FACULTY OF LIFE SCIENCES

SYLLABI

FOR

B.Sc. (Hons.) Biotechnology Third Year

Programme Code BSHBT

(5th and 6th Semester)

CBCS SYSTEM

(Session: 2023–2024)

MATA GUJRI COLLEGE

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B. Sc. (Hons.) Biotechnology Third Year
(5th and 6th Semester)
Subject and Distribution of Marks
(Academic Session 2023-2024)
Semester V

Paper No and code	Name of paper	Credit per week	Internal Marks*	External Marks	Total Marks
BSHBT (C11-501)	Bioprocess technology	4	25	75	100
BSHBT (C12- 502)	Recombinant DNA Technology	4	25	75	100
BSHBT (DSE 1-503)	Discipline Specific Elective Any 2 DSE Subjects /1 DSE Subject and Project work in semester 5 from List page no 7	4	25	75	100
BSHBT (DSE 2 -504)		4	25	75	100
BSHBT (GE 5-505)	General Elective Chemistry/Zoology/Botany	4	25	75	100
LC-18(C11-501)	Lab Course: Pertaining to theory paper 501	2	--	50	50
LC-19(C12-502)	Lab Course: Pertaining to theory paper 502	2	--	50	50
LC-20(DSE1-503)	Lab Course: Pertaining to theory paper 503	2	--	50	50
LC-21(DSE2-504)	Lab Course: Pertaining to theory paper 504	2		50	50
LC-22(GE-5 505)	Lab Course: Pertaining to theory paper 505	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
BSHBT (C13-601)	Bio analytical tools	4	25	75	100
BSHBT (C14-602)	Genomics and proteomics	4	25	75	100
BSHBT (DSE 3- 603)	**Any 2 DSE Subjects in semester 6 from List page no 7**	4	25	75	100
BSHBT (DSE 4-604)		4	25	75	100
BSHBT (GE6-605)	General Elective Chemistry/Zoology/Botany	4	25	75	100
LC-23 (C13-601)	Lab Course: Pertaining to theory paper 601	2	--	50	50
LC-24 (C14-602)	Lab Course: Pertaining to theory paper 602	2	--	50	50
LC-25 (DSE 3-603)	Lab Course: Pertaining to theory paper 603	2	--	50	50
LC-26 (DSE4-604)	Lab Course: Pertaining to theory paper 604	2	--	50	50
LC-27 (GE6-605)	Lab Course: Pertaining to theory paper 605	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.(Hons.)Biotechnology Third Year

(Semester V)

Paper BSHBT (C11-501) - 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.

Learning outcomes: The course will make the student to understand:
1. The role of a bioprocess engineer in chemical, pharmaceutical and distillation industry.
2.The integrated bioprocess, design reactors, maintain contamination free environment in bioprocesses.
3.To develop concepts to scale-up bioprocesses for industry as well as research organizations.

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

Time allowed : 3 Hrs. **Pass Marks : 40%**

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 downstream processing (USP and DSP).

Bioreactors: Construction of Bioreactor, Types of bioreactors, (STR, airlift, packed bed fluidized. Cylindro - 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 and Heat transfer: KLa, determination of KLa (sulphite oxidation and gassing out method), factors affecting KLa value. Heat transfer.

UNIT-II

Downstream 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**.**

Mathematical modeling, Neural networking and computers in fermentation technology.

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 Dieo Caliornia.
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. Bailley 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 501 (C-11-501)- Bioprocess Technology

Practical Time **4 Hrs/Week** **M. Marks : 50**

Time allowed for Examination: 3 Hrs. **Pass Marks : 40%**

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 BSHBT (C12 -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

Learning outcomes: Students will gain an understanding:

1. awareness about various molecular tools
2. The course particularly aims at understanding concept of transformants, its screening methods.
3. Its applications of genetic engineering in plants and animals.

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

Time allowed : 3 Hrs. **Pass Marks :40%**

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). Cloning vectors Plasmids (pBR322, pUC18) and other cloning vectors (Bacteriophage-derived vectors M13).

Transformation & screening: Introduction to transformation and different techniques: Physical, chemical and biological. Screening of recombinants (antibiotic resistance and blue white selection).

Amplification of DNA: Principle and applications of Polymerase chain reaction (PCR) and its various types. Preparation and comparison of Genomic and cDNA libraries.

UNIT II

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 animals: Applications of Genetic Engineering in animals: Production and applications of transgenic mice, Therapeutic products produced by genetic engineering-vaccines and hormones

Genetic engineering in plants: Applications of Genetic Engineering in plants: Production and applications of Bt brinjal and flavr savr tomato

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 502 (C 12 -502) Recombinant DNA Technology

Practical Time 4 Hrs/Week M. Marks : 50

Time allowed for Examination: 3 Hrs. Pass Marks : 40%

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 *E.coli*
2. Qualitative and quantitative analysis of DNA using spectrophotometer
3. Plasmid DNA isolation
4. Restriction digestion of DNA
5. Preparation of Transformants
6. Transformation of competent cells.
7. Demonstration of PCR

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List of Discipline Specific Elective

1. **Optional 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 BSHBT (503)- BSHBT (504) DSE(1 and 2) for 5th Semester

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

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

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

Discipline Specific Elective Paper BSHBT (503)- BSHBT (504) DSE-1 and 2,

for 5th Semester

Paper BSHBT (503) - BSHBT (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 its applications.
3. To construct Phylogenetic Trees & perform evaluation of them.

Learning outcomes: By the end of the course the student will be able to:

1. To uncover how various tools and techniques of bioinformatics can be utilized in studies pertaining to macromolecules (DNA, RNA, protein).
2.To analyze, interpret and study biological data (sequence, structure, etc) stored in various databases available on internet.
3.To construct and evaluate phylogenetic trees and their applications in MSA.

Lectures to be delivered 60 M. Marks : 75

Time allowed : 3 Hrs. Pass Marks : 40%

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, Nucleotide databases:Genbank,DDBJ, EMBL, Protein databases:SWISS PROT,SCOP,PDB.

Retrieval and submission tools: Entrez, Information retrieval from biological database. Introduction to submission tools (sequin, bankit, webin).

UNIT-II

Sequence alignment: Methods and goals, local and global alignment. Scoring matrices.(PAM & BLOSSUM) Introduction to BLAST,types and steps.

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

Sequence and Phylogeny analysis: Multiple Sequence Alignment, (methods and applications), Phylogenetic Analysis: Distance based methods of tree construction (UPGMA, NJ, FM) and evaluation methods (Jack knife, bootstrap).

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 : 40%

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:Entrez
2. Understanding and use of various web resources: Genbank
3. Protein information resource (PIR)
4. Understanding and using: PDB, SWISSPROT, TREMBL
5. Using various BLAST and interpretation of results.
6. Retrieval of information from nucleotide databases.
7. Sequence alignment using BLAST.
8. Multiple sequence alignment using Clustal W.
9. Phylogenetic analysis (Tree explorer).

Option-II Animal Biotechnology

Course Objective:

1. This course enables students to understand the various tools and techniques for animal cell culture for the production of transgenic animals.
2. It also deals with various gene transfer methods and components of tissue engineering.
3. It also deals with applications of animal cell culture and its products.

Learning outcomes: By the end of the course the student will be able to:

1. learn the fundamental concept of animal cell culture techniques, hybridoma technology.
2. understand the concept of tissue engineering and its components.
3. understand the significance of transgenic animals and applications of animal cell culture and its products.

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

Time allowed : 3 Hrs. **Pass Marks : 40%**

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 products: vaccines, recombinant proteins, Scaling up of the animal cell culture.

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, Embryo Transfer technology in cattle, embryo cloning.

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., Caudy, A. and Witkowski, J.K. (2007). Recombinant DNAgenes 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 : 40%**

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. Preparation of Hanks Balanced salt solution
2. Preparation of Minimal Essential Growth medium
3. To check the viability of the cells using Trypan Blue dye exclusion assay.
4. Check the cytotoxicity of the compounds using MTT assay.
5. Demonstration of culturing technique for Animal biotechnology.

Paper BSHBT (503)- BSHBT (504) DSE-1 and 2

Option-III Medical Microbiology

Course Objective:

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

Learning outcomes: Medical Microbiology introduces

1. basic principles and diseases caused by virus
2. applies clinical relevance in four segments of the academic preparation for physicians: immunology, bacteriology, mycology, and virology.
3. learn about fungal and protozoan infections.

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

Time allowed : 3 Hrs. **Pass Marks : 40%**

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.anthracis, 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 Aspergillosis*), 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. .

4. 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 : 40%**

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.
5. Staining methods: Gram's staining permanent slides showing Acid fast staining, Capsule staining and spore staining.

Paper BSHBT (503)- BSHBT (504) DSE-1 and 2
Option-IV- Biostatistics

Lectures to be Delivered	**60**	**M. Marks : 75**
Time allowed:	**3 Hours**	**Pass Marks : 40%**

Course Objective:

1. Utilization of mathematical basics and foundation statistics are mandatory for analysis
2. Interpretation of result of experiments and research work.
3.This course will enrich the students how to utilize various tools of biostatics in interpretation of biological data.

Learning outcomes:

1.Students will be able to characterize data and understand different sampling methods.
2.The course covers core areas of biostatistics including probability
3. The course covers the concept of correlation and regression.

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 : 40%

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 BSHBT (503)- BSHBT (504) DSE-1 and 2
Option-V Ecology And Environment Management

Course Objectives:
1. Its objective is to study various components of environment.
2. To study pollution and environmental health**.**
3.To study the concept of Biotransformation and bioremediation.

Learning outcomes: By the end of the course the student will be able to:
1.An exposure to ecological perspective of the environmental challenges, opportunities, ecological management of the natural environment.
2. Insight into the management of interaction of human with the environment.
3. An insight into how biotechnology can be utilized for protection of environment.

Lectures to be delivered 60 M. Marks : 75

Time allowed : 3 Hrs. Pass Marks : 40%

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. (5thedition) 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 Enforsement 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 : 40%**

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

BSHCHE GE-5: CHEMISTRY V

Lectures to be Delivered 60 **M. Marks : 75**
Time allowed: 3 Hours **Pass Marks : 40%**

Course Objectives

- To get a deep insight into the various spectroscopic methods used for the characterization of organic compounds.
- Enable the students to elucidate the structure of organic compounds by analyzing the spectral data.
- To understand the general concept of reaction kinetics and mechanism of squareplanar and octahedral complexes.
- To identify the substance being oxidized and reduced.
- To know the role of metals in biological system.
- To describe the strength of an acid or base in terms of the extent to which itsmolecules donate or accept protons.

Course Outcomes

After the completion of this course, students will be able to:

CO1 Understand the basic principles of the following spectroscopic techniques: UV/Vis,IR and proton NMR spectroscopy.

CO2 Explain and rationalize the inorganic reaction mechanisms of square planar andoctahedral complexes.

CO3 To describe how the strength of either an acid or base is indicated by the magnitude ofits equilibrium constant.

Instructions for the Paper-Setter

The question paper will consist of three units: I, II and III. Unit I and II will have four questions from each unit of the syllabus and will carry 12 marks each. Unit III will consist of 9 questions from the whole syllabus and will be of 3 marks each.

Instructions for the Candidates

Candidates are required to attempt two questions each from units: I and II, unit III is compulsory. Note: Internal assessment will be given on the basis of mid semester tests (12), class performance (6), assignments/quiz (7).

Unit-I

UV-Visible Spectroscopy

Absorption spectra: Ultraviolet (UV) absorption spectroscopy-absorption laws (Beer- Lambert's law), molar absorptivity, presentation and analysis of UV spectra, types of electronic transitions, effect of conjugation, concept of chromophore and auxochrome, bathochromic, hyperchromic and hypochromic

shifts, UV spectra of conjugated enes and enones, Woodward-Fiesher rules for calculation of λmax of dienes and enones. Applications of UV spectroscopy.

Infrared (IR) Absorption Spectroscopy

Molecular vibrations, Hooke's law, selection rules, intensity and position of IR bands, measurement of IR spectrum, fingerprint region, characteristic absorptions of various functional groups and interpretation of IR spectra of simple organic compounds. Applications of IR spectroscopy.

Nuclear Magnetic Resonance (NMR) Spectroscopy

Proton magnetic resonance (PMR) spectroscopy, nuclear shielding and deshielding, chemical shift and molecular structure, spin-spin splitting and coupling constants, Interpretation of PMR spectra of simple organic molecules such as ethyl bromide, ethanol, acetaldehyde, 1,1,2tribromomethane, ethyl acetate, toluene and acetophenone.

(30 lectures)

Unit-II

Oxidation and Reduction

Oxidation and reduction reactions, oxidation number, redox reactions in terms of oxidation number, standard electrode potential, electrode potential of a cell, electrochemical series, use of redox potential data-analysis of redox cycle, redox stability in water- Frost and Pourbaix diagram.

Reaction Kinetics and Mechanism

Thermodynamic and kinetic stability of complexes, labile and inert complexes, interpretation of lability and inertness of complexes. Kinetics of substitution reactions in square planar complexes, the trans effect, theories and mechanism of trans effect.

Acids and Bases

Classification of acids and bases as hard and soft, Pearson's HSAB concept, acid-base strength and hardness-softness. Symbiosis, theoretical basis of hardness and softness, electronegativity and hardness-softness.

Books recommended:

- W. Kemp, Organic Spectroscopy,UK.
- J. Mohan, Organic Spectroscopy: Principles and Applications, 2001.
- D.L. Pavia, G.M. Lampan and G.S. Kriz, Introduction to Spectroscopy, Hartcourt CollegePublishers.
- Y.R. Sharma, Organic Spectroscopy,2015.
- J. D. Lee, Concise Inorganic chemistry, ELBS.
- F. A. Cotton and G. Wilkinson, Advanced Inorganic Chemistry, Wiley, VCH,1999.

- B. R. Puri, L.R. Sharma and K. C. Kalia, Principle of Inorganic chemistry, Milestone Publishers,Delhi.
- J. E. Huheey, Inorganic Chemistry, PrenticeHall.
- P. Atkins, Physical Chemistry,1978.
- A. Elias and B.D. Gupta, Basic Organometallic Chemistry,2013.

BSHCHE-GE-V Lab:

Practical Time **3 Hrs** **M. Marks : 50**

Pass Marks : 40%

INSTRUCTIONS FOR THE PAPER SETTER/CANDIDATE

Instructions: Practical examination will be conducted in one single day and marks distribution will be as follows:

Notebook: 5 marks
Viva: 10 marks
Write-up and Performance: 35 marks

Course Objectives

To impart a thorough knowledge on absorption spectra of colored compounds using Beer-Lambert's law.

Course Outcomes

At the end of this course, the students will be able to:

- Synthesize various organic compounds through multi-step reactions and characterize these compounds using IR and NMR spectroscopic techniques.
- Understand and operate the UV-Visible spectrophotometer for the study of metal-ligand complexes.

Instructions: Practical examination will be conducted in one single day and marks distribution will be as follows:

Notebook: 5 marks
Viva: 10 marks
Write-up and Performance: 35 marks

1. Preparation of benzpinacol from benzophenone (photoreduction).
2. Preparation of Benzpinacolone from benzpinacol (pinacol-pinacolone rearrangement).
3. Estimation of glycine by Sorenson's formalin method.
4. Study of the titration curve of glycine.
5. Saponification value of an oil or a fat.
6. To study UV-Vis spectra of $KMnO4$ solution and determine its λ_{max}.
7. Verify Lambert-Beer's law using 5% $CuSO_4$ solution.
8. Preparation of acetylacetonate complexes of Cu^{2+}/Fe^{3+}. Find the λ_{max} of the complex.
9. To draw calibration curve for various concentrations of $FeSO4$/1-10-phenanthroline complex and hence to find the coefficient of its molar absorptivity.

BSHBOT 501: Reproductive Biology of Angiosperms

Lectures to be Delivered **60** **M. Marks : 75**
Time allowed: **3 Hours** **Pass Marks : 40%**

Course objective: Objective of the paper is to impart knowledge about various aspects of reproductive biology of angiosperms like pollination, fertilization and Embryogeny.

Course Learning Outcomes:

The students will be learning

- What are the proximate causes and consequences of transition in the reproductive attributes offlowering plants?
- What are the theoretical assumptions, and evidences in the evolution of gender in floweringplants?
- How male sterility in plants is naturally or artificially accomplished, and how the mechanismcan be used in yield improvement?
- What are the different stages of concealment of ovules in angiosperms?
- Why the development of embryo and endosperm is essentially interdependent, and are theirexceptions to this interdependence?
- How to differentiate aposporous and sexual modes of reproduction?

Pedagogy: Class room lectures, power point presentations, and field visits, etc. The students alsomake group discussions.

Instructions for the paper setter:

The Question paper will consist of three sections A,B and C. Section A and B will have four questions respectively from respective units of the syllabus and will carry 12 marks each. Section C will consist of 9 short answer type questions carrying 3 marks each which will cover the entire syllabus and carry 27 marks

Instructions for candidates

Candidates are required to attempt two questions from section A and two questions from section B of the question paper and entire section C.

UNIT-I

1. Flower: Structure and development; Placentation and inflorescence types.
2. Stamen: Morphology, structure and development of anther; morphological nature of stamen. Microsporogenesis, structure and development of male gametophyte.
3. Pollen: Structural organization, germinal furrows, wall development and ornamentation, role of callose and tapetum in pollen development; pollen agglutinations, germination and storage, and allergenic aspects.

4. Carpel: Morphology, Structure, development and types of ovules, Megasporogenesisand embryo sac, morphological nature of carpel.

UNIT-II

5. Pollination: Anther dehiscence, types of pollination, pollinators, control ofpollination.
6. Fertilization: Structure of stigma and style, stigma receptivity, post pollinationevents,syngamy and triple fusion.
7. Endosperm: Types, development, cytological, histological structures and functions.
8. Embryogeny:Zygote, its structural organization, pre-embryo types, embryodevelopment in monocots and dicots, nutrition of embryo.

Practicals (BSHBOT-501 P)

1. Study of different inflorescence
2. Study of different types of placentation.
3. Study of different flowers: basic structure of flowers.
4. Study of pollen grains and various pollen agglutinations.
5. Study of various developmental stages; microsporogenesis, Megasporogenesis andembryo development.
6. Types of ovules.

Suggested Reading

1. Bhojwani, S.S. and Bhatnagar, S.P. 1950. The Embryology of Angiosperms, VikasInc., New York, pp. 453.
2. Johri, B.M. (Ed.). 1984. Embryology of Angiosperms, Springer - Verlag, Berlin, pp.830.
3. Maheshwari, P. 2000. An Introduction to the Embryology of Angiosperm, McGraw-Hill Publishing House, New Delhi, pp. 357.

BSZOODSE 505 : WILD LIFE CONSERVATION AND MANAGEMENT

Course Learning Objectives: To educate the students about the importance of wild life, threats to wild life , its conservation and management and the important Environment and wild life policies and laws. The emphasis will be on developing interest and invoking a sense of responsibility among students towards wildlife conservation. The course also explores different techniques, perspectives, and approaches to both identify and achieve wildlife management goals.

Course Learning Outcomes : Upon successfully completing this course, students will be able to:

- Become aware about the importance of wildlife in general, and its conservation and management in particular.
- Comprehend the application of the principles of ecology and animal behaviour to formulate strategies for the management of wildlife populations and their habitats.
- Understand the management practices required to achieve a healthy ecosystem for wildlife
- Know the key factors for loss of wildlife and important strategies for their in situ and ex situ conservation.
- Recognize the techniques for estimation, remote sensing and Global Position Tracking for wildlife.
- Know about the Protected Area Networks in India,Ecotourism and the various environment policies and laws for conservation.

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

Time allowed : 3 Hrs. **Pass Marks : 40%**

INSTRUCTIONS TO THE PAPER SETTER

The question paper will consist of three sections A, B and C. Section A and B will have four questions each from the respective section of syllabus and will carry 12 marks each. Section C will consist of 9 short- answer type questions of three marks each and will cover the entire syllabus uniformly .

INSTRUCTIONS FOR CANDIDATES

Candidates are required to attempt two questions each from section A and B and the entire section C .

SECTION A

1: Introduction to Wild Life : (6Hrs)

Biodiversity and its importance, What is wild life, Importance of wildlife conservation , Objectives of conservation of wildlife, Conservation strategies.

2:Evaluation and Management of Wildlife (10 hrs)

Habitat analysis: a) Physical parameters: Topography, Geology, Soil and water; b) Biological Parameters: food, cover, forage, browse and cover estimation, Standard evaluation procedures: remote sensing and GIS

3: Population Estimation: (12 hrs)

Population Density, natality, mortality, survivorship curves, age ratio, sex ratio, fertility schedules, survivorship curve .Faecal Analysis of ungulates and carnivores, Faecal samples, Hair identification, Pug marks and census method

4: Management Planning of Wildlife in Protected Areas : (8hrs)

Estimation of carrying capacity, Human-wildlife conflict, Eco tourism / wild life tourism in forests, Climax communities: characteristics and theories, Ecology of purterbance.

SECTION B

5: Wildlife of India : (8 hrs)

Different types with references to animals, causes of depletion, Need of conservation of wildlife.

6: Wildlife conservation and management: (6hrs)

Types of wildlife Conservation (In Situ and Ex Situ),
Location and Important fauna of the sanctuaries and national parks of India.

7: Wildlife Projects in India : (6 hrs)

Importance of Wild life Projects, Major wildlife projects in India (a) Project tiger, (b) Gir Lion Sanctuary Project, (c) Crocodile Breeding Project and (d) Project Hangul (e) Project One Horned Rhinoceros.

8: Environmental Policies and Laws: (4hrs)

Willife (Protection) Act, 1972
The Forest (Protection) Act, 1980
Environment (Protection) Act, 1986
The Biodiversity Act, 2002

Recommended Books

1. Saha, G.K. and Mazumdar, S. (2017). Wildlife Biology: An Indian Perspective. PHI learning Pvt. Ltd. ISBN: 8120353137, 978-812035313
2. Sinclair, A.R.E., Fryxell, J.M. and Caughley,G. (2006). Wildlife Ecology, Conservation and Management. Wiley-Blackwell, Oxford, UK.
3. Singh, S.K. (2005). Text Book of Wildlife Management. IBDC, Lucknow. **S**
4. Negi, S. S. (1995), Hand Book of National Park, Sanctuaries and Biosphere Reservoirs in India, Indus publishing Co., New Delhi
5. Tirvedi, P.R. and Singh, U. K. (1996), Environmental Laws of Wildlife

Suggested Readings

1. Prater, S. H. (1980), The Book of Indian Animals, Bombay Natural History Society, Bombay.
2. Saharia, V. P. (1982), Wildlife in India, Natraj Publisher, Dehradun.
3. Caughley, G., and Sinclair, A.R.E. (1994). Wildlife Ecology and Management. Blackwell Science.
4. Sutherland, W.J. (2000). The Conservation Handbook: Research, Management and Policy. Blackwell Sciences
5. Biology and Wildlife Management: Exercises for Class, Field, and Laboratory. Blackwell Publishing.
6. Giles, R. H. (1984), Wildlife Management Techniques, Natraj Publishers, Dehradun..
7. Negi, S. S. (1995), Hand Book of National Park, Sanctuaries and Biosphere Reservoirs in India, Indus publishing Co., New Delhi
8. Prater, S. H. (1980), The Book of Indian Animals, Bombay Natural History Society, Bombay
9. Saharia, V. P. (1982), Wildlife in India, Natraj Publisher, Dehradun.
10. Online resources :

- https://swayam.gov.in/courses/4687-july-2018-wildlife-conservation
- https://swayam.gov.in/courses/5364-jan-2019-wild-life-ecology
- https://www.iucn.org/theme/protected-areas/our-work/capacity-development/moocs
- https://www.zsl.org/united-for-wildlife-free-conservation-courses

WILD LIFE CONSERVATION AND MANAGEMENT

PRACTICALS (CREDITS 2)

1. Study of any five endangered/ threatened species.
2. Study of basic equipment needed in wild life studies : Compass, Binoculars, Radio telemetry, Global positioning system
3. Plotting of the three types of survivorship curves from the hypothetical data.
4. Study of wildlife population estimation methods: Complete and Incomplete counts (through videos)
5. Study of the Location and Important fauna of various sanctuaries and national parks of India.
6. Study of the distribution of animals through zoogeographical maps
7. A visit to a zoological park to study different wild animals and make a report

Guidelines for conduction of Examination

Time allowed : 4 hrs **M.M. 50**

1.	To identify the Endangered/ threatened species of the given specimen A, B and C and write a note on it.	3X 4=12	
2.	To plot the survivorship from the data given.	5	
3.	Write short note on the given method of wild life population estimation.	4	
4.	To identify the equipment used in wild life studies and to write a note on it	5	
5.	To identify the given Zoogeographical area given . Write a note on it.	4	
6.	Write short note on the given Sanctuary / National park of India.	4	
7.	Project on wild life	6	
8.	Practical note book		5
9.	Viva		5

Teaching and Learning Process:

- Traditional chalk and Talk method , LCD projector
- Case study approach.
- Projection of videos or short movies available on the subject
- Digital collection of pictures of pugmarks, hoof marks, bird's nests, wild fauna and flora
- Group discussions
- Project based reports, assignments and E-posters
- Field-based research projects

B.Sc. (Hons.) Biotechnology Third Year

(Semester VI)

Paper BSHBT (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
3.To make the students aware about principles and applied application of bioanalytical techniques.

Learning outcomes: Bio Analytical tools are cell-based bioassays that give a measure of the effect and presence of known and unknown chemicals in complex environmental samples. At the end of this course students would be able to understand:

1. about the principle, working, maintain and calibrations of bio analytical tools and techniques for industrial and research purpose.
2.Specifically students will be able to learn about techniques such as electrophoresis, microscopy,
3. students able to learn about spectroscopy, centrifugation and chromatography.

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

Time allowed : 3 Hrs. **Pass Marks : 40%**

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

Spectroscopy: Principle and applications of UV-Visible, 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, types (differential and density gradient) 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, ion exchange 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 601 (C13-601)- Bioanalytical Tools

Practical Time 4 Hrs/Week M. Marks : 50

Time allowed for Examination: 3 Hrs. Pass Marks : 40 %

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. Spectrum analysis of FTIR, MS, HPLC .
4. Determine the Rcf required for sedimentation of given cell /biomass/molecules.
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.
8. Demonstration of FTIR and fluorescence spectroscopy.
9. Demonstration of GM counter

Paper BSHBT (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.
3. To make the students aware about techniques for proteome analysis.

Learning outcomes: By the end of the course the student will be able to:

1. Understand structural organization of genome and proteome.
2. Apply the different techniques of genomics to study and analyze the genome
3. Understand proteome analysis.

Lectures to be delivered 60 M. Marks : 75

Time allowed : 3 Hrs. Pass Marks : 40%

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 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, Selected Model Organism Genome Database (Mus Musculus genome database).

UNIT II

Introduction to protein structure: Chemical properties of proteins. Physical interactions that determine the property of proteins. Short-range interactions, electrostatic forces, van der waal interactions, hydrogen bonds, Hydrophobic interactions. Determination of sizes (Sedimentation analysis, gel filteration, 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). *i*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 BSHBT (C14-602)- Genomics & Proteomics

Practical Time 4 Hrs/Week M. Marks : 50

Time allowed for Examination: 3 Hrs. Pass Marks : 40%

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 interaction studies.
6. Hydropathy plots
7. Protein structure prediction(Homology and comparative structure)

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Discipline Specific Elective

1) **Optional 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 BSHBT (503)- BSHBT (504) DSE(1 and 2) for 5th Semester

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

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

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

Discipline Specific Elective

Paper BSHBT (603)- BSHBT (604) DSE-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 bioremediation techniques, nonpolluting technologies viz. bioenergy and biomining.
3. To acquaint the students about pollutant detection through application of biosensors.

Learning outcomes: The student will be able to:

1. learn the fundamental concept of existing and emerging technologies that are important in the area of environmental bioremediation
2. understand the aerobic anaerobic treatment techniques for wastewater
3. learn about concept of mineral leaching, use of biosensors for pollutant detection.

Lectures to be delivered 60 M. Marks : 75

Time allowed : 3 Hrs. Pass Marks : 40%

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 and hazards

Soil & Air pollution: sources, types of soil and air pollutants and its hazards

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 and factor affecting biogas production, UASB, Anaerobic filter reactor, **Bioremediation:** Types, application for treatment of heavy metals and pesticides.

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

Biosensors: Biosensors, structure, 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 : 40%

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. Analysis of Total Dissolved Solids (TDS), Total solids, Hardness and alkalinity of waste water.
2. Analysis of Dissolved oxygen in waste water.
3. Analysis of BOD of waste water.
4. Analysis of COD of waste water.
5. Bacterial Examination of Water quality by MPN Method.
6. Determination of chromium concentration in the water sample by DPC method.
7. Demonstration of Biogas production.
8. Demonstration of Flame photometer.

Paper BSHBT (603)- BSHBT (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
3.It also familiarizes them with effect of the environment on phototrophic metabolism.

Learning outcomes: The student has fundamental understanding of:

1.Cellular composition, membrane transport, energy generation, diversity of metabolic processes, growth and cell death, and techniques used to elucidate physiological processes.
2.Integrating primary scientific literature of microbiology to further the understanding of microbial physiology.
3.Develop scientific writing skills and critical thinking about scientific research.

Lectures to be delivered 60 M. Marks : 75

Time allowed : 3 Hrs. Pass Marks : 40%

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. Hydrogen oxidizing 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.

9. 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 Time **4 Hrs/Week** **M. Marks : 50**

Time allowed for Examination: 3 Hrs. **Pass Marks : 40%**

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 BSHBT (603)- BSHBT (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.

Learning outcomes: By the end of the course the student will be able to understand:
1. learn fundamental concept of scaling up in industry
2. learn the concept and working of bioreactors
3. learn the basics of mass transfer and down stream processing

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

Time allowed : 3 Hrs. **Pass Marks : 40%**

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 : 40%**

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 (□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 BSHBT (603)- BSHBT (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 flavor enhancers.
3. This course enables students to understand reasons of food spoilage and its control by physical and chemical methods. Students will also understand various water borne diseases and intoxications.

Learning outcomes: By the end of course student will be able to understand:
1. The concept of food fermentation and its applications.
2. Various value-added products, flavour enhancers.
3. Students will also get insight of food spoilage due to microbial growth food, its control and various water borne diseases and intoxications.

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

Time allowed: 3 Hrs. **Pass Marks :40%**

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, pickles, coffee, cocoa, tea)

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

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

UNIT II

Flavour enhancers: Nucleosides, nucleotides and related compounds. Microbial production of Organic acids (Citric acid, Acetic acid) and their uses in foods/food products. Microbial production of Amino acids (Glutamic acid).

Food Spoilage : Intrinsic and extrinsic factors (Food Spoilage). Control mechanisms of food spoilage: Physical and Chemical. Food and water borne diseases: Gastroenteritis, Diarrhea, Shigellosis, Salmonellosis, Typhoid, Cholera, Polio, Hepatitis.

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

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
5. Food Biotechnology- (Eds.) R.Angold, G.A.Beech, J.Taggart.
6. 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 : 40 %**

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. Preparation of Distilled and Un-distilled alcoholic beverages.
5. Dairy fermented products (yoghurt/ unripened cheese).
6. Sauerkraut production
7. Production of acetic acid and estimation of the product.
8. SCP production (yeast).
9. Effect of internal factors on microbial growth in food *i.e.* pH, Temperature, Water Activity
10. Indian fermented food preparation.
11. Visit to malt factory

Generic Elective Papers (GE) (Minor-Chemistry)

BSHCHE-GE-VI Lab: Heterocyclic compounds and Transition metal complexes

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

Time allowed: 3 Hours Pass Marks : 40%

Course Objectives

The course is adequated with basic knowledge of nitrogen containing functional groups, heterocyclic & polynuclearcompounds.
To learn about electronic spectra and magnetic properties of transition metal complexes.

Course Outcomes

At the end of this course, the students will be able to:
Learn the technique of synthesis of heterocyclic compounds used in synthesis of various drugs & students will also get basic idea of properties and reactions of heterocycliccompounds.
Identify the repeat units of particular polymers and specify the isomeric structures which can exist for those repeating units.
To estimate the number and weight average molecular masses of polymer samples given by the degree of polymerization and mass fraction of chains present.
Learn the concept of electronic transitions responsible for the imparting colour to transition metal complexes.

Instructions for the Paper-Setter

The question paper will consist of three units: I, II and III. Unit I and II will have four questions from each unit of the syllabus and will carry 12 marks each. Unit III will consist of 9 questions from the whole syllabus and will be of 3 marks each.

Instructions for the Candidates

Candidates are required to attempt two questions each from units: I and II, unit III is compulsory. Note: Internal assessment will be given on the basis of mid semester tests (12.5), Attendance (5), general conduct (2.5), assignments/quiz/seminar (5).

UNIT-I

Heterocyclic-I(15Hrs.)

Introduction: Molecular orbital picture of pyrrole, furan, thiophene, pyridine. Classification, Nomenclature, structure and aromaticity in 5 and 6 membered rings containing heteroatom. Methods of synthesis, reaction and mechanism of electrophilic substitution of: Furan (Paal Knorr synthesis, Fiest-Benary synthesis) Pyrrole (Paal Knorr synthesis, Hantzsch pyrrole synthesis), thiophene (Paal Knorr synthesis, from acetylene), pyridine (Hantzsch synthesis , from pyrrole), comparison of basicity of pyridine, piperidine and pyrrole.

Heterocyclic-II(5Hrs.)

Indole (Fischer indole synthesis, Madelung synthesis, Reissert synthesis, Bischler synthesis), Quinoline (Skraup synthesis, Doebner-Miller synthesis), Isoquinoline (Bischer-Napieralski synthesis, Pomeranz-Fritsch synthesis), Basicity, electrophilic and nucleophilic substitution reactions of indole.

OrganicPolymers(10 Hrs.)

Brief introduction to preparation, structure, properties of the polymers, condensation and addition polymerization, Polyurethanes, polydienes, Polycarbonates, Conducting Polymers, (polyacetylene, polyaniline, poly (p-phenylene sulphide polypyrrole, polythiophene).

UNIT-II

Molecular Symmetry(5 Hrs.)

Basics of symmetry, symmetry elements and symmetry operations

Electronic Spectra of Transition Metal Complexes(12 Hrs.)

Types of electronic transitions, selection rules for d-d transitions, relaxation to selection rules, spectroscopic ground states, spectro chemical series, Orgel energy level diagrams for d^1, d^2, d^3, d^7,d^8, d^9 states, discussion of electronic spectrum of $[Ti(H_2O)_6]^{3+}$ and $[V(H_2O)_6]^{3+}$complex ion, Jahn Teller effect.

Magnetic Properties of Transition Metal Complexes(13 Hrs.)

Types of magnetic behavior, methods of determining magnetic susceptibility, Curie law, Neel's point, spin-only formula, L-S coupling, correlation of μ_s and μ_{eff} values, orbital contribution to magnetic moment, temperature independent paramagnetism, magnetic behavior of first row transition metal compounds.

Reference Books

- R.T Morrison and R.N Boyd, Organic Chemistry darling Kindersley (India) Pvt. Ltd. (PearsonEducation).
- J.A. Joule and K. Mills, Heterocyclic Chemistry, 4thEd.
- T. L. Gilchrist Hetrocyclic Chemistry 3rdEd.
- S.P. Singh, R.P. Kapoor, S.M. Mukherji, R. Dass, Organic Chemistry, Volume2.
- J.E. Huheey, Inorganic Chemistry, Prentice Hall, 3rdEd.
- F.A Cotton and Wilkinson; InorganicChemistry.
- B. R. Puri, L.R. Sharma and K. C. Kalia, Principle of Inorganic chemistry, Milestone Publishers,Delhi.

Generic Elective Papers (GE) (Minor-Chemistry)

BSHCHE-GE-VI Lab: Heterocyclic compounds and Transition metal complexes

Practical Time **3 Hrs** **M. Marks : 50**

Pass Marks : 40%

Course Objectives

- To impart the knowledge of methods of preparation of coordinationcomplexes.
- The technique of synthesis of heterocyclic compound is important in the synthesis of different drugs. This course gives the quantitative idea about the synthesis of heterocycliccompounds.

Course Outcomes

At the end of this course, the students will be able to

- Learn various synthetic and mechanistic approaches for heterocycliccompounds.
- Learn about the synthesis and coordination chemistry of various transition metal complexes.

INSTRUCTIONS FOR THE PAPER SETTER/CANDIDATE

Notebook: 5 marks
Viva: 10 marks
Write-up and Performance: 35 marks

1. Preparation of sodium trioxalotoferrate(III).
2. Preparation oftrisoxalotoaluminate.
3. Preparation of tetramminecopper sulphatecomplex.
4. Preparation of cis and trans-bisoxalatodiaquachromate (III)ion.
5. Preparation of hexaaminecobalt(III).
6. Estimation of Mg^{2+} by usingchlorophyll.
7. Preparation of 2-phenyl indole from phenylhydrazone.
8. Preparation ofbenzimidazole.
9. Preparation of caprolactam.
10. Preparation of1,2,3,4-tetrahydrocarbazole.
11. Synthesis of Indole by Paal- Knorr Synthesismethod.

BSHBOT DSE II: Plant Breeding

Lectures to be Delivered **60** **M. Marks : 75**
Time allowed: **3 Hours** **Pass Marks : 40%**

Course Objectives: Objective of the subject is to impart knowledge about plant breeding techniques, Germplasm collection, types of reproduction in plants and non conventional breeding.

Course Learning Outcomes:

The students will understand about:

- The objective of plant breeding, reproduction in plants, role of self incompatibility in plants.
- The concept of hybridization and how plants improve with the hybridization.
- Mutation breeding in plants and gene transfer in plants through different methods.

Pedagogy: Class room lectures, power point presentations and field visits etc. The students also make group discussions.

Instructions for the paper setter:

The Question paper will consist of three sections A,B and C. Section A and B will have four questions respectively from respective units of the syllabus and will carry 12 marks each. Section C will consist of 9 short answer type questions carrying 3 marks each which will cover the entire syllabus and carry 27 marks.

Instructions for candidates

Candidates are required to attempt two questions from section A and two questions from section B of the question paper and entire section C.

UNIT-I

1. Introduction to plant breeding: History, objectives and achievements.
2. Reproduction in crops: Vegetative, Asexual and sexual, apomixis.
3. Self incompatibility: type and role in plant breeding.
4. Male Sterility: Concept, classification, genetic control and breeding utility.

UNIT-II

5. Plant introduction and Germplasms collection (a brief account); Methods of plant improvement: Pure line and mass selection and clonal selection.
6. Hybridization in self and cross pollinated crops; hybrid vigour.
7. Mutation breeding: procedure for mutation breeding; achievements, application and its limitation.
8. Non-conventional breeding: Gene transfer strategies, direct and indirect methods of gene transfer, transgenic plants.

PRACTICAL (BSHBOT-504 P)

Practical Time:3hr **M.M.50**

Pass marks :40%

- 1.To study the various modes of pollination.
- 2.Emasculation and bagging.
- 3.To study the anthesis time in different flowers.
- 4.To estimate pollen viability test by glyceroacetocarmine.
- 5.To study seed purity and seed viability through TTC and seed germination test.

Suggested Reading

1. Chaudhari, HK. 1976. Elementary Principles of Plant Breeding, Oxford & IBHPublishing Co., New Delhi.
2. Singh, BD. 1988. Plant Breeding, Kalyani Publishers, New Delhi

BSZOO(H)CC 601 : DEVELOPMENTAL BIOLOGY

Course Learning Objectives: To provide an in-depth knowledge on the embryonic and post embryonic developmental processes. The approach of this paper is to make the students realize the most fascinating aspect of developmental biology that a single fertilized egg can give rise to a fully developed complex organism. The students are introduced to model organisms like Drosophila, Frog and Chick to study different types of eggs, cleavage patterns and various morphogenetic movements during gastrulation leading to formation of germ layers and their fate. By understanding the developmental processes, the students can relate to errors occurring during development leading to congenital disorders and human diseases. The students are made aware of the areas of great interest including stem cell therapy, tissue engineering and regenerative medicine.

Course Learning Outcomes : Upon successfully completing this course, students will be able to:

- Understand the events that lead to formation of a multicellular organism from a single fertilized egg, the zygote.
- Acquire basic knowledge of the cellular processes of development and the molecular mechanisms underlying these.
- Describe the general patterns and sequential developmental stages during embryogenesis; and understand how the developmental processes lead to establishment of body plan of multicellular organisms.
- Discuss the general mechanisms involved in morphogenesis and to explain how different cells and tissues interact in a coordinated way to form various tissues and organs.
- understand about the evolutionary development of various animals.
- Know the process of ageing leading to interventions that can improve the overall health and quality of life in aged people.
- Learn the importance of latest techniques like stem cell therapy, in vitro fertilization and amniocentesis etc. to be applied for human welfare.
- Develop the skill to raise and maintain culture of Drosophila in the laboratory

Lectures to be delivered **60** **M. Marks : 75**
Time allowed : 3 Hrs. **Pass Marks :40%**

INSTRUCTIONS TO THE PAPER SETTER

The question paper will consist of three sections A, B and C. Section A and B will have four questions each from the respective section of syllabus and will carry 12 marks each. Section C will consist of 9 short- answer type questions of three marks each and will cover the entire syllabus uniformly .

INSTRUCTIONS FOR CANDIDATES

Candidates are required to attempt two questions each from section A and B and the entire section C.

SECTION A

Unit 1: Introduction **4hrs**

Historical perspective and basic concepts: Phases of development, Cell-Cell interaction, Pattern formation, Differentiation and growth, Differential gene expression, Cytoplasmic determinants and asymmetric cell division

Unit 2: Gametogenesis

with particular reference to differentiation of spermatozoa, vitellogenesis; role of follicle/Sertoli cells in gametogenesis**.** **3hrs**

Unit 3 :Egg maturation

:Types of eggs, egg membranes ,polarity of egg**.** **1 hr**

Unit 4:Fertilization:

Mechanism, types and significance. Blocks to polyspermy **.** **4 hrs**

Unit 5: Cleavage:

Characteristics, planes ,patterns, determinate and indeterminate cleavage, influence of yolk on cleavage , laws of cleavage, blastulation, types of blastula**.** **3 hrs**

Unit 6 :Gastrulation:

Definition, morphogenetic movements: epiboly, emboly, invagination, involution, ingression, divergence and extension. Fate maps. 5hrs

Unit 7: Induction 4hrs

Basic concepts of organizers and inductors and their role in Determination and differentiation 4 hrs

SECTION B

Unit 8: Embryogenesis of Frog: 4hrs

Spawning, organization of unfertilized egg, Cleavage and blastulation, Fate map, Gastrulation

Unit 9: Embryogenesis of Chick: 6hrs

Structure of fertilized egg, Cleavage, Blastulation, Fate map, Gastrulation, Comparison of blastopore and primitive streak. Extraembryonic membranes (Development and functions)

Unit 10: Embryogenesis of Rabbit: 4hrs

Cleavage, blastulation, gastrulation. Implantation. Development and function of extraembryonic membranes, formation of Placenta.

Mammalian placenta – structure, types and functions. **2hrs**

Unit 11: Post Embryonic Development 12hrs

Metamorphosis: Changes, hormonal regulations in amphibians and insects;

Regeneration: Modes of regeneration, epimorphosis, morphallaxis and compensatory regeneration (with one example each); Ageing: Concepts and Theories

Unit 12: Implications of Developmental Biology 9hrs

Teratogenesis: Teratogenic agents and their effects on embryonic development; *In vitro* fertilization, Stem cell (ESC), Amniocentesis

DEVELOPMENTAL BIOLOGY

PRACTICALS (CREDITS 2)

Practical Time 4 Hrs **M. Marks : 50**

Pass Marks : 40 %

1. Study of whole mounts and sections of developmental stages of frog through permanent slides: Cleavage stages, blastula, gastrula, neurula, tail-bud stage, tadpole (external and internal gill stages)
2. Study of whole mounts of developmental stages of chick through permanent slides: Primitive streak (13 and 18 hours), 21, 24, 28, 33, 36, 48, 72, and 96 hours of incubation (Hamilton and Hamburger stages)
3. Study of the developmental stages and life cycle of *Drosophila* from stock culture
4. Study of different sections of placenta (photomicropgraph/ slides)
5.Study of teratogenic agents and their effect on developments in humans through pictures/ Videos .
6. Project report on *Drosophila* culture/chick embryo development

Guidelines for the conduction of Practical Examination

Time Allowed : 3hrs **Maximum Marks : 50**

1. To Identify the developmental stage in the given permanent slide and to write two identification point for each:
   A. Frog : 3 slides 09
   B. Chick : 3 slides 09
2. To identify the section of placenta (2 slides / Photomicrograph) and to write a note on it 06
3. To identify the development Defect and to comment on it 6
4. Project 08
5. Practical record 06
6. Viva 06

Recommended Books

1. Gilbert, S. F. (2010). Developmental Biology, IX Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA
2. Balinsky B. I. and Fabian B. C. (1981). An Introduction to Embryology, V Edition, International Thompson Computer Press

Suggested Readings

1. Kalthoff (2008). Analysis of Biological Development, II Edition, McGraw-HillPublishers
2. Lewis Wolpert (2002). Principles of Development. II Edition, Oxford University
3. Urspaung, H. Major Problems in Developmental Biology, Academic Press, New York, 1966.
4. Verma, P.S. and Aggarwal, V.K. Chordate Embryology,(1997), S.Chand& Company Ltd.

Online Tools and Web Resources:

- SwayamNPTEL : Introduction to Developmental Biology https://swayam.gov.in/nd1_noc20_bt35/preview
- https://www.hhmi.org/biointeractive/human-embryonic-development
- https://www.khanacademy.org/science/biology/developmental-biology
- https://ocw.mit.edu/courses/biology/7-22-developmental-biology-fall-2005/index.htm
- https://embryology.med.unsw.edu.au/embryology/index.php/Main_Page

Teaching and Learning Process:

- interactive lectures, classroom discussions
- Video digital format will be adopted to supplement theoretical lessons
- Permanent slides/ photomicrographs/animations
- Educational trips such as visit to a poultry farm and dairy research institute will be conducted to enhance their understanding of the theoretical concepts.
- Embryological models
- to undertake project work on maintaining culture of Drosophila to observe its life cycle
- Fertilized eggs of chick obtained from poultry farm will be incubated in the laboratory to study the developmental stages.