
Organs of immune System	2
phagocytosis, and inflammatory responses	1
Hematopoesis	1
Immunogens and Immunoglobulins	1
Antigens and haptens,	1
Superantigens and antigenic determinants	1
Immunoglobulins- basic structure and classes	1
Subclasses of immunoglobulins	1
Biological effector functions mediated by antibody	1
Genetic organization of immunoglobulin genes	1
Generation of antibody diversity	1
UNIT- II	
Immune effector responses: **(01.02.18 to 28.02.18)**	
Humoral immune responses	2
B cell receptor and B cell maturation	2
Activation and differentiation of B cells	1
T- dependent and T- independent antigens	1
Role of TH cells in humoral immune response	2
primary and secondary humoral immune response	3
T cell receptors	1
T cell development and activation	1
Mechanism of cell mediated immune response	1
Major histocomptibility complex	1
Antigen processing and presentation	1
Cytokines and complement system	3
UNIT – III	
Techniques in Immunology (**1.03.18 to 31.03.18)**	
Antigen-antibody reactions	2
Affinity and avidity	2
Immuno precipitation techniques	1
Immunodiffusion techniques	1
Immunoelectrophoresis	1
rocket immunoelectrophoresis	1
ounter current immuno electrophoresis	1
radio-immunoassay and ELISA	3
Immunofluorescence	1
Flow cytometry	1
Monoclonal antibodies and hybridoma technology	3
UNIT – IV	

Clinical Immunology **(1.04.18 to 27.04.18)**

Immunity to infection	1
Bacteria, viral and parasitic infections	3
Vaccines	1
A brief account of: Hypersensitivity- Type I-IV	3
Autoimmunity- types of autoimmune diseases	3
Transplantation immunology	1
Immunological basis of graft rejection	1
Tumour immunology	1
Cancer and the immune system Immunodeficiency diseases	3

TEXT / REFERENCE BOOKS

1. Immunology, ed. R.A. Goldsby ,T. J. Kindt, B.A. Osborne, W.H.Freeman & company, New.York.
2. Essential of Immunology, ed. Ivon Roitt, Peter Delves, Blackswell, Scientific Publications. Oxford.
3. Fundanental of immunology, ed. Paul W.E. Raven press, New York.

(Dr Suman)

BT – 506 MS GENETIC ENGINEERING

M. Sc. Semester - II (Biotechnology)

L	P	Credits			
4	--	4	Class Work	:	50 Marks
			Examination	:	100 Marks
			Total	:	150 Marks
			Duration of Examination	:	3 Hours

OBJECTIVES:

1. To review the basic concept of genetic engineering, its history and sound knowledge of scope of Recombinant DNA technology.
2. To acquaint the students to versatile tools and techniques employed in genetic engineering and recombinant DNA technology, study moral and ethical aspects related to its implementation.
3. The objective of this course is to impart knowledge to students and apply their understanding of DNA to manipulate specific genes to produce desired traits.
4. Students will study the methods to modify genes to create genetically modified organisms and example applications of bacteria, plant and animals.
5. To gain knowledge that recombinant DNA technology coupled with the knowledge of transformation opens many doors in genetic engineering. With alteration of DNA, desired genes can be inserted into another organism.
6. This course provides theoretical bases to properties and applications of versatile DNA modifying enzymes, cloning strategies, vector types, host genotype specificities for selection and screening of recombinants and/or recombinant transformants.
7. To develop an intuitive understanding of general techniques used by genetic engineers to modify DNA.
8. To impart students widening of the knowledge with cloning strategies and techniques for recombinant selection.
9. To allow skills and make students understand the molecular probes and Polymerase Chain Reaction.
10. To gain knowledge about expression of cloned genes in bacteria, in yeast, expression in plants and in mammalian cells.
11. To study the latest hybridization techniques and molecular mapping.
12. To identify and analyze innovative researches being carried out in bacterial, plant and animal world with of applications of genetic engineering.

OUTCOME:

After successful completion of this course students are expected to be able to:

1. To know the scope of genetic engineering, techniques used for manipulation of the genetic material.
2. Able to know the tools, vectors, enzymes commonly used strategies for cloning, selection of recombinants.
3. To understand the principles and strategy used for various PCR techniques, role, importance and applications of PCR.
4. To gain knowledge on Applications of Genetic engineering in microbial, plant and animal world.
5. This course may be deemed as a foundation course serving as a platform for introduction of more advanced cutting-edge technologies that essentially are an amalgamation of basic techniques combined in diverse forms and sequence; to be introduced later in the program.

TEXT / REFERENCE BOOKS:

1. Primrose, S.B., Twyman, R.M. and Old, R.W. Principles of Gene Manipulation. 6th Edition, S.B. University Press. (2001).
2. Brown T.A. Genomes., 3rd ed. Garland Science. (2006).
3. Smita Rastogi and Neelam Pathak. Genetic Engineering (2009) Oxford University Press.
4. Sambrook, J. and Russel, D.W. Molecular Cloning: A Laboratory Manual, Vols 1-3, CSHL. (2001).
5. Selected papers from scientific journals.
6. Technical Literature from Stratagene, Promega, Novagen, New England Biolab etc.

LECTUREWISE PROGRAMME: (from 08.01.18 to 27.04.18)

Introduction to the subject: **S**cope of Genetic Engineering (08.01.18)	1	
UNIT-I		
Tools for Gene Cloning: **(09.01.18 to 20.01.18)**		
Introduction, historical background.	1	
Restriction enzymes.		2
Modifying enzymes, ligases, polymerases.	2	
Linkers and adaptors		1
Homo-polymeric tailing, labelling of DNA.	1	
Nick translation, random priming	1	
Cloning vectors: (23.01.18 to 31.01.18)		
Plasmids.		2
Bacteriophages, cosmids and phasmids.		2
Artificial chromosomes as vectors (YAC, BAC, MAC).		1
Practice and questions		1
UNIT-II		
Cloning strategies and recombinant selection: (02.02.18 to 23.02.18)		
Cloning strategy, methods of gene isolation	2	
Chemical Synthesis of gene.		1
Construction of genomic and cDNA library.	2	
Chromosome walking and chromosome jumping	2	
Different screening methods: genetic, immunochemical		2
Nucleic acid hybridization, HRT and HART.		1
Practice and questions		1
UNIT-III		
Molecular probes and Polymerase Chain Reaction: (26.02.18 to 14.03.18)		
Molecular probes, labeling (radioactive vs non-radioactive)	1	
Uses of probes and primer designing.		2
PCR: principle, types and variations.		2
Modified PCR (inverse PCR, anchored PCR etc.)		1
PCR for mutagenesis, RT-PCR, asymmetric PCR.		1
Cloning of PCR products. Applications of PCR.		1
Expression of cloned genes: (16.03.18 to 27.03.18)		
Expression of cloned genes in bacteria.		2
Expression of cloned genes in yeast.		1
Expression of cloned genes in plants.		2
Expression of cloned genes in mammalian cells.		1
Practice and questions		2
UNIT-IV		
Hybridization techniques: (28.03.18 to 11.04.18)		
Southern, Northern, and Western Hybridization		2
Molecular Mapping		1
Molecular markers (RAPD, RFLP, AFLP, STS)		2
Applications of Genetic Engineering: (12.04.18 to 27.04.18)		
DNase foot-printing, gene silencing technologies		2
Applications of Genetic engineering in microbial, plant and animal world	3	
Practice and questions		2

Home Assignments: 2–3 assignments are given during the semester.
Evaluation Procedure

1.	Surprise Quiz/ Tutorial Test	5 Marks
2.	Assignment / Project / Performance in the Class	5 Marks
3.	Minor Tests (Two tests having equal weightage) Minor Test I : 14-16 Feb, 2018 Minor Test II : 4 -6 April, 2018	40 Marks
4.	Major test (University Examination)	100 Marks

Award of Grades Based on Absolute Marks: The University is following the system of grading based on absolute marks (after applying moderation if any). Following grading will be done based on the % of marks obtained in all the components of evaluation part of the subject.
A+ (90% - 100 %), A (80% - 89%),
B+ (70% - 79%) , B(62% - 69%),
C+ (55% - 61%), C (46% - 54%),
D (40% - 45), F (Less than 40 %)
For F grade, a candidate shall be required to appear in the major test of concerned course only in the subsequent examination(s) to obtain the requisite marks/grade.

Attendance Record – Candidate should attend at least75% attendance of the total classes held of the subject
Chamber consultation hour: Any vacant period.

Note: In the semester examination, the examiner will set 08 questions in all selecting two from each unit (1 & 2 from unit I, 3 & 4 from unit II, 5 &6 from unit III and 7 & 8 from unit IV). The students will be required to attempt only 5 questions selecting at least one question from each unit. All questions will carry equal marks.

(Dr. Aditi Arya)

BT– 508 MS INTRODUCTION TO BIOINFORMATICS

M. Sc. Semester - II (Biotechnology)

L P Credits **Class Work : 50 Marks**

4 -- 4 **Examination : 100 Marks**

Total : 150 Marks **Duration of Examination : 3 Hours**

OBJECTIVES:

1. To study the basic concept of Bioinformatics.
2. To develop understanding of various databases and their retrieval systems.
3. To understand the applications of tools used for research
4. To analyze the role of various algorithms for understanding phylogenetic relationship

OUTCOME:

1. Able to know the importance of various bioinformatics tools in research and development.
2. Able to know the importance of phylogenetic analysis
3. Able to understand the importance of bioinformatics to perform various experiments in a single click.

INTRODUCTION TO BIOINFORMATICS (08.01.18 to 27.04.18)	No. of hours
UNIT-I: Introduction to operating and number systems: (09.01.18 to 31.01.18)	
Windows, Unix, Linux; binary, octal and hexadecimal number systems.	2
Basics of Networking and programming: Internet, Intranet, networking protocols,	2
FTP,www., flow charts, algorithms, assemblers, interpreters, compilers.	4
Databases and Databanks: Introduction, collecting and storing sequences in laboratory,	2
structure databases: PDB, MMDB, NCBI databases: SEQ-IDs, Bio SEQs- SETs, SEQ-	2
ANNOT, SEQ- DESCR, submitting DNA sequences to the databases.	2
UNIT-II: Information retrieval from biological databases: (1.02.18 to 28.02.18)	
Retrieving database entries, integrated information retrieval, ENTREZ system,	2
sequence data bases beyond NCBI, medical data bases.	2
Sequence alignment and database searching: Introduction, evolutionary	2
basis of sequence alignment, optimal alignment methods,	2
statistical significance of alignment, database similarity searching,	2
FASTA, BLAST. Multiple sequence alignment:	2
Exhaustive algorithms, heuristic algorithms, progressive alignment methods,	2
iterative alignment, block-based alignment.	2
UNIT-III: Phylogenetic analysis: (1.03.18 to 30.03.18)	
Elements of phylogenetic models, identifying paralogs and orthologs, steps in	2
phylogenetic data analysis: alignment, determining the substitution model,	2
tree building, tree evaluation, forms of tree representation Distance based method:	2
unweighted pair group method with arithmetic mean, neighbor joining and	3
Fitch-Margoliash method, minimum evolution. Character- based methods:	3
maximum parsimony and maximum likelihood, bootstrapping by jacknifing,	3
phylogenetics software: PHYLIP and PAUP.	2
UNIT-IV: (1.04.18 to 27.04.18)	
Predictive methods using nucleotide sequences: framework,	2
marking repetitive DNA, database search, codon bias detection,	2

detecting function sites in the DM, integrated gene passing,	2
finding tRNA genes. Predictive methods using protein sequences:	2
protein identity based on composition, Propsearch,	2
physical properties based on sequences, secondary structure	2
and folding classes, Sspread So pma , specialized structure of features, tertiary structure.	3

TEXT / REFERENCE BOOKS:

1. Bioinformatics – Concepts, Skills, Applications".S.C. Rastogi, Namita Mendiratta, Parag Rastogi.
2. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins. Andréa's D. Baxevanis, B.F. Francis Ouellette.
3. Biological Sequence Analysis: Probabilistic Models of Proteins and Nucleic Acids.Richard Durbin
4. Shanmughavel, P. 2005. Principles of Bioinformatics, Pointer Publishers, Jaipur, India.
5. DNA and Protein Sequence Analysis. A Practical approach.Bishop M.J.Rawlings C.J. (Eds.).
6. Introduction to Bioinformatics.Teresa. K. Atwood and David J. Parry-Smith.

(Dr Sonia Mann)

BT – 510 MS BIOTECHNOLOGY LAB- IV						
M. Sc. Semester - II (Biotechnology)						
L	**P**	**Credits**		**Class Work**	**:**	**50 Marks**
--	**4**	**2**		**Examination**	**:**	**50 Marks**
				Total	**:**	**100 Marks**
				Duration of Examination	**:**	**6 Hours**

Objectives

1. To study various practices used for animal cell culture
2. To acquaint students with principles and functioning of commonly used instruments
3. To evaluate various media used for animal cell culturing
4. To perform experiments used for disease diagnosis

Outcomes

1. Recall advanced knowledge of the underlying principles of immunology and its application in solving problems in biological systems.
2. Have an awareness of some current research activities in the field and possible applications of this knowledge.

List of Experiments/Exercises

8.01.18-31.01.18

1. Routine techniques in handling laboratory animals: Feeding, cleaning & hygienic measures.
2. Inoculation and bleeding of laboratory animals (mice/ rabbit).
3. Preparation and administration of antigens.

1.02.18-28.02.2018

1. Quantification of immunoglobulins.
2. To perform single radial immunodiffusion test.
3. To perform double immunodiffusion test.
4. Latex agglutination test.

1.03.18-26.04.18

5. Isolation and purification of immunoglobulins
6. To perform different types of ELISA.
7. To perform immunoeletrophoresis with the given antigen-antibody sample.
8. To perform differential leukocyte count of the given blood sample.
9. To perform total leukocyte count of the given blood sample.

TEXT /REFERENCE BOOKS:

Immunology, Kuby JWH Freeman and Company, New York
Practical Immunology (vol 1 & 2) by G.P.Talwar

1.	Test / Viva	20 marks
2	Class performance	20 marks
3.	Practical Records	10 marks

Award of grades will be according to university rules and regulations.
Attendance record- Candidate should have atleast 75% attendance of the total classes held in the subject.
Consultation hour: Any vacant period

(Dr Krishan K. Selwal)

BT – 512 MS BIOTECHNOLOGY LAB- V

M. Sc. Semester - II (Biotechnology)

L	P	Credits			
--	4	2	**Class Work**	**:**	**50 Marks**
			Examination	**:**	**50 Marks**
			Total	**:**	**100 Marks**
			Duration of Examination	**:**	**6 Hours**

OBJECTIVES

1. To illustrate creative use of modern tools and techniques for manipulation and analysis of genomic sequences.
2. To expose students to application of recombinant DNA technology in biotechnological research.
3. To train students in strategizing research methodologies employing genetic engineering techniques.

Outcomes:

1. Technical know-how on versatile techniques in genetic engineering lab.
2. An understanding on application of genetic engineering techniques in basic and applied experimental biology.
3. Proficiency in designing and conducting experiments involving genetic manipulation.

List of Experiments/Exercises

1. Isolation of plasmid DNA, construction of RE map, and restriction endonuclease profile analysis.
2. Construction of recombinant DNA and transformation of E.coli cells with rDNA.
3. Extraction of double stranded genomic RNA from viral samples.
4. Polyacrylamide gel electrophoresis (PAGE) for detection of segmented genomic RNA
5. Polymerase chain reaction for detection of pathogens in blood/and other clinical samples.
6. RT-PCR for detection of RNA.
7. Cloning of PCR products followed by nucleic acid sequencing.
8. Restriction endonuclease profile analysis.
9. RFLP and RAPD.
10. Southern hybridization/ Northern hybridization.

BOOKS:

1. Sambrook J & Russel DW. 2001. Molecular Cloning: a Laboratory Manual. Cold Spring Harbour Lab. Press.
2. Twyman RM. 2003. Advanced Molecular Biology. Bios Scientific.
3. Molecular Biology-Principles and practices(2009): Priyanka Siwach and Namita Singh, Laxmi Publications, New Delhi
4. Laboratory Manual for Biotechnology (2014) : Ashish Verma, Surajit Singh and Anchal Singh, S. Chand and Company Pvt. Ltd., New Delhi

Note: The students will be required to perform 08 experiments/ exercises from the above list and the other two experiments may be designed by the department based on the related theory course.

(Dr. Aditi Arya)

BT – 514 MS BIOTECHNOLOGY LAB- VI

M. Sc. Semester -II (Biotechnology)

L	P	Credits			
--	4	2	**Class Work**	**:**	**50 Marks**
			Examination	**:**	**50 Marks**
			Total	**:**	**100 Marks**
			Duration of Examination	**:**	**6 Hours**

Objectives:

1. To visualize various biological databanks and to learn about different file formats.
2. To perform pairwise and multiple sequence alignment using different tools.
3. To perform protein sequence analysis (ExPasy) and to study molecular visualization tool (Swiss-pdb viewer).
4. To perform phylogenetic tree construction.
5. To study gene structure and function prediction (using GenScan, GeneMark).
6. To learn to analyze biological data using biostatistical tools.

Outcomes:

1. Students will gain knowledge about various biological databases and the different tools used to retrieve and analyze the available biological data.
2. Students will be able to perform gene sequence analysis and phylogenetic studies with the help of online tools.
3. Students will be able to use several biostatistical tools for data analysis.

Text /Reference Books:

1. Bioinformatics: A Practical Approach by K. Mani and N. Vijayaraj, Aparna Publications, Coimbatore.
2. Bioinformatics. Higgins & Taylor (2000). OUP.
3. Practical statistics for Experimental Biologists. Wardlaw, A.C. (1985). John Wiley and Sons.

Note: T he students will be required to perform 08 experiments/ exercises from the given list and the other two experiments may be designed by the department based on the related theory course.

Experiment Schedule (08.01.2018 to 27.01.2018):

08.01.18 to 02.02.18	
Introduction about various biological databases	1
To learn about Database file formats and Data retrieval tools	1
Similarity searching using NCBI, BLAST	1
Multiple sequence alignment using Clustal	1
05.02.2018 to 02.03.2018	
To learn about Molecular visualization tools: Swiss-Pdb Viewer	1
Protein sequence analysis using ExPasy	1

To perform phylogenetic tree construction	2
05.03.18 to 30.03.18	
To perform structural and functional genome annotation using different prediction tools	2
To learn about the basics of PERL programming	2
02.04.18 to 26.04.18	
To apply different biostastical tools to biological data analysis	3

Evaluation Procedure

1.	Test / Viva	20 marks
2.	Class performance	20 marks
3.	Practical Records	10marks
4.	Major Test (University examination)	50 marks

Award of Grades Based on Absolute Marks: The University is following the system of grading based on absolute marks (after applying moderation if any). Following grading will be done based on the % of marks obtained in all the components of evaluation part of the subject. A+ (90% - 100 %), A (80% - 89%), B+ (70% - 79%) , B(62% - 69%), C+ (55% - 61%),C (46% - 54%), D (40% - 45), F (Less than 40 %) For F grade, a candidate shallbe required to appear in the major test of concerned course only in the subsequent examination(s) to obtain the requisite marks/grade.

Attendance Record – Candidate should attend at least75% of the total classes held in the subject

Chamber consultation hour: Any vacant period.

(Dr Kiran Nehra)

BT – 602 MS MEDICAL BIOTECHNOLOGY

MSc. Semester - III (Biotechnology)

L	P	Credits			
4	--	4	Class Work	:	50 Marks
			Examination	:	100 Marks
			Total	:	150 Marks
			Duration of Examination	:	3 Hours

Course objective

1. To review basic concept of infection and immunity
2. To study the mechanism of microbial pathogenesis.
3. To review the immune mechanisms against infections
4. To study the clinically significant diseases caused by pathogenic bacteria.
5. To study the medically important pathogenic viruses.
6. To examine the clinical load of virulent fungal pathogens
7. To develop an understanding of the antimicrobial chemotherapy
8. To scrutinize drug resistance
9. To analyse other therapeutic measures like – Gene therapy and hormone therapy
10. Evaluation of vaccines and vaccination measures

Outcomes

1. Students will have an overall concept of disease and immune response
2. Students will be able to analyse the methods of disease causation and thus prevention
3. Able to identify the clinically important bacteria, fungi & viruses
4. Students will be able to inspect various therapeutic measures for disease prevention
5. Will get a clear picture of infectious agents and methods of diagnosis and prevention of diseases

Lecture wise schedule : (8.01.18-27.04.18)

Unit I (8.01.18-16.01.18) (Total no. of lectures -6)

Microbial Pathogenesis: Classification of medically important microorganisms; Normal microbial flora of human body; role of the resident flora; Infection and its types, sources of infection. Transmission of diseases anti-phagocytic factors; mechanism of bacterial adhesion. Role of aggressins, depolymerising enzymes, organotropisms, virulence and virulence factors Exotoxins and endotoxins

Unit I (17.01.18-31.01.18) (Total no. of lectures -7)

Organs and cells of immune system and Basic immune response ,
Cell mediated and Humoral immunity.

UNIT II (1.02.18-13.02.2018) (Total no. of lectures -8)

Microbial Diseases Caused by Bacteria: Medically important pathogenic bacteria: Staphylococcus, Streptococcus, Clostridium, Enterobacteriacea

UNIT II (14.02.18-2.03.18) (Total no. of lectures -6)

Haemophilus, Mycobacteria, Spirochaetes A detailed account of Pathogenesis,

virulence & treatment.

UNIT-III: (5.03.18-16.03.18) (Total no. of lectures -5)

Microbial Diseases Caused by Viruses and Fungi: Medically important pathogenic Viruses: Orthomyxoviruses, Hepatitisviruses, Oncogenicviruses, HIV viruses:

UNIT-III: (19.03.18-30.03.18) (Total no. of lectures -6)

Medically important pathogenic Fungi: Dermatophytic & Dimorphic fungi, Opportunistic fungal Pathogens A brief account of Pathogenesis, virulence & treatment.

UNIT-IV: (2.04.18-13.04.18) (Total no. of lectures -6)

Antimicrobial Chemotherapy: Anti- bacterial Chemotherapy using various inhibitors. Anti-viral & Anti-fungal Chemotherapy, Drug resistance

UNIT-IV:(16.04.18-27.04.18) (Total no. of lectures -7)

Gene therapy, Vaccines, Antisense therapy, Enzyme and hormone therapy
RNA based therapeutics.

TEXT / REFERENCE BOOKS:

1. Ananthanarayanan, R. and Jayaram Panicker C.K. Text of Microbiology, Orient Longman. (1997).
2. Mackie and McCartney, Medical Microbiology Vol.1: Microbial Infection Vol.2: Practical Medical Microbiology Churchill Livingstone. (1996).
3. Shanson D.C., Microbiology in Clinical Practice. Wright PSG. (1982).
4. Baron E.J., Peterson L.R. and Finegold S.M. Mos, Bailey and Scott's Diagnostic Microbiology. (1990).
5. Jawetz et. al. Medical Microbiology.
6. Davis Harper, Microbiology, Row publisher.
7. Kuby, Immunology
8. Roitt, Brostoff, Male, Immunology.

NOTE: In the semester examination, the examiner will set eight questions in all, selecting two from each unit. The candidates will be required to attempt five questions in all selecting at least one from each unit. All questions will carry equal marks.

Home assignments :- 3-4 assignments are given during the semester

EVALUATION PROCEDURE

1.	Surprise quiz/ tutorial test	5 marks
2.	Assignment/ class presentation	5 marks
3.	Minor test I Minor test II	20marks (each)= 40
4.	Major Test (University examination)	100 marks

Award of grades will be according to university rules and regulations.

Attendance record- Candidate should have atleast 75% attendance of the total classes held in the subject.

Chamber Consultation hour: Any vacant period

(Dr Pamela singh)

BT– 604 MS ANIMAL BIOTECHNOLOGY-I
M. Sc. Semester - III (Biotechnology)

L	P	Credits			
4	--	4	Class Work	:	50 Marks
			Examination	:	100 Marks
			Total	:	150 Marks
			Duration of Examination	:	3 Hours

OBJECTIVES:

1. To provide students with a scientific and technical understanding of animal biotechnology
2. Developing DNA - based diagnostics and genetically engineered vaccines for animals,
3. Studying and developing animal genomics and its varied applications such as transgenic animals

Outcomes

- Production of transgenic animals and cloning.
- Knowledge of molecular methods for the study and management of cell culture analysis and the ability to apply molecular biology techniques for diagnosis.
- Knowledge of molecular biology techniques related to the optimization of livestock production.

TEXT / REFERENCE BOOKS

1. Molecular Biotechnology: Principles and Applications of recombinant DNA, ed. Bernard R. Glick, Jack. J. Pasternak, ASM press Washington DC.
2. Animal Cell biotechnology, ed. R.E. Spier and J.D Griffiths, 1988, Academic press, U.S.A.
3. Living resources for Biotechnology of Animal cells, ed. A. Doyle, R. Hay and B.E. Kirsop, 1990, Cambridge University Press, Cambridge, U.K.
4. Culture of Animal Cells: A Manual of Basic Technique, Fifth Edition, by R. Ian Freshney.

Section	Lectures **(08.01.18 - 27.04.2018)**	Approx # Lectures
UNIT-I **(08.01.18-30.01.2018)**	Animal cell lines and its applications.	1
	Techniques for growth of animal cell lines-Plasma clot method, Raft method, Agar-gel method, Grid method,	2
	Cyclic exposure to Medium and Gas phase, Advantages,	1
	Concept of Biohazards in animal cell culture laboratory-Biosafety issues	2
	Total number of lectures/classes in section 1	6
UNIT-II **(01.02.18 – 26.02.18)**	Preparation and Sterilization of cell culture media and reagents.	2
	Introduction to the balance salt solutions and simple growth medium.	1
	Brief discussion on the chemical, physical and metabolic functions of different constituents of culture medium.	2
	Animal cell laboratory infrastructure, equipment, culture vessels equipment, culture vessels	2
	Total number of lectures in section 2	7
UNIT-III **(27.02.18-22.03.18)**	Isolation, maintenance and preservation of cell lines	2
	Manipulation of cell line selection	1
		2

	Types, maintenance and Immobilization of cell lines and its application Production of secondary metabolites- biotransformation, Induction of cell line mutants Germplasm conservation and establishment of gene banks	2 1
	Total number of lectures in section 3	8
UNIT-IV **(23.03.18-26.04.18)**	Gene cloning and transgenic techniques: Techniques for mammalian cells, establishment of immortal cell lines, Cloning in mammalian cells, Expression of mammalian genes in prokaryotic and eukaryotic systems, Extinction of gene function by antisense RNA and DNA. Transfection methods, Embryonic Stem Cell Transfer, Targetted Gene Transfer. - Transgene integration, Detection of Transgenics through Transgene function. Transgenic animals:-Mice, Rabbits, Cattle, Goat, Sheep, Pigs and Fish.	1 2 1 1 2 1 1 5
	Total number of lectures in section 4	14

Evaluation Procedure

1.	Minor Test – I (14-16 Feb, 2018)	20 marks
2	Minor Test – II (4 -6 April, 2018)	20 marks
3.	Assignment / Written Quiz	10 marks

Attendance Record – Candidate should attend at least75% attendance of the total classes held of the subject
Consultation period: Any vacant period.

(Dr Krishan K. Selwal)

BT-606 MS ENVIRONMENT BIOTECHNOLOGY-I

M. Sc Semester - IV (Biotechnology)

L	T	P	Credits	Sessional Marks:	50
4	-	-	04	Theory Marks:	100
				Duration of Exams:3 Hours	

OBJECTIVES:

- To prevent, arrest and reverse environmental degradation through the appropriate use of biotechnology in combination with other technologies.
- To study the conservation of resources via the recycling of waste materials.
- To study the recoveries of more valuable products such as metals, oils, and vitamins with the use of technology.
- To study the role of microorganisms in the recovery of minerals of commercial interest.
- To study the reclaiming of organically polluted water, application of microbes to degrade recalcitrant compounds.
- To study the use of animal waste as fertilizer and recycling of microbial protein as an animal feed and removal of heavy metals found in sewage sledges.
- To promote the use of biotechnological techniques with emphasis on bioremediation of land and water, waste treatment, soil conservation, reforestation, afforestation and land rehabilitation.
- To apply biotechnological processes and their products to protect environmental integrity with a view to long-term ecological security.

OUTCOMES:

- Students will be able to understand the technology based aspect of the subject.
- Able to conduct applied research in basic and translational environment biotechnology
- Understand the reality and potential of biotechnology in the field of renewable energy, the recovery of polluted land and organic waste recycling.
- Know how to apply practical and theoretical knowledge when implementing environmental and food biosafety systems with relation to genetically modified organisms.
- Identify the applicability of the laboratory techniques used in environment biotechnology.
- Able to adopt production processes that make optimal use of natural resources, by recycling biomass, recovering energy and minimizing waste generation.
- In nutshell, environmental biotechnology is the integration of natural and engineering sciences to achieve the application of organisms, cells, parts thereof and molecular analogues for products and services.

TEXT / REFERENCE BOOKS:

1. E.P. Odum: fundamentals of Ecology
2. Amann, R.I. Stromley, J. Stahl: Applied and Environmental microbiology
3. Dash: Concepts of Ecology
4. Varma and Agarwal: Environmental Biology
5. B.K. Sharma: Environmental Chemistry
6. Peavy and Rowe: Environmental Pollution
7. Asthana and Asthana: Environment Problems and Solutions
8. Saigo, Canninhham: Environmental Science
9. M. Eisendbud, Environmental radioactivity, Academic Press
10. E.D.Enger, B.E. Smith, Environmental Science- Astudy of Inter relationships, WCB Publication.

LECTUREWISE PLAN OF THE SUBJECT (08.01.18 to 27.04.18)

Basic Ecological Concepts and Principles (08.01.18) 1

UNIT- I

(09.01.18 to 22.01.18)

Our Environment: Geological Consideration; Scope of Ecology; Principles and concepts of ecosystem	2
Types of ecosystem; Cybernetics and Homeostasis.	1
Energy transfer in an ecosystem; Energy budget; Ecological efficiencies	2
Biogeochemical cycles(N,C,P).	1

(23.01.18 to 07.02.18)

Microbes and Environment: Role of microorganisms in natural system and artificial system.	3
Influence of Microbes on the Earth's Environment and Inhabitants; Microbes and Nutrient cycles.	3
Organic farming and reforestation applications.	2

UNIT- II

(09.02.18 to 23.02.18)

Ecotoxicology: Definition; classification of toxicants in environment	2
Factors affecting toxicity; Bio-transformation of toxicants; Bio-accumulation.	1
Biodiversity: Definition; Historical and geographical causes for diversity;	1
Types of diversity; Biodiversity hot spots in India; Methods of biodiversity conservation; Gene banks; Cryopreservation; Vulnerability and extinction of biodiversity;	2+2
Introduction to biodiversity database: endangered animals, endemism and Red data books.	2+2
Bioremediation and Bioaugmentation; Definition; Types; Future prospects with applications	

UNIT – III

(26.02.18 to 14.03.18)

Environmental Pollution: Concept of Environmental Pollution; Origin of pollution.	2
Classification and nature of Environmental Pollutants; Major air pollutants and their sources.	3
Particulate matter; Formation of fog and photochemical smog and acid rain;	2
Types, sources and consequences of water pollution, ecological and biochemical aspects of water pollution; water pollution control.	2+1

(16.03.18 to 26.03.18)

Types and possible hazards of radioactive substances; Effects of radioactive waste pollution on environment and impact of radiation on life.	2
Concept of soil pollution; Control of soil pollution; Concept of solid waste; Major sources of solid waste; Technical approach for solid waste management	2+2

UNIT – IV

(27.03.18 to 17.04.18)

Environment Quality control.	1
Quality of environment for life on earth and man	1
Deterioration of environmental quality with reference to anthropogenic impact	2
Methods of assessment of environmental quality; Concept of Remote sensing.	1+2
Application of remote sensing in environmental studies	1

(18.04.18 to 27.04.18)

Concept of Geographical Information System	2
Types of Geographical Data;.	2
Importance of GIS in environmental studies	1

Home Assignments :4 –5 assignments are given during the semester.

Evaluation Procedure

1.	Surprise Quiz/ Tutorial Test	05 Marks
2.	Assignment / Project / Performance in the Class	05 Marks
3.	Minor Tests (Two tests having equal weight age) Minor Test I : 14-16 Feb, 2018 Minor Test II : 4 -6 April, 2018	40 Marks
4.	Major test (University Examination)	100 Marks

Award of Grades Based on Absolute Marks: The University is following the system of grading based on absolute marks (after applying moderation if any). Following grading will be done based on the % of marks obtained in all the components of evaluation part of the subject.

A+ (90% - 100 %), A (80% - 89%), B+ (70% - 79%) , B(62% - 69%), C+ (55% - 61%),C (46% - 54%), D (40% - 45), F (Less than 40 %)

For F grade, a candidate shall be required to appear in the major test of concerned course only in the subsequent examination(s) to obtain the requisite marks/grade.

Attendance Record – Candidate should attend at least75% attendance of the total classes held of the subject

Chamber consultation hour: Any vacant period.

Note:

1. In the semester examination, the examiner will set 08 questions in all selecting two from each unit (1 & 2 from unit I, 3 & 4 from unit II, 5 &6 from unit III and 7 & 8 from unit IV). The students will be required to attempt only 5 questions selecting at least one question from each unit. All questions will carry equal marks.
2. The use of scientific calculator will be allowed in the examination. However, programmable calculator and cellular phone will not be allowed.

(Dr. Sonia Dahiya)

BT- 608 MS BIOETHICS, BIOSAFETY AND IPR

M. Sc. Semester -IV (Biotechnology)

L	P	Credits			
4	--	4	Class Work	:	50 Marks
			Examination	:	100 Marks
			Total	:	150 Marks
			Duration of Examination	:	3 Hours

OBJECTIVES:

1. To review the basic concepts of Bioethics.
2. To develop an intuitive understanding of ethical issues related to biotechnology and biomedical research and their impact to living system.
3. To educate public with the processes of biotechnology involved in generating new forms of life for informed decision making
4. To identify Socioeconomic Impacts of Biotechnology
5. To analyze Beneficial applications and development of research focus to the need of the poor, identification of directions for yield effect in agriculture
6. To study the intuitive understanding of bioremediation and environmental impacts of release of GMOs,
7. To review the social issues to biotechnology.
8. To study and understand about Intellectual property rights, and Intellectual Property protection
9. To understand the development and need of patents and methods of application of patents
10. To develop an intuitive understanding of trade secret, copy rights, trade mark, legal implications, farmer's rights, plant breeder's rights.
11. To study Historical Background & Introduction to Biological Safety Cabinets and Primary Containment for Biohazards.
12. To understand about the Biosafety Levels & their Specificity regarding the microorganisms.
13. To analyze recommended Biosafety levels for infectious agents and infected animals; Biosafety guidelines issued by Government of India.
14. To analyze GMOs & LMOs and their impact on Environment.
15. To develop an intuitive understanding of Roles of Institutional Biosafety Committee, RCGM, GEAC etc. for GMO applications in food and agriculture sectors
16. To study the Overview of National Regulations and relevant International Agreements including Cartagena Protocol

OUTCOME:

6. Able to Know about the bioethics related to biotechnology and biomedical research.
7. Able to know the social and ethical issues relating to the generation of new life forms and their impacts on social life.
8. Able to understand about intellectual property rights and protections, patents and their application methods.
9. Able to find the need of copyrights, legal implications, Trade Marks, Trade Secrets and farmer's and plant Breeder's right.
10. Able to understand about Biosafety levels, their need to develop in the institutions and role of Institutional Biosafety committee.

Books:

1. Thomas, J.A. and Fuch, R.L. Biotechnology and Safety Assessment. Academic Press. (2002).

2. Fleming, D.A., Hunt, D.L., Biological safety Principles and practices. ASM Press. (2000).
3. Sateesh, M.K. Bioethics &Biosaftey, IK Publishers. (2008).
4. Sassaon A. Biotechnologies and development. UNESCO Publications. (1988).
5. Sasson A. Biotechnologies in developing countries, UNESCO Publishers, (1993).
6. Singh K., Intellectual Property Rights on Biotechnology BCIL, New Delhi. (2008).

LECTUREWISE PROGRAMME: (from 08.01.18 to 27.04.18)

Introduction of the subject (08.01.18)	1
UNIT- I	
BIOETHICS (09.01.18 to 05.02.18)	
Reviews of basic concept of Bioethics	2
Ethical issues related to biotechnology and biomedical research	2
Ethical issues and their impact to living system	3
Public education of the processes of biotechnology involved in generating new forms of life for informed decision making	3
UNIT- II	
SOCIOECONOMIC IMPACTS OF BIOTECHNOLOGY (06.02.18 to 23.02.18)	
Introduction to the Socioeconomic Impacts of Biotechnology	2
Beneficial applications and development of research focus to the need of the poor	2
Identification of directions for yield effect in agriculture	2
Bioremediation and environmental impacts of release of GMOs	2
Social issues to biotechnology	1
UNIT – III	
INTELLECTUAL PROPERTY RIGHTS (24.02.18 to 27.03.18)	
Intellectual property rights, and Intellectual Property protection	2
Patents and methods of application of patents	2
Trade secret, copy rights, trade mark, legal implications, farmers rights, plant breeder's rights	2
International and National conventions on Biotechnology and related areas.	2
GATT, TRIPS, Biodiversity convention, etc	1
UNIT – IV	
BIOSAFETY (28.03.18 to 27.04.18)	
Introduction of Biosafety; Historical Background; Introduction to Biological Safety Cabinets	2
Primary Containment for Biohazards; Biosafety Levels	2
Biosafety Levels of Specific Microorganisms; Recommended Biosafety Levels for Infectious Agents and Infected Animals	2
Biosafety guidelines - Government of India	2
Definition of GMOs & LMOs, Environmental release of GMOs	1
Roles of Institutional Biosafety Committee, RCGM, GEAC etc. for GMO applications in food and agriculture	3
Overview of National Regulations and relevant International Agreements including Cartagena Protocol	2

Home Assignments: 4 –5 assignments are given during the semester.

Evaluation Procedure

1.	Surprise Quiz/ Tutorial Test	5 Marks
2.	Assignment / Project / Performance in the Class	5 Marks
3.	Minor Tests (Two tests having equal weightage) Minor Test I : 14-16 Feb, 2018 Minor Test II : 4 -6 April, 2018	15 Marks

4.	Major test (University Examination)	75 Marks

Award of Grades Based on Absolute Marks: The University is following the system of grading based on absolute marks (after applying moderation if any). Following grading will be done based on the % of marks obtained in all the components of evaluation part of the subject.
A+ (90% - 100 %), A (80% - 89%), B+ (70% - 79%) , B(62% - 69%), C+ (55% - 61%),C (46% - 54%), D (40% - 45), F (Less than 40 %)

For F grade, a candidate shallbe required to appear in the major test of concerned course only in the subsequent examination(s) to obtain the requisite marks/grade.

Attendance Record – Candidate should attend at least75% attendance of the total classes held of the subject

Chamber consultation hour: Any vacant period.

Note:

3. In the semester examination, the examiner will set 08 questions in all selecting two from each unit (1 & 2 from unit I, 3 & 4 from unit II, 5 &6 from unit III and 7 & 8 from unit IV). The students will be required to attempt only 5 questions selecting at least one question from each unit. All questions will carry equal marks.
4. The use of scientific calculator will be allowed in the examination. However, programmable calculator and cellular phone will not be allowed.
5. The use of properties (water, air, steam etc) tables, heat transfer tables, charts is permitted

(Dr. Manjit K. Selwal)

BT – 610 MS BIOTECHNOLOGY LAB – X

M. Sc. Semester - IV (Biotechnology)

L	P	Credits			
--	4	2	**Class Work**	:	**50 Marks**
			Examination	:	**50 Marks**
			Total	:	**100 Marks**
			Duration of Exam	:	**3 hours**

Objectives

1. To study various practices used for animal cell culture
2. To acquaint students with principles and functioning of commonly used instruments
3. To evaluate various media used for animal cell culturing
4. To perform experiments like SRID & DID , IE used for disease diagnosis
5. To study methods to characterize the microbial pathogens
6. To study methods of isolation of bacterial pathogens

Outcomes

1. Students will develop an insight into practices to be followed for generation and maintenance of animal cell cultures
2. Able to learn diagnostic procedures for identification of microbial pathogens
3. Able to identify the different antibiotics effective on bacterial pathogens

List of Experiments/Exercises

8.01.18-31.1.18 (Total no. of Labs-4)

1. Sterilization of plastic ware and glass ware used in animal cell culture.
2. To demonstrate the principle and functioning of commonly used instruments in animal biotechnology lab.
3. Preparation of various media used for animal cell culturing.
4. Trypsinization of monolayer and subculturing.

1.02.18-2.03.18(Total no. of Labs-3)

5. To perform SRID, DID for disease diagnosis.
6. Immunoelectrophoresis for detection of pathogens.
7. To perform biochemical tests for identification of pathogens.

5.03.18-30.03.18 (Total no. of Labs-4)

8. To detect blood groups of the given samples.
9. To perform TLC, DLC of the given blood samples.
10. To study the microbial flora of skin.
11. To determine the microbial content of dental cavities.

2.04.18-27.4.18 (Total no. of Labs-4)

12. To perform widal for diagnosis of typhoid.
13. To perform VDRL for diagnosis of syphilis.
14. To demonstrate the effect of different antibiotics on bacterial pathogens.

TEXT /REFERENCE BOOKS

1. Practical microbiology cappuccino & Sherman .
2. Practical immunology by GP Talwar.
3. Practical technology by Hudson & Hay.

Note: The students will be required to perform 08 experiments/ exercises from the above list and the other two experiments may be designed by the department based on the related theory course.

EVALUATION PROCEDURE

1.	Test / Viva	20 marks
2.	Class performance	20 marks
3.	Practical Records	10marks
4.	Major Test (University examination)	50 marks

Award of grades will be according to university rules and regulations.

Attendance record- Candidate should have atleast 75% attendance of the total classes held in the subject.

Chamber Consultation hour: Any vacant period

(Dr Pamela Singh)

M. Sc. SEMESTER – IV(BIOTECHNOLOGY)
BT612MS : BIOTECHNOLOGY LAB-XI

L	T	P	Credits
-	-	4	4

Class Work Marks : 50 **Exam Marks : 50**
Total Marks : 100 **Duration of Exam : 3 Hrs.**

COURSE OBJECTIVES:

1. To understand the Preparation of buffers and general lab rules.
2. Awareness of Biotechnology Research implication.
3. Awareness about the type of micro-organism from diverse habitats.
4. To understand the microbial degradation process.

OUTCOME:

11. Able to understand the concept and utility of lab rules and safety aspects related to environmental Biotechnology.

12. Able to understand the from experiments the concept of the course.

13. Able to comprehend and develop the scientific temper related to the biotechnology.

14. Discussion of the related environmental BT labs.

15. Motivation in students for continuous learning and improvement of experimentation skills advancement & skills.

BOOKS/WEB REFERENCES

1. Microbiology manual: KR Aneja
2. Biotechnology manual: By Dubey
3. Deptt lab manual
4. Microbiology manual : Cappucino and Sherman
5. Bergeys manual od systematic microbiology
6. Internet resources

List of Experiments/Exercises (from 08.01.18 to 27.04.18)	**For each batch A & B**
09.01.18 to 20.01.18	
Lab rules, handling of instruments and preparation of solution and buffers	1,1
Effect of pesticides on soil microbes	1,1
Repeat if missed/ interested students	1,1
23.01.18 to 31.01.18	
Microbial degradation of textile dyes/pesticides/hydrocarbons and oil	2,2
Effect of heavy metals on microbial growth.	1,1
Repeat if missed/ interested students	1,1
02.02.18 to 23.02.18	
Isolation of Rhizospheric bacteria	1,1
Isolation and screening of microorganisms involved in degradation of xenobiotics	2,2
Repeat if missed/ interested students	1,1
26.02.18 to 14.03.18	
Isolation of Nitrogen fixers/ phosphate solubilizers	2,2
Wastewater analysis for physico-chemical characteristic	2,2
Repeat if missed/ interested students	1,1

16.03.18 to 26.03.18

Vermicomposting: collection, preparation and analysis of composted material for NPK, moisture holding and microbial load.	2,2
Repeat if missed/ interested students	1,1

27.03.18 to 17.04.18

Microorganisms from polluted environment/soil /water resources/ air	2,2
Pollutant removal using microorganisms from industrial effluent	1,1
Repeat if missed/ interested students	1,1

Evaluation Procedure

1.	Surprise Quiz/ Tutorial Test	10 Marks
2.	Assignment / Project / Performance in the Class	10 Marks
3.	Minor Tests (Two tests having equal weightage) Minor Test I : 14-16 Feb, 2018 Minor Test II : 4 -6 April, 2018	15 Marks
4.	Major test (University Examination, Semester end Exam)	50 Marks

Award of Grades Based on Absolute Marks: The University is following the system of grading based on absolute marks (after applying moderation if any). Following grading will be done based on the % of marks obtained in all the components of evaluation part of the subject.

A+ (90% - 100 %), A (80% - 89%), B+ (70% - 79%) , B(62% - 69%), C+ (55% - 61%),C (46% - 54%), D (40% - 45), F (Less than 40 %)

For F grade, a candidate shall be required to appear in the major test of concerned course only in the subsequent examination(s) to obtain the requisite marks/grade.

Attendance Record – Candidate should attend at least75% attendance of the total classes held of the subject

(Dr. Dharmender Kumar)
Department of Biotechnology