

FACULTY OF LIFE SCIENCES
SYLLABI
FOR
B.Sc. (Hons.) Biotechnology Third Year
(5th and 6th Semester)
CBCS SYSTEM
(Session: 2018-2019)



MATA GUJRI COLLEGE
FATEHGARH SAHIB-140406, PUNJAB



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**B. Sc. (Hons.) Biotechnology Third Year
(5th and 6th Semester)
Subject and Distribution of Marks
(Academic Session 2018-19)
Semester V**

Paper No and code	Name of paper	Credit per week	Internal Marks*	External Marks	Total Marks
Paper-XIX (C11-501)	Bioprocess technology	4	25	75	100
Paper-XX (C12-12 502)	Recombinant DNA Technology	4	25	75	100
Paper-XXI (DSE 1-503)	Discipline Specific Elective	4	25	75	100
Paper-XXII (DSE-2 504)	Any 2 DSE Subjects in semester 5 from List page no 7	4	25	75	100
Paper-XXIII (GE 5-505)	General Elective Chemistry/Botany/Zoology	4	25	75	100
LC-18(C11-501)	Lab Course: Pertaining to theory paper XIX	2	--	50	50
LC-19(C12-502)	Lab Course: Pertaining to theory paper XX	2	--	50	50
LC-20(DSE1-503)	Lab Course: Pertaining to theory paper -XXI	2	--	50	50
LC-21(DSE2-504)	Lab Course: Pertaining to theory paper -XXII	2		50	50
LC-22(GE-5 505)	Lab Course: Pertaining to theory paper-XXIII	2	--	50	50
Total		30	125	625	750

Semester - VI

Paper No and code	Name of paper	Credit/ Week	Internal Marks*	External Marks	Total Marks
Paper-XXIV (C13-601)	Bio analytical tools	4	25	75	100
Paper-XXV (C14-602)	Genomics and proteomics	4	25	75	100
Paper-XXVI(DSE 3 603)	Any 2 DSE Subjects in semester 6 from List page no 7	4	25	75	100
Paper-XXVII(DSE4-604)		4	25	75	100
Paper-XXVIII(GE6-605)	General Elective Chemistry/Botany/Zoology	4	25	75	100
LC-23 (C13-601)	Lab Course: Pertaining to theory paper XXIV	2	--	50	50
LC-24 (C14-602)	Lab Course: Pertaining to theory paper XXV	2	--	50	50
LC-25 (DSE 3-603)	Lab Course: Pertaining to theory paper -XXVI	2	--	50	50
LC-26 (DSE4-604)	Lab Course: Pertaining to theory paper-XXVII	2	--	50	50
LC-27 (GE6-605)	Lab Course: Pertaining to theory paper XXVIII	2	--	50	50
Total		30	125	625	750

*Internal assessment (25): Seminar (5 Marks) MST (10 Marks), Assignments (5), Attendance for the seminar/symposium/industrial/Educational visit (5 marks)

**B.Sc.(Hon.)Biotechnology Third Year
(Semester V)**

Paper XIX (C-11-501) - Bioprocess Technology

Course Objective:

1. This course enables students to understand the concept of sterilization, bioreactors and mass transfer and their equipment design.
2. This course enables students to understand Upstream and downstream processing in the bioprocess technology
3. This course facilitates students to acquire the knowledge about scale up and bioprocess economics.

Lectures to be delivered 60

M. Marks : 75

Time allowed : 3 Hrs.

Pass Marks : 35%

INSTRUCTIONS FOR THE PAPER SETTER/CANDIDATE

The question paper will consist of three sections. Section A and B (Consist of unit I and II of the syllabus, respectively) will have four questions each from respective units and candidates are required to attempt two questions each from section A and B. Each question in section A and B shall carry 15 marks. Section C will consist of 10 short answer type questions covering entire syllabus and the candidates are required to attempt all questions. Each question in section C will carry 1.5 marks.

UNIT-I

Introduction: Bioprocess, Bioprocess engineering, Biochemical engineering, upstream and down stream processing (USP and DSP).

Bioreactors: Construction of Bioreactor, Types of bioreactors, (STR, airlift, packed bed fluidized. Cyllindro-conical).

Bioprocess control and monitoring systems: Sensors (inline, on line, off line), Methods of measuring process variables (temperature, flow rate, pressure, biomass, dissolved oxygen, oxygen in air, stirring, pH).

Sterilization principles and practices: methods of media sterilization (heat and filter), criteria of sterilization, batch and continuous sterilization systems, sterilization of bioreactors.

Aeration and agitation: aeration and agitation systems for bioreactors and their design.

Mass transfer coefficient: KLa, determination of KLa (sulphite oxidation and gassing out method), factors affecting KLa value.

UNIT-II

Down stream processing (DSP): Methods of cell separation from fermentation medium (filtration and centrifugation).

Cell Breakage: Physical and chemical methods of cell breakage.

Recovery/purification of byproducts: solid-liquid extraction, liquid-liquid extraction, dialysis, chromatographic techniques (adsorption, ion exchange, molecular sieve; high performance liquid chromatography) distillation, drying.

Scale up: optimization and scale up of bioprocesses.

Bioprocess economics: cost determination of bioprocess, capital

investment for equipments, raw materials, consumables and other costs etc.

Recent advancement in the bioprocess engineering.

Books Recommended:

1. Bioprocess Engineering by Michael L. Shuler and Fikret Kargi. Pearson Education London UK.
2. Bioprocess Engineering Principles by Pauline M. Doran. Academic Press San Diego California.
3. Biochemical Engineering by A. Aiba, A.E. Humphery and N.F. Mkili University of Tokyo.
4. Biotechnology Vol : 1, 2 and 7 by Moo Young, Pergamoon Press, NY,
5. Comprehensive Biotechnology Vol. 2 by Moo Young, Pergamnon Press, NY.
6. Fundamentals of Biotechnology by P. Prave, F. Eaus, W. Sitting and D.A. Sukatech, ECH Weinheim.
7. Biochemical Engienering Fundamentals by J.E. Bailey and D.F. Ollis, McGraw Hill Co., NY.
8. Methods in Industrial Microbiology by B. Sikyata, Ellis Horwood Ltd., London.
9. Principles of Fermentation Technology by P.F. Stanbury and A. Whitaker, Pergamnon Press, NY

Lab Course LC 18- Pertaining to: Paper XIX (C-11-501)- Bioprocess Technology

Practical Time 4 Hrs/Week

M. Marks : 50

Time allowed for Examination: 3 Hrs.

Pass Marks : 35%

INSTRUCTIONS FOR THE PAPER SETTER/CANDIDATE

The Final practical paper will consist of three sections A, B and C. Section A will contain write up (12.5 Marks) from the list of practical pertaining to lab course. Section B will contain practical to perform in examination (25 Marks) Section C will contain, practical note Book Evaluation and Viva Voce (12.5 Marks).

List of Practicals :

1. Introduction to laboratory scale bioreactor and its fabrication.
2. Determine thermal death time of culture and evaluate sterilization techniques.
3. Evaluation of cell disruption technique for extraction of intracellular components in Bacteria.
4. Production and analysis of amylase.
5. Evaluation of effectiveness of biomass harvesting techniques in downstream processing.
5. Extraction of protein by ammonium sulfate and Acetone extraction.
6. Distillation for the separation of bioethanol.
7. Drying of Byproducts

Paper XX (C-12 -502) Recombinant DNA Technology

Course Objective:

1. To make the students conversant with tools and techniques of recombinant DNA technology
2. To make the student acquire sound knowledge of DNA libraries and cloning aspect in organisms.
3. To acquaint the student with application of RDT in industry and agriculture

Lectures to be delivered 60

M. Marks : 75

Time allowed : 3 Hrs.

Pass Marks : 35%

INSTRUCTIONS FOR THE PAPER SETTER/CANDIDATE

The question paper will consist of three sections. Section A and B (Consist of unit I and II of the syllabus, respectively) will have four questions each from respective units and candidates are required to attempt two questions each from section A and B. Each question in section A and B shall carry 15 marks. Section C will consist of 10 short answer type questions covering entire syllabus and the candidates are required to attempt all questions. Each question in section C will carry 1.5 marks.

UNIT-I

Molecular tools and applications- Introduction to R DNA technology and its tools: restriction enzymes, ligases, polymerases, alkaline phosphatase. Transformation, Plasmids(pBR322, pUC18) and other cloning vectors (Bacteriophage-derived vectors M13), Transformation techniques. Principle and applications of Polymerase chain reaction (PCR) and RT- (Reverse transcription) PCR.

Restriction and modification system: Restriction mapping. Southern and Northern hybridization. Preparation and comparison of Genomic and cDNA library, screening of recombinants. Genome mapping, DNA fingerprinting, Applications of Genetic Engineering in animals: Production and applications of transgenic mice, Therapeutic products produced by genetic engineering-blood proteins and vaccines (one example each).

UNIT II (25 Periods)

Random and site-directed mutagenesis: Primer extension and PCR based methods of site directed mutagenesis, Random mutagenesis, Gene shuffling, production of chimeric proteins.

Genetic engineering in plants: Use of *Agrobacterium tumefaciens* and *A. rhizogenes*, Ti plasmids, Strategies for gene transfer to plant cells, Direct DNA transfer to plants, Gene targeting in plants, Use of plant viruses as episomal expression vectors..

Books Recommended:

1. Brown TA. (2006). Gene Cloning and DNA Analysis. 5th edition. Blackwell Publishing, Oxford, U.K.
2. Clark DP and Pazdernik NJ. (2009). Biotechnology-Applying the Genetic

Revolution. Elsevier Academic Press, USA.

3. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington
4. Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford, U.K.
5. Sambrook J, Fritsch EF and Maniatis T. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press.

**Lab Course LC 19 Pertaining to XX (C-12 -502) Recombinant DNA
Technology**

Practical Time 4 Hrs/Week

M. Marks : 50

Time allowed for Examination: 3 Hrs.

Pass Marks : 35%

INSTRUCTIONS FOR THE PAPER SETTER/CANDIDATE

The Final practical paper will consist of three sections A, B and C. Section A will contain write up (12.5 Marks) from the list of practical pertaining to lab course. Section B will contain practical to perform in examination (25 Marks) Section C will contain, practical note Book Evaluation and Viva Voce (12.5 Marks).

List of Practicals:

1. Isolation of chromosomal DNA from plant cells
2. Isolation of chromosomal DNA from *E.coli*
3. Qualitative and quantitative analysis of DNA using spectrophotometer
4. Plasmid DNA isolation
5. Restriction digestion of DNA
6. Making competent cells
7. Transformation of competent cells.
8. Demonstration of PCR

List of Discipline Specific Elective

- 1. Optional Dissertation or project work in place of one Discipline Specific Elective Paper (6 credits) in 5th Semester**
- 2. Student can Choose any two DSE paper in 5th and 6th Sem form the given bellow List**

Paper XXI (503)-XXII (504) DSE(1 and 2) for 5th Semester

1. Bioinformatics
2. Animal Biotechnology
3. Medical Microbiology
4. Biostatistics
5. Ecology and Environment Management

Paper XXVI (603)-XXVII (604) DSE (3 and 4) for 6th Semester

1. Environmental Biotechnology
2. Microbial Physiology
3. Biochemical Engineering
- 4. Food Biotechnology**

Discipline Specific Elective Paper XXI (503)-XXII (504) DSE-1 and 2, for 5th Semester

**Paper XXI (503)-XXII (504) DSE-1 and 2
Option-1 Bioinformatics**

Course Objective:

1. To make the student familiar with the fundamentals of computer and Bioinformatics.
2. To become familiar with Sequence Analysis and Phylogenetic Trees & their construction

Lectures to be delivered

60

M. Marks : 75

Time allowed : 3 Hrs.

Pass Marks : 35%

INSTRUCTIONS FOR THE PAPER SETTER/CANDIDATE

The question paper will consist of three sections. Section A and B (Consist of unit I and II of the syllabus, respectively) will have four questions each from respective units and candidates are required to attempt two questions each from section A and B. Each question in section A and B shall carry 15 marks. Section C will consist of 10 short answer type questions covering entire syllabus and the candidates are required to attempt all questions. Each question in section C will carry 1.5 marks.

UNIT-I

Bioinformatics and its databases: Definition, introduction and applications. Biological database: Types of databases, Primary, secondary and specialized databases

Search Engines and Format: Entrez, Information retrieval from biological database. Sequence format: Genbank, FASTA.

Sequence databases: INSDC Introduction to submission (sequin, bankit). Prosite, PDB, SCOP

UNIT-II

Sequence alignment: Methods and goals, local and global alignment. Scoring matrices.

Homology analysis: Introduction to Orthologs, paralogs, analogs..Applications of homology analysis.

Sequence and Phylogeny analysis :Introduction to BLAST, using it on the web, Interpreting results, Multiple Sequence Alignment, Phylogenetic Analysis

Books Recommended:

1. Ghosh Z. and Bibekanand M. (2008) Bioinformatics: Principles and Applications. Oxford University Press.
2. Pevsner J. (2009) Bioinformatics and Functional Genomics. II Edition. Wiley-Blackwell.
3. Campbell A. M., Heyer L. J. (2006) Discovering Genomics, Proteomics and Bioinformatics. II Edition. Benjamin Cummings.

Lab Course LC 20/21- Pertaining to: Option-1 Bioinformatics

Practical Time 4 Hrs/Week

M. Marks : 50

Time allowed for Examination: 3 Hrs.

Pass Marks : 35%

INSTRUCTIONS FOR THE PAPER SETTER/CANDIDATE

The Final practical paper will consist of three sections A, B and C. Section A will contain write up (12.5 Marks) from the list of practical pertaining to lab course. Section B will contain practical to perform in examination (25 Marks) Section C will contain, practical note Book Evaluation and Viva Voce (12.5 Marks).

Practical's List :

1. Sequence information resource
2. Understanding and use of various web resources: EMBL, Genbank, Entrez, Unigene,
1. Protein information resource (PIR)
2. Understanding and using: PDB, Swissprot, TREMBL
3. Using various BLAST and interpretation of results.
4. Retrieval of information from nucleotide databases.
5. Sequence alignment using BLAST.
6. Multiple sequence alignment using Clustal W.

**Paper XXI (503)-XXII (504) DSE-1 and 2
Option-II Animal Biotechnology**

Course Objective:

1. This course enables students to understand the concept of Tools and techniques of for animal cell culture for the production of transgenic animals.
2. It also deals with various gene transfer methods.

Lectures to be delivered 60

M. Marks : 75

Time allowed : 3 Hrs.

Pass Marks : 35%

INSTRUCTIONS FOR THE PAPER SETTER/CANDIDATE

The question paper will consist of three sections. Section A and B (Consist of unit I and II of the syllabus, respectively) will have four questions each from respective units and candidates are required to attempt two questions each from section A and B. Each question in section A and B shall carry 15 marks. Section C will consist of 10 short answer type questions covering entire syllabus and the candidates are required to attempt all questions. Each question in section C will carry 1.5 marks.

UNIT-I

Introduction to animal culture: History, media composition, Initiation, isolation of animal material, Organ culture, cell culture, Gas and nutrient exchange, large scale culture of animal cell lines, somatic cell fusion, Hybridoma technology.

Tissue engineering: Basic concept of tissue engineering, components of tissue engineering

Cell culture based vaccines: cell culture based vaccines, cells as protein factory, Scaling up of the animal cell culture: different methods of scale up at laboratory and industrial level.

UNIT II

Transgenic animals and their applications: Concept of transgenics, strategies for gene transfer, Methods of transfection in animals. Applications of transgenic animals, Safety and ethical issues of transgenic animals.

In vitro fertilization (IVF): in Humans and Embryo Transfer technology in cattle.

Applications of Animal cell culture: Applications of animal cell culture and its products.

Books Recommended:

1. Brown, T.A. (1998). Molecular biology Labfax II: Gene analysis. II Edition. Academic Press, California, USA.
2. Butler, M. (2004). Animal cell culture and technology: The basics. II Edition. Bios scientific publishers.
3. Glick, B.R. and Pasternak, J.J. (2009). Molecular biotechnology- Principles and applications of recombinant DNA. IV Edition. ASM press, Washington, USA.
4. Griffiths, A.J.F., J.H. Miller, Suzuki, D.T., Lewontin, R.C. and Gelbart,

W.M. (2009). An introduction to genetic analysis. IX Edition. Freeman & Co., N.Y., USA.

5. Watson, J.D., Myers, R.M., Cauchy, A. and Witkowski, J.K. (2007). Recombinant DNA Genes and genomes- A short course. III Edition. Freeman and Co., N.Y., USA.

Lab Course LC 20/21- Pertaining to: Option-II-Animal Biotechnology

Practical Time 4 Hrs/Week

M. Marks : 50

Time allowed for Examination: 3 Hrs.

Pass Marks : 35%

INSTRUCTIONS FOR THE PAPER SETTER/CANDIDATE

The Final practical paper will consist of three sections A, B and C. Section A will contain write up (12.5 Marks) from the list of practical pertaining to lab course. Section B will contain practical to perform in examination (25 Marks) Section C will contain, practical note Book Evaluation and Viva Voce (12.5 Marks).

Practical's List :

1. Sterilization techniques: Theory and Practical: Glass ware sterilization, Media sterilization, Laboratory sterilization
2. Sources of contamination and decontamination measures.
3. Preparation of Hanks Balanced salt solution
4. Preparation of Minimal Essential Growth medium
5. To check the viability of the cells using Trypan Blue dye exclusion assay.
6. Checking the cytotoxicity of the compounds using MTT Assay.

Paper XXI (503)-XXII (504) DSE-1 and 2

Option-III Medical Microbiology

Course Objective:

1. This course facilitates students to study normal microflora, pathogenicity, laboratory diagnosis, chemotherapy of gram negative and positive bacteria.
2. This course enables students to understand the concept of viral and fungal infections.

Lectures to be delivered

60

M. Marks : 75

Time allowed : 3 Hrs.

Pass Marks : 35%

INSTRUCTIONS FOR THE PAPER SETTER/CANDIDATE

The question paper will consist of three sections. Section A and B (Consist of unit I and II of the syllabus, respectively) will have four questions each from respective units and candidates are required to attempt two questions each from section A and B. Each question in section A and B shall carry 15 marks. Section C will consist of 10 short answer type questions covering entire syllabus and the candidates are required to attempt all questions. Each question in section C will carry 1.5 marks.

UNIT I

Introduction: Normal microflora of human body, nosocomial infections, carriers, septic shock, septicemia, pathogenicity, virulence factors, toxins, biosafety levels. Morphology, pathogenesis, symptoms, laboratory diagnosis, preventive measures and chemotherapy of gram positive bacteria: *S.aureus*, *S.pyogenes*, *B.anthraxis*, *C.perferinges* *C.tetani*, *C.botulinum*, *C.diphtheriae* *M.tuberculosis* and *M. leprae*.

Morphology, pathogeneis, symptoms: laboratory diagnosis, preventive measures and chemotherapy caused by gram negative bacteria: *E.coli*, *N. gonorrhoea*, *N. meningitidis*, *P.aeruginosa*, *S. typhi*, *S. dysenteriae*, *Y. pestis*, *B. abortus*, *H. influenzae*, *V. cholerae*, *M pneumoniae*, *T. pallidum* and *M. pneumoniae*.

UNIT II

Diseases caused by viruses- Picornavirus, Orthomyxoviruses, Paramyxoviruses, Rhabdoviruses, Reoviruses, Pox virus, Herpes virus, Papova virus, Retro viruses (including HIV/AIDS) and Hepatitis viruses.

Fungal and Protozoan infections: Dermatophytoses (*Trichophyton*, *Microsporun* and *Epidermophyton*) Subcutaneous infection (*Sporothrix*, *Cryptococcus*), systemic infection (*Histoplasma*, *Coccidoides*) and opportunistic fungal infections (*Candidiasis* *Aspergillois*), Gastrointestinal infections (Amoebiasis, Giardiasis), Blood-borne infections (Leishmaniasis, Malaria)

Books Recommended:

1. Brooks GF, Carroll KC, Butel JS and Morse SA. (2007). Jawetz, Melnick

and Adelberg's

2. Medical Microbiology. 24th edition. McGraw Hill Publication.
3. Goering R, Dockrell H, Zuckerman M and Wakelin D. (2007). Mims' Medical Microbiology. 4th edition. Elsevier. .
3. Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. 7th edition. McGraw Hill Higher Education.

Lab Course LC 20/21- Pertaining to: Option-III-Medical Microbiology

Practical Time 4 Hrs/Week

M. Marks : 50

Time allowed for Examination: 3 Hrs.

Pass Marks : 35%

INSTRUCTIONS FOR THE PAPER SETTER/CANDIDATE

The Final practical paper will consist of three sections A, B and C. Section A will contain write up (12.5 Marks) from the list of practical pertaining to lab course. Section B will contain practical to perform in examination (25 Marks) Section C will contain, practical note Book Evaluation and Viva Voce (12.5 Marks).

Practical's List :

1. Identification of pathogenic bacteria (any two) based on cultural, morphological and biochemical characteristics.
2. Growth curve of a bacterium.
3. To perform antibacterial testing by Kirby-Bauer method.
4. To prepare temporary mounts of *Aspergillus* and *Candida* by appropriate staining.
4. Staining methods: Gram's staining permanent slides showing Acid fast staining, Capsule staining and spore staining.

**Paper XXI (503)-XXII (504) DSE-1 and 2
Option-IV-Biostatistics**

Lectures to be Delivered **60** **M. Marks : 75**

Time allowed: **3 Hours** **Pass Marks : 35%**

INSTRUCTIONS FOR THE PAPER SETTER/CANDIDATE

The question paper will consist of three sections. Section A and B (Consist of unit I and II of the syllabus, respectively) will have four questions each from respective units and candidates are required to attempt two questions each from section A and B. Each question in section A and B shall carry 15 marks. Section C will consist of 10 short answer type questions covering entire syllabus and the candidates are required to attempt all questions. Each question in section C will carry 1.5 marks.

UNIT-I

Introduction to Biostatistics: Basic definitions and applications.

Data collection and presentation: Types of data, methods of collection of primary and secondary data.

Methods of data presentation: Diagrammatic representation by line and bar diagram, General rules for constructing diagram.

Measures of central tendency: Mean, Median, Mode.

Measures of variability: Range, Quartile deviation, standard deviation.

Correlation and regression: Positive and negative correlation, Karl-Pearsons co-efficient of correlation

UNIT-II

Regression: Linear regression, coefficients of regression.

Skewness: Measures of Skewness, Karl-Pearsons coefficient of skewness.

Theory of Probability: Introduction to probability, Terminology, A PRIORI Probability, Addition and Multiplication theorems (without proof) or Probability.

Random variable: Definition, Types, Distribution function.

Mathematical expectations: Theorems on expectation, variable of linear combination Probability.

Distributions: Binomial poisson (definitions and Problems).

Books Recommended:

1. Bliss, C.I.K. Statistics in biology, Vol. 1, Mac-Graw Hill, NewYork.
2. Bailey, N.T. J. Statistical Methods in Biology, English Univ. Press.
3. Lachin, Biostatistical Methods.
4. Campbell, RC Statistics for Biologist, Cambridge University Press, UK.
5. Sokal, R S. and James, F. Introduction to Biostatistics.
6. Banerjee PK . Introduction to biostatistics, 3rd edition, Chand Publishers.
7. S.C Gupta, Fundamentals of Statistics.

Lab Course LC 20/21- Pertaining to: Option-IV-Biostatistics

Practical Time 4 Hrs/Week

M. Marks : 50

Time allowed for Examination: 5 Hrs.

Pass Marks : 35%

INSTRUCTIONS FOR THE PAPER SETTER/CANDIDATE

The Final practical paper will consist of three sections A, B and C. Section A will contain write up (12.5 Marks) from the list of practical pertaining to lab course. Section B will contain practical to perform in examination (25 Marks) Section C will contain, practical note Book Evaluation and Viva Voce (12.5 Marks).

Practical's List :

1. Representation of Statistical data by a) Bar b) Line c) Pie diagrams.
2. Determination of Statistical averages/ central tendencies.
a) Arithmetic mean b) Median c) Mode.
3. Determination of measures of Dispersion
a) Mean deviation b) Standard deviation and coefficient of variation.
4. Problem based on binomial and poisson distribution.

**Paper XXI (503)-XXII (504) DSE-1 and 2
Option-V Ecology And Environment Management**

Course Objectives:

1. Its objective is to study our environment.
2. To study pollution and environmental health.

Lectures to be delivered

60

M. Marks : 75

Time allowed : 3 Hrs.

Pass Marks : 35%

INSTRUCTIONS FOR THE PAPER SETTER/CANDIDATE

The question paper will consist of three sections. Section A and B (Consist of unit I and II of the syllabus, respectively) will have four questions each from respective units and candidates are required to attempt two questions each from section A and B. Each question in section A and B shall carry 15 marks. Section C will consist of 10 short answer type questions covering entire syllabus and the candidates are required to attempt all questions. Each question in section C will carry 1.5 marks.

UNIT-I

Our Environment: Geological consideration of Atmosphere, Hydrosphere, Lithosphere Scope of Ecology. Development & Evolution of Ecosystem. Principles & Concepts of Ecosystem. Structure of ecosystem. Strata of an ecosystem. Types of ecosystem including habitats. Cybernetics & Homeostasis. Biological control of chemical environment.

Energy transfer in an Ecosystem: Food chain, food web, Energy budget, Production & decomposition in a system. Ecological efficiencies, Trophic structure & energy pyramids, Ecological energetic, principles pertaining to limiting factors, Bio-geochemical cycles (N, C, P cycles).

UNIT-II

Pollution & environmental Health related to Soil, Water, Air, Food, Pesticides, Metals, Solvents, Radiations. Detection of Environmental pollutant. Indicators & detection systems.

Bio-transformation: Plastic, Aromatics, Hazardous wastes Environmental cleanup: Case studies Environmental biotechnologies, Biotechnologies in protection and preservation of environment. Bioremediation, Waste disposal

Books Recommended:

1. Chapman, J.L., Reiss, M.J. 1999. Ecology: Principles and applications (2nd edition) Cambridge University Press.
2. Divan Rosencraz, Environmental laws and policies in India, Oxford Publication.
3. Ghosh, S.K., Singh, R. 2003. Social forestry and forest management. Global Vision Publishing House
4. Joseph, B., Environmental studies, Tata Mc Graw Hill.
5. Michael Allabay, Basics of environmental science, Routledge Press.
6. Miller, G.T. 2002. Sustaining the earth, an integrated approach. (5th edition) Books/Cole, Thompson Learning, Inc.

7. Mohapatra Textbook of environmental biotechnology IK publication.
8. Rana SVS, Environmental pollution – health and toxicology, Narosa Publication
9. Sinha, S. 2010. Handbook on Wildlife Law Enforcement in India. TRAFFIC, India.
10. Thakur, I S, Environmental Biotechnology, I K Publication

Lab Course LC 20/21- Pertaining to Option-V- Ecology And Environment Management

Practical Time 4 Hrs/Week

M. Marks : 50

Time allowed for Examination: 3 Hrs.

Pass Marks : 35%

INSTRUCTIONS FOR THE PAPER SETTER/CANDIDATE

The Final practical paper will consist of three sections A, B and C. Section A will contain write up (12.5 Marks) from the list of practical pertaining to lab course. Section B will contain practical to perform in examination (25 Marks) Section C will contain, practical note Book Evaluation and Viva Voce (12.5 Marks).

Practical's List :

1. Study of all the biotic and abiotic components of any simple ecosystem- natural pond or terrestrial ecosystem or human modified ecosystem.
2. Determination of population density in a terrestrial community or hypothetical community by quad rate method and calculation of the Simpson's and Shannon- Weiner diversity index for the same community.
3. Principle of GPS (Global Positioning System).
4. Study of the life table and fecundity table, plotting of the three types of survivorship curves from the hypothetical data.
5. Study of the types of soil, their texture by sieve method and rapid tests for –pH, chlorides, nitrates, carbonates and organic carbon
6. Study any five endangered/ threatened species- one from each class

Paper XXIII (GE 5 505) – Chemistry -5 (Organic Chemistry-II)

Lectures to be Delivered 60

M. Marks : 75

Time allowed: 3 Hours

Pass Marks : 35%

INSTRUCTIONS FOR THE PAPER SETTER/CANDIDATE

INSTRUCTIONS FOR THE PAPER SETTER/CANDIDATE

The question paper will consist of three sections. Section A and B (Consist of unit I and II of the syllabus, respectively) will have four questions each from respective units and candidates are required to attempt two questions each from section A and B. Each question in section A and B shall carry 15 marks. Section C will consist of 10 short answer type questions covering entire syllabus and the candidates are required to attempt all questions. Each question in section C will carry 1.5 marks

SECTION – A

Dienes and Alkynes: Nomenclature of dienes and alkynes. Isolated, Conjugated, Cumulated Dienes, structure of Allenes, butadiene; Polymerisation of dienes, chemical reactions 1, 2 and 1, 4 additions; Diels alder reaction. Chemical reactions of alkynes, acidity of alkynes. Mechanism of electrophilic and nucleophilic addition reactions, Hydroboration-oxidation, Metal-NH₃ reductions, oxidation and polymerization.

Alkyl Halides: Nomenclature and classes of alkyl halides, Methods of preparation including Finkelstein and Hunsdiecker reaction. Chemical reactions. Mechanisms of nucleophilic substitution reactions of alkyl halides, SN¹ and SN² mechanism with stereo- chemical aspects and effect of solvent, Nucleophilic substitution versus elimination, Haloform reaction with Mechanistic details.

Aromatic Hydrocarbons: Aromaticity: Huckel's rule, aromatic character of arenes, cyclic carbocations/carbanions and heterocyclic compounds with suitable examples, antiaromaticity and nonaromaticity. Structure and stability of benzene: Electrophilic Aromatic substitution : Halogenation, nitration, sulphonation, and Friedel-craft's alkylation/acylation with their mechanism. Stability of wheland intermediates (Sigma complex). Activation/deactivation of the aromatic ring and directing effects of the groups.

Aryl Halides

Nomenclature of aryl halides; methods of formation; nucleophilic aromatic substitution. Addition-elimination and elimination-addition mechanisms of nucleophilic aromatic substitution reactions. Relative reactivities of alkyl halides, allyl, Benzyl, vinyl and aryl halides towards the nucleophilic substitutions.

Section -B

Alcohols: Classification and nomenclature. Monohydric alcohols :- Nomenclature,

methods of formation by reduction of aldehydes, ketones, carboxylic acids and esters. Hydrogen bonding. Acidic nature of alcohols, Reactions of alcohols. Dihydric alcohols: Nomenclature, methods of formation, chemical reactions of vicinal glycols, oxidative cleavage with $\text{Pb}(\text{OAc})_4$ and HIO_4 and pinacol-pinacolone arrangement. Trihydric alcohols: Nomenclature, method of formation and chemical reactions of glycerol.

Phenols, Ethers and Epoxides :- Phenols: Nomenclature, structure and bonding. Preparation of phenols, physical properties and acidic character. Comparative acidic strengths of alcohols and phenols, resonance stabilization of phenoxide ion. Reaction of phenols-electrophilic aromatic substitution, acylation and carboxylation, Mechanism of Fries rearrangement, acylation and carboxylation. Gatterman synthesis, Hauben Hoesch reaction. Leaderr Manasse reaction and Reimer-Tiemann reaction.

Aldehydes and Ketones: Nomenclature and structure of the carbonyl group. Synthesis of aldehydes and ketones with particular reference of the synthesis of aldehydes from acid chlorides, synthesis of aldehydes and ketones using 1,3 – dithianes, synthesis of ketones from nitriles and from carboxylic acids, physical properties and mechanism of nucleophilic addition to carbonyl group with particular emphasis of Benzoin, Aldol, Perkin and Knoevenagel condensations, Condensation with ammonia and its derivatives, Wittig reaction and Mannich reaction. Use of acetals as protecting group, Oxidation of aldehydes, Baeyer-Villiger oxidation of ketones, Cannizzaro reaction, MPV reaction, Clemmensen, Wolff-kishner reduction, LiAlH_4 and NaBH_4 reductions, Halogenation of enolizable ketones.

Reference :

- Robert Thornton Morrison and Robert Neilson Boyd, organic chemistry, Dorling Kindersley (India) pvt. Ltd. (Pearson Education).
- I.L. Finar, Organic Chem. (Vol-I) Dorling Kindersley (India) pvt.ltd (Pearson Education).
- Robert Thornton Morrison and Robert Neilson Boyd; Organic Chemistry; Darling Kindersley (India) Pvt. Ltd. (Pearson education).
- Fred W. Billmeyer, textbook of polymer science, John Wiley & sons Inc.
- I.L. Finar, organic chemistry (volume I) Dorling Kindersley (India) pvt.Ltd. (Pearson education).

Lab Course LC22 (GE 5-505)-Pertaining to Chemistry Paper

Practical Time 3 Hrs/Week

M. Marks : 50

Time allowed for Examination: 4 Hrs

Pass Marks : 35%

INSTRUCTIONS FOR THE PAPER SETTER/CANDIDATE

The Final practical paper will consist of three sections A, B and C. Section A will contain write up (25 Marks) from the list of practical pertaining to lab course. Section B will contain practical to perform in examination (50 Marks) Section C will contain, practical note Book Evaluation and Viva Voce (25 Marks).

1. Qualitative analysis: Detection of elements (N, S and halogens) and functional groups (phenolic, carboxylic, carbonyl, esters, carbohydrates, amines, amides, nitro and anilide in simple organic compounds
2. Preparation of derivatives of compounds having functional groups: (phenolic, carboxylic, carbonyl, esters, carbohydrates, amines, amides, nitro and anilide).

**B.Sc. (Hons.) Biotechnology Third Year
(Semester VI)**

Paper XXIV (C13-601) Bioanalytical Tools

Course Objectives:

1. To make the students conversant with basics of biotechniques.
2. To acquaint the students with concepts of important fundamental, principles and applied application of bioanalytical techniques.

Lectures to be delivered

60

M. Marks : 75

Time allowed : 3 Hrs.

Pass Marks : 35%

INSTRUCTIONS FOR THE PAPER SETTER/CANDIDATE

The question paper will consist of three sections. Section A and B (Consist of unit I and II of the syllabus, respectively) will have four questions each from respective units and candidates are required to attempt two questions each from section A and B. Each question in section A and B shall carry 15 marks. Section C will consist of 10 short answer type questions covering entire syllabus and the candidates are required to attempt all questions. Each question in section C will carry 1.5 marks.

UNIT-I (25 Periods)

Spectroscopy: Principle and applications of Atomic absorption spectrophotometry, Infrared spectroscopy, Introduction to Nuclear Magnetic Resonance, Electron Spin Resonance.

Mass spectrometry: Principle and applications of mass spectrometry.

Electrophoresis: Starch-gel, polyacrylamide gel (native and SDS-PAGE), agarose-gel electrophoresis, pulse field gel electrophoresis, immuno- electrophoresis, isoelectric focusing, Western blotting.

Microscopy: Properties; Light and Bright field Microscopy, Dark field Spectroscopy Microscopy; Phase contrast, Electron microscopy: Scanning and Transmission Electron Microscopy.

Unit – II

Centrifugation: Basic Principles and applications of centrifugation.

Crystallography: X-ray diffraction, Braggs law, Determination of crystal structure.

Chromatography: Types of chromatography, Principle and Application of paper chromatography, thin layer chromatography, column chromatography, affinity chromatography, gas chromatography and HPLC.

Radioisotope techniques: Radiotracers technique, GM counter, Use of isotopes as tracers in biological sciences.

Books Recommended:

1. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley& Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8th edition Lippincott Williams and Wilkins, Philadelphia.
3. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition.

ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.

4. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009

Lab Course LC 23 Pertaining to Paper XXIV (C-13-601)- Bioanalytical Tools

Practical Time 4 Hrs/Week

M. Marks : 50

Time allowed for Examination: 3 Hrs.

Pass Marks : 35%

INSTRUCTIONS FOR THE PAPER SETTER/CANDIDATE

The Final practical paper will consist of three sections A, B and C. Section A will contain write up (12.5 Marks) from the list of practical pertaining to lab course. Section B will contain practical to perform in examination (25 Marks) Section C will contain, practical note Book Evaluation and Viva Voce (12.5 Marks).

Practical's List:

1. Native gel electrophoresis of proteins
2. SDS-polyacrylamide slab gel electrophoresis of proteins under reducing conditions.
3. Preparation of the sub-cellular fractions of rat liver cells.
4. Preparation of protoplasts from leaves.
5. Separation of amino acids by paper chromatography.
6. To identify lipids in a given sample by TLC.
7. To verify the validity of Beer's law and determine the molar extinction coefficient of different substances.

Paper XXV (C14-602) -Genomics & Proteomics

Course Objectives:

1. To make the students conversant with methods of sequencing and various softwares for genome analysis.
2. To acquaint the students with concepts of protein structure and various methods to study protein structure.

Lectures to be delivered

60

M. Marks : 75

Time allowed : 3 Hrs.

Pass Marks : 35%

INSTRUCTIONS FOR THE PAPER SETTER/CANDIDATE

The question paper will consist of three sections. Section A and B (Consist of unit I and II of the syllabus, respectively) will have four questions each from respective units and candidates are required to attempt two questions each from section A and B. Each question in section A and B shall carry 15 marks. Section C will consist of 10 short answer type questions covering entire syllabus and the candidates are required to attempt all questions. Each question in section C will carry 1.5 marks.

UNIT-I (25 Periods)

Introduction to Genomics, DNA sequencing methods – manual & automated: Maxam & Gilbert and Sangers method. Pyrosequencing, Genome Sequencing: Shotgun & Hierarchical (clone contig) methods, Computer tools for sequencing projects: Genome sequence assembly software.

Managing and Distributing Genome Data: Web based servers and softwares for genome analysis:ENSEMBL, VISTA Genome Browser, NCBI genome. Selected Model Organisms'Genomes and Databases.

UNIT II (35 Periods)

Introduction to protein structure: Chemical properties of proteins. Physical interactions that determine the property of proteins. Short-range interactions, electrostatic forces, van der waalinteractions, hydrogen bonds, Hydrophobic interactions. Determination of sizes (Sedimentationanalysis, gel filtration, SDS-PAGE); Native PAGE, Determination of covalent structures –Edman degradation.

Introduction to Proteomics: Analysis of proteomes. 2D-PAGE. Sample preparation, solubilization, reduction, resolution. Reproducibility of 2D-PAGE. Mass spectrometry based methods for protein identification. *De novo* sequencing using mass spectrometric data.

Books Recommended:

1. Genes IX by Benjamin Lewin, Johns and Bartlett Publisher, 2006.
2. Modern Biotechnology, 2nd Edition, S.B. Primrose, Blackwell Publishing, 1987.
3. Molecular Biotechnology: Principles and Applications of Recombinant DNA, 4th Edition,
1. B.R. Glick, J.J. Pasternak and C.L. Patten, 2010.
4. Molecular Cloning: A Laboratory Manual (3rd Edition) Sambrook and Russell Vol. I to III, 1989.

5. Principles of Gene Manipulation 6th Edition, S.B.Primrose, R.M.Twyman and R.W. Old. Blackwell Science, 2001.
6. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc.
2. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. IX Edition. Benjamin Cummings.
3. Russell, P. J. (2009). *Genetics- A Molecular Approach*. III Edition. Benjamin Cummings.
4. Glick, B.R., Pasternak, J.J. (2003). *Molecular Biotechnology- Principles and Applications of recombinant DNA*. ASM Press, Washington.
5. Pevsner, J. (2009). *Bioinformatics and Functional Genomics*. II Edition. John Wiley & Sons.

Lab Course LC 24 Pertaining to Paper XXV (C-14-602)- Genomics & Proteomics

Practical Time 4 Hrs/Week

M. Marks : 50

Time allowed for Examination: 3 Hrs.

Pass Marks : 35%

INSTRUCTIONS FOR THE PAPER SETTER/CANDIDATE

The Final practical paper will consist of three sections A, B and C. Section A will contain write up (12.5 Marks) from the list of practical pertaining to lab course. Section B will contain practical to perform in examination (25 Marks) Section C will contain, practical note Book Evaluation and Viva Voce (12.5 Marks).

Practical's List:

1. Use of SNP databases at NCBI and other sites
2. Use of OMIM database
3. Detection of Open Reading Frames using ORF Finder
4. Proteomics 2D PAGE database
5. Softwares for Protein localization.
6. Hydropathy plots
7. Protein structure prediction.

Discipline Specific Elective

- 1) **Optional Dissertation or project work in place of one Discipline Specific Elective Paper (6 credits) in 5th Semester can be opted.**
- 2) **Student can Choose any two DSE paper in 5th and 6th Sem form the given bellow List**

Paper XXI (503)-XXII (504) DSE(1 and 2) for 5th Semester

1. **Bioinformatics**
2. **Animal Biotechnology**
3. **Medical Microbiology**
4. **Biostatistics**
5. **Ecology and Environment Management**

Paper XXVI (603)-XXVII (604) DSE (3 and 4) for 6th Semester

1. **Environmental Biotechnology**
2. **Microbial Physiology**
3. **Biochemical Engineering**
4. **Food Biotechnology**

Discipline Specific Elective

Paper XXVI (603)-XXVII (604) DSC-3 and 4 Option-I Environmental Biotechnology

Course Objectives:

1. The main objective of this course is to impart students an understanding of pollution of environment by air, water and soil responsible for degradation of natural resources and degradation of biodiversity.
2. It also familiarizes them with various remediation techniques, nonpolluting technologies viz. bioenergy and biomining.

Lectures to be delivered

60

M. Marks : 75

Time allowed : 3 Hrs.

Pass Marks : 35%

INSTRUCTIONS FOR THE PAPER SETTER/CANDIDATE

The question paper will consist of three sections. Section A and B (Consist of unit I and II of the syllabus, respectively) will have four questions each from respective units and candidates are required to attempt two questions each from section A and B. Each question in section A and B shall carry 15 marks. Section C will consist of 10 short answer type questions covering entire syllabus and the candidates are required to attempt all questions. Each question in section C will carry 1.5 marks.

UNIT-I

Introduction to environment: Pollution, Types of pollution, hazards

Air pollution: sources , types of air pollutants, hazards, units of measurement

Water pollution: sources, types, effects, physical, chemical and biological water quality parameters

Treatment technologies I: Activated sludge treatment, oxidation ponds, lagoons, trickling filters, RBC.

UNIT II

Treatment technologies II: Biogas production, mechanism, microbiology, UASB, Anaerobic filter reactor, factors effecting biogas production.

Bioremediation: Types, application for treatment of heavy metals, pesticides.

Bioleaching: Types, processes, applications by enrichment of ores by microorganisms (Gold, Copper and Uranium).

Biosensors: Biosensors, types , applications in pollutant detection.

Books Recommended:

1. A text book of biotechnology, R.C Dubey, S. Chand & company ltd. New Delhi.
2. Environmental Biotechnology, Pradipta Kumar Mohapatra
3. Industrial water pollution control, W. Wesley Elbenfields Mc graw Hill

international Editions.

4. Environmental Engineering, Howard and Peevy, Donald R. Rowe and George technologies, Mc Graw Hill International edition (1988).

5. Advances in industrial wastewater treatment edited by P.K.Goel, technoscience publications, First editions.

6. Basic Environmental Science by G.S.P Iyer, Educational Publishers and Distributors, New Delhi.

7. Principles of Environmental Engineering, Gilbert Masters

Lab Course LC 25/26- Pertaining to: Option-1-Environmental Biotechnology

Practical Time 4 Hrs/Week

M. Marks : 50

Time allowed for Examination: 3 Hrs.

Pass Marks : 35%

INSTRUCTIONS FOR THE PAPER SETTER/CANDIDATE

The Final practical paper will consist of three sections A, B and C. Section A will contain write up (12.5 Marks) from the list of practical pertaining to lab course. Section B will contain practical to perform in examination (25 Marks) Section C will contain, practical note Book Evaluation and Viva Voce (12.5 Marks).

Practical's List:

1. Calculation of Total Dissolved Solids (TDS), Total solids, Hardness and alkalinity of water sample.
2. Calculation of Dissolved oxygen in water sample.
3. Calculation of BOD of water sample.
4. Calculation of COD of water sample.
5. Bacterial Examination of Water by MPN Method.
6. Determination of chromium concentration in the water sample by DPC method

**Paper XXVI (603)-XXVII (604) DSE-3 and 4
Option-II- Microbial Physiology**

Course Objectives:

1. The main objective of this course is to impart students an understanding of Nutritional classification of microorganisms and growth curves.
2. It also familiarizes them with effect of the environment on microbial growth and phototrophic metabolism.

Lectures to be delivered 60

M. Marks : 75

Time allowed : 3 Hrs.

Pass Marks : 35%

INSTRUCTIONS FOR THE PAPER SETTER/CANDIDATE

The question paper will consist of three sections. Section A and B (Consist of unit I and II of the syllabus, respectively) will have four questions each from respective units and candidates are required to attempt two questions each from section A and B. Each question in section A and B shall carry 15 marks. Section C will consist of 10 short answer type questions covering entire syllabus and the candidates are required to attempt all questions. Each question in section C will carry 1.5 marks.

UNIT I

Nutritional classification of microorganisms based on carbon, energy and electron sources, Metabolite Transport, Diffusion: Passive and facilitated, Primary active and secondary active transport, Group translocation (phosphotransferase system), symport, antiport and uniport, electrogenic and electro neutral transport, transport of Iron.

Microbial Growth. Definition of growth, balanced and unbalanced growth, growth curve, the mathematics of growth-generation time, specific growth rate, batch and continuous culture, synchronous growth, diauxie growth curve. Measurement of microbial growth. Measurement of cell numbers, cell mass and metabolic activity

UNIT II

Effect of the environment on microbial growth: Temperature- temperature ranges for microbial growth, classification based on temperature ranges and adaptations, pH-classification based on pH ranges and adaptations, solutes and water activity, oxygen concentration, radiation and pressure. Chemolithotrophic metabolism Physiological groups of aerobic and anaerobic chemolithotrophs. Hydrogenoxidizing bacteria and methanogens.

Phototrophic metabolism. Historical account of photosynthesis, diversity of phototrophic bacteria, anoxygenic and oxygenic photosynthesis, photosynthetic pigments: action and absorption spectrum, type, structure and location, physiology of bacterial photosynthesis: light reactions, cyclic and non-cyclic photophosphorylation. Carbon dioxide fixation, Calvin cycle and reductive TCA cycle

Books Recommended:

1. Gottschalk G. (1986). Bacterial Metabolism. 2nd edition. Springer Verlag
2. Madigan MT, Martinko JM and Parker J. (2003). Brock Biology of Microorganisms. 10th edition. Pearson/ Benjamin Cummings.
3. Moat AG and Foster JW. (2002). Microbial Physiology. 4th edition. John Wiley & Sons.
4. Reddy SR and Reddy SM. (2005). Microbial Physiology. Scientific Publishers India.
5. Stanier RY, Ingrahm JI, Wheelis ML and Painter PR. (1987). General Microbiology. 5th edition, McMillan Press.
7. Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. 7th edition. McGraw Hill Higher Education.

Lab Course LC 25/26- Pertaining to Option-II- Microbial Physiology

Practical 4 Hrs/Week

M. Marks : 50

Time

Time allowed for Examination: 3 Hrs.

Pass Marks : 35%

INSTRUCTIONS FOR THE PAPER SETTER/CANDIDATE

The Final practical paper will consist of three sections A, B and C. Section A will contain write up (12.5 Marks) from the list of practical pertaining to lab course. Section B will contain practical to perform in examination (25 Marks) Section C will contain, practical note Book Evaluation and Viva Voce (12.5 Marks).

Practical's List:

1. To study and plot the growth curve of *E coli* using turbidometric method and to calculate specific growth rate and generation time.
2. To study and plot the growth curve of *Aspergillus niger* by radial growth measurements.
3. To study the effect of pH on the growth of *E. coli*
4. To study the effect of temperature of *Aspergillus niger* by dry weight method.
5. Demonstration of the thermal death time and decimal reduction time of *E. coli*.

**Paper XXVI (603)-XXVII (604) DSE-3 and 4
Option-III Biochemical Engineering**

Course Objective:

1. This course enables students to understand the concept of sterilization, bioreactors and mass transfer and their equipment design.
2. This course enables students to understand Upstream and downstream processing in the bioprocess technology
3. This course facilitates students to acquire the knowledge about scale up and bioprocess economics.

Lectures to be delivered 60

M. Marks : 75

Time allowed : 3 Hrs.

Pass Marks : 35%

INSTRUCTIONS FOR THE PAPER SETTER/CANDIDATE

The question paper will consist of three sections. Section A and B (Consist of unit I and II of the syllabus, respectively) will have four questions each from respective units and candidates are required to attempt two questions each from section A and B. Each question in section A and B shall carry 15 marks. Section C will consist of 10 short answer type questions covering entire syllabus and the candidates are required to attempt all questions. Each question in section C will carry 1.5 marks.

UNIT I

Microbial Growth Kinetics: Thermodynamic principles, Stationary cell growth, Growth yield, Specific growth rate, Product yield, Saturation constant, Biomass energetics, Yield equations based on YG, YO₂, YATP, Maintenance energy, Growth kinetics of batch, fed-batch, plug flow and continuous culture, High cell density cultures; Types of fermentation depending upon the product formation, Product synthesis kinetics, Growth and non-growth associated product synthesis.

Bioreactors and Scale up: Basic concepts of bioreactors, parameters of biochemical process, packed bed, fed-batch, bubble column, fluidized bed, trickle bed, CSTR, plug flow reactors, Innovative bioreactors, Reactor Dynamics and reactors with non-ideal characteristics; Translation of laboratory, pilot and plant scale data, Criteria for translation between two scale of operation, Scale-up practices; Manual and automatic control system, on-line and off-line analytical instruments.

UNIT II

Kinetics and Engineering of Sterilization: Kinetics of media sterilization, design of batch sterilization process, D-time, Z-value and F-value, calculation of Del-factor and holding time, Richards rapid method for design of sterilization cycles, Design of continuous sterilization, Air sterilization-design of air filters, Effect of air velocity and bed depth on filtration.

Mass Transfer and Downstream Processing: Fluids and its properties, Non-Newtonian fluids, introduction to transport phenomena, Gas-liquid mass transfer, mass transfer resistances, and determination of oxygen transfer coefficient;

Recovery and purification of products from fermentation broth, Main Unit Operations in downstream processing, Membrane separation (microfiltration and ultrafiltration), Disruption of microbial cells

Books Recommended:

1. Biochemical Engineering: Aiba and Hemphery
2. Biochemical Engineering Fundamentals: J. E. Bailey and D. F. Ollis
3. Principles of Microbes and Cell Cultivation: S. John Pirt
4. Bioprocess Engineering Principles: Pauline M. Doran
5. Principles of fermentation technology: P.F. Stanbury and A. Whitekar

Lab Course LC 25/26- Pertaining to Option-III Biochemical Engineering

Practical Time 4 Hrs/Week

M. Marks : 50

Time allowed for Examination: 3 Hrs.

Pass Marks : 35%

INSTRUCTIONS FOR THE PAPER SETTER/CANDIDATE

The Final practical paper will consist of three sections A, B and C. Section A will contain write up (12.5 Marks) from the list of practical pertaining to lab course. Section B will contain practical to perform in examination (25 Marks) Section C will contain, practical note Book Evaluation and Viva Voce (12.5 Marks).

Practical's List:

1. Microbial Growth kinetics-Determination of specific growth rate (μ_{max}), saturation constant (KS) and growth yield (YX/S) for *Saccharomyces cerevisiae* in batch culture.
2. Determination of KLa by sulphite oxidation method.
3. Determination of thermal death rate constant and decimal reduction time for *E. coli*.
4. Disruption of microbial cells (Baker's yeast) for the release of the intracellular protein.
5. Bio-transformation of sucrose into high fructose syrup by immobilized cell of
a. *Saccharomyces cerevisiae*

**Paper XXVI (603)-XXVII (604) DSE-3 and 4
Option-IV Food Biotechnology**

Course Objective:

- 1.This course enables students to understand the composition of food, food fermentation.
- 2.This course enables students to understand value added products and food spoilage.

Lectures to be delivered

60

M. Marks : 75

Time allowed : 3 Hrs.

Pass Marks : 35%

INSTRUCTIONS FOR THE PAPER SETTER/CANDIDATE

The question paper will consist of three sections. Section A and B (Consist of unit I and II of the syllabus, respectively) will have four questions each from respective units and candidates are required to attempt two questions each from section A and B. Each question in section A and B shall carry 15 marks. Section C will consist of 10 short answer type questions covering entire syllabus and the candidates are required to attempt all questions. Each question in section C will carry 1.5 marks.

UNIT I

Historical Background, Composition of Food, Improvement of food resources through Biotechnology (e.g. Golden Rice, Potato etc.), Traditional fermented foods (meat, fish, bread, sauerkraut, soy bean, coffee, cocoa, tea)

Food Fermentations: Fermented milk, Cheese, Butter, Yoghurt Alcoholic beverages (Beer, Wine, Whisky), Sauerkraut, Pickles, Soy products, Tea, coffee etc.

Value addition products: like High Fructose Syrup, Invert Sugars etc. SCPs (e.g. Spirulina, Yeast etc.) as food supplements, Edible fungus: Mushrooms Potential of Probiotics

UNIT II

Flavour enhancers: Nucleosides, nucleotides and related compounds Organic acids (Citric acid, Acetic acid) and their uses in foods/food products Importance of Vitamins and their supplementation in foods and feedstock. Food preservation and storage Food Processing

Growth of microorganisms in food: Intrinsic and extrinsic factors Food Spoilage (microbial and non-microbial) Control mechanisms of food spoilage: Physical and Chemical Food and water borne diseases: Gastroenteritis, Diarrhea, Shigellosis, Salmonellosis, Typhoid, Cholera, Polio, Hepatitis, Dental Infections, etc.

Food borne intoxications: Staphylococcal, Bacillus, Clostridium etc. Detection of food-borne pathogens.

Books Recommended:

1. Food Sciences and Food biotechnology- G.F.G. Lopez, G. Canaas, E.V.Nathan
2. Genetically Modified Foods- M.Ruse, D. Castle (Eds.)

3. Biotechnology of Food Crops in Developing Countries- T.Hohn and K.M. Leisinger (Eds.)
4. Biotechnology and Food Process Engineering- H.G. Schwartzberg, M.A. Rao (Eds.) 64
6. Food Biotechnology- (Eds.) R.Angold, G.A.Beech, J.Taggart.
5. Food Biotechnology—Microorganisms-(Ed.) Y.H. Hui et al

Lab Course LC 25/26- Pertaining to Option-IV Food Biotechnology

Practical Time 4 Hrs/Week

M. Marks : 50

Time allowed for Examination: 3 Hrs.

Pass Marks : 35%

INSTRUCTIONS FOR THE PAPER SETTER/CANDIDATE

The Final practical paper will consist of three sections A, B and C. Section A will contain write up (12.5 Marks) from the list of practical pertaining to lab course. Section B will contain practical to perform in examination (25 Marks) Section C will contain, practical note Book Evaluation and Viva Voce (12.5 Marks).

Practical's List:

1. Estimation of Total Plate Count in any food sample.
2. Detection of *Salmonella*, *E. coli* in food material.
3. MBRT test of milk samples.
4. Malt preparation for beer making.
5. Cheese making (Non-ripened cheese).
6. Sauerkraut production
7. Acetic acid/Vinegar Production and estimation of the product.
8. Toxin detection in the food materials.
9. Effect of internal factors on microbial growth in food *i.e.* pH, Temperature, Water Activity

Paper XXVIII (GE-6-605) –Chemistry -6 (Physical Chemistry -II)

Lectures to be Delivered **60**

M. Marks : 75

Time allowed: **3 Hours**

Pass Marks : 35%

INSTRUCTIONS FOR THE PAPER SETTER/CANDIDATE

INSTRUCTIONS FOR THE PAPER SETTER/CANDIDATE

The question paper will consist of three sections. Section A and B (Consist of unit I and II of the syllabus, respectively) will have four questions each from respective units and candidates are required to attempt two questions each from section A and B. Each question in section A and B shall carry 15 marks. Section C will consist of 10 short answer type questions covering entire syllabus and the candidates are required to attempt all questions. Each question in section C will carry 1.5 marks

SECTION – A

Conductance:-

Electrolytic conduction, specific conductance, equivalent conductance, relation between specific and equivalent conductance ,variation of equivalent and specific conductance with dilution, ionic mobility, transport numbers, method of determination of transport number by Hittof's method and moving boundry method, Debye-Huckel Onsager equation for strong electrolytes.

Electrochemistry:-

Introduction, galvanic cells, half reactions and reversible electrodes, electrode potential, Nernst equation, standard hydrogen electrode, reference electrodes, standard electrode potentials ,electrochemical series and its significance, chemical cells, reversible and irreversible cells with examples, concentration cells ,liquid junction potential, acid base titrations ,applications of EMF corrosion.

Solutions and Colligative Properties:-

Ideal and non- ideal solutions, lowering of vapour pressure, Raoults's and Henry's law and their applications. Diffusion and osmosis, osmotic pressure, law of osmotic pressure, elevation in boiling point, Depression in freezing point and Cryoscopy, Relative lowering of vapour pressure applications in Calculating molar masses of abnormal, dissociated and associated solutes in solution

Surface Chemistry:-

Adsorption, absorption, adsorbent, adsorption by solids, applications of adsorption, factors influencing adsorption, The Freundlich & Langmuir theory of adsorption. solution.

SECTION -B

The Colloidal state:-

Classification of colloids, Lyophobic & Lyophilic sols, preparation of colloidal solutions , purification of colloidal solutions , optical properties, emulsions ,gels, importance & application of colloids.

Statistical Thermodynamics:-

Types of statistics (Maxwell-Boltzmann, Bose-Einstein, Fermi-Dirac Statistics), partition function, molecular ,translational, rotational, vibrational, electronic, nuclear partition function, thermodynamic properties in terms of the partition function, molar partition function of a system, entropy and probability, classical statistical mechanics-phase space, ensembles, ensemble average.

Phase Rule:-

Phase, components, degrees of freedom, conditions of equilibrium between phases, Gibbs phase rule, one component systems-H₂O, CO₂ , sulphur system and desilverisation of lead, two component system-type A-simple eutectic system Ag-Pb,Bi-Cd,KI-H₂O,typeB-formation of compounds with congruent and incongruent melting points -FeCl₃-H₂O,Mg-Zn,NaCl-H₂O, CuSO₄-H₂O,freezing mixtures ,acetone-dry ice.

Catalysis:-

Introduction, homogeneous and heterogeneous catalytic reactions, acid base catalysis ,enzyme catalysis, mechanism of enzyme catalysis, The Michaelis -Menten equation, promoters, Inhibitors.

Macromolecules:-

Macromolecules and polymers, classification of polymers (isotactic, atactic, syndiotactic, stereoregular, graft polymers) polymerization reaction, determination of molar mass of polymer by weight average and number average method, PDI.

References:-

1. Physical Chemistry by Gurdeep Raj
2. Physical Chemistry by Gurthu
3. Physical Chemistry by Puri Sharma Pathania
4. Physical Chemistry by K L Kapoor
5. Physical Chemistry by G.W.Castellan
6. Physical Chemistry by D.W. Ball
7. Statistical Thermodynamics by M C Gupta

Lab Course LC-28 (GE-6 605) Pertaining to Chemistry Paper

Practical Time 3 Hrs/Week

M. Marks : 50

Time allowed for Examination: 4 Hrs

Pass Marks : 35%

INSTRUCTIONS FOR THE PAPER SETTER/CANDIDATE

The Final practical paper will consist of three sections A, B and C. Section A will contain write up (25 Marks) from the list of practical pertaining to lab course. Section B will contain practical to perform in examination (50 Marks) Section C will contain, practical note Book Evaluation and Viva Voce (25 Marks).

List of Practical:

1. Determine the surface tension of glycerin and ethanol at room temperature using stalagmometer by drop number method.
2. Determine the coefficient of viscosity of glycerin and ethanol using Ostwald viscometer.
3. To determine the solubility of benzoic acid at different temperature and to determine the ΔH of the dissolution process.
4. To determine the heat capacity of calorimeter and enthalpy of neutralization by HCl with NaOH.
5. To study adsorption of acetic acid from aqueous solution by charcoal.
6. To study the effect of acid strength on rate of hydrolysis of ethyl acetate.