University of Rajasthan
Jaipur

SYLLABUS

(Three/Four Year Under Graduate Programme in Biotechnology)

I & II Semester

Examination-2023-24

Syllabus for Bachelor Degree in Biotechnology

(From the Academic Year 2023-24 onwards)

(Syllabus as per NEP-2020 and Choice Based Credit System)

University of Rajasthan,
Jaipur-302004

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Vision:

To create potential and competent professionals in Biotechnology through career oriented courses with practical training and advanced technical skills; equipped with societal and environmental responsibility.

Mission:

- Dissemination of global demand based knowledge through teaching with technical professionalism.
- Creation of individuals with social and environmental concern.
- Training the students to create economically and environmentally viable solutions.

Programme Outcomes

PO1. Developing the potential for vertical career growth in biotech-industries, service sectors and related fields.
PO2. Development of in-depth analytical and critical thinking, so that students would be able to identify and solve the problems related to Bio-technology field.
PO3. Proficient knowledge in the major domains of biotechnology including plant Biotechnology, Industrial Biotechnology, Bioprocess technology, Animal biotechnology etc.
PO4. Students can successfully learn tools and techniques related to biotechnology.
PO5. Development of Analysis and solving problems related to biology with the help of modern technology.
PO6. After completion of course students would be able to execute their professional roles in society as biotechnology professionals in pharma, medical, industry, academia etc.
PO7. Students will be able to learn skills to work as a team with the people from multidisciplinary environment.
PO8. To design and develop sustainable solutions to major biological problems by applying appropriate biotechnology tools.
PO9. Develop skills, attitude and values required for self-directed, lifelong learning and professional development.
PO10. Acquire knowledge and understanding of norms and ethics in the field of biotechnology.

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B.Sc.BIOTECHNOLOGY

COURSE STRUCTURE UNDER C.B.C.S.

Year	Sem	Course Code	Course Title	Credit		Marks
				T	P	
1st			Hindi–I			
	I		English– I			
		Sub 1 Major	Cell Biology and Genetics	4	2	
		Sub 2 Major	Microbiology	4	2	
		Sub 3 Major/Minor	BioprocessTechnology	4	2	
	II	Sub 1 Major	Molecular Biology	4	2	
		Sub 2 Major	Bioinformatics and Biostatistics	4	2	
		Sub 3 Major/Minor	Instrumentation and Biotechniques	4	2	
2nd	III	Sub 1 Major	Plant Biochemistry	4	2	
		Sub 2Major	AnimalBiochemistry	4	2	
		Sub 3Major/Minor	Immunology	4	2	
	VI	Sub 1Major	Plant Physiology	4	2	
		Sub 2Major	Animal Physiology	4	2	
		Sub 3Major/Minor	Molecular Genetics	4	2	
3rd	V	Sub 1Major	Animal Biotechnology	4	2	
		Sub 2Major	Plant Biotechnology	4	2	
		Sub 3 Major/Minor	Scientific Writing and Presentation	4	2	
	VI	Sub 1 Major	Bio-resources and Waste Management	4	2	
		Sub 2 Major	Recombinant DNA Technology	4	2	
		Sub 3 Major/Minor	Dissertation		6	
4th	VII	Sub 1 Major	Food and Dairy Technology	4	2	
		Sub 2 Major	Industrial Relations and Entrepreneurship	4	2	
		Sub 3 Major/Minor	Environmental Biotechnology	4	2	
	VIII	Sub 1 Major	Genomics and Proteomics	4	2	
		Sub 2 Major	Bioethics and IPR	4	2	
		Sub 3 Major/Minor	Industrial Training and Project Report		6	

Semester I

BTH-UG-A01 Cell biology and Genetics

Objectives

- To understand the structural organization of cells and genetics.
- To understand functions of organelles in the cell.
- To differentiate between plant and animal cells and to analyze different stages of mitosis and meiosis

Course Outcomes:

At the completion of the course, the student would be able to:

	BTH A01
Cognitive level	**Course outcomes**
1. Understanding	➢ The functions and structural properties of different cells. ➢ Differentiation between prokaryotic and eukaryotic cells. ➢ learn, understand and develop skill and hands on training in basics of cell biology and genetics. ➢
2. Memorizing	➢ The structural and functional aspects of cellular organelles. ➢ Diagrammatic representation of prokaryotic, plant, and animal cell.
3. Applying	➢ Variations in functions of cell organelles. ➢ Mendel's law on heredity. ➢ Monohybrid, dihybrid, trihybrid, test and back cross. ➢ Concept of cell cycle, abnormalities, cell membrane, cell-cell interactions. ➢ Possibilities of mutations and mutagens. ➢ Concept of C-value paradox.

Unit-I

Cell: Typical structure of Prokaryotic and eukaryotic (animal and plant) cells, Diversity of cell size and shape; Cell theory, C-value paradox, Cell Membrane: Chemical components of biological membranes, organization and Fluid Mosaic Model. **Structure and Function of Cell organelles:** Cytoskeleton and Extra cellular matrix; Vacuoles and micro bodies: Structure and functions of Ribosomes, Mitochondria, Chloroplasts, Genome and biogenesis of mitochondria and chloroplast; Nucleus: Structure and function, nuclear envelope. **15 hrs.**

Unit-II

Chromosome organization and Cell Division: Chromosomes: chromatin and chromosomes organization, euchromatin and heterochromatin, nucleosome model, genes, DNA as genetic material. Chromosome morphology; specialized types of chromosomes (Sex chromosomes, lampbrush Chromosome, Polytene chromosome). **Structural and numerical aberrations in human chromosomes and ploidy in plants:** Deletion, Duplication, Translocation, Inversion, Aneuploidy and Polyploidy. **Mutations**: Types of mutations, spontaneous and induced mutations, Physical and chemical mutagens. 15 hrs

Unit-III

Cell cycle, Cancer and Cell Signaling: Cell Cycle: Mitosis and Meiosis, Different stages of Meiosis I and Meiosis II, synaptonemalc omplex, chiasmata formation and crossing over.: Control points in cell-cycle progression in yeast and higher organisms; programmed cell death; Cancer – chromosomal disorders,

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oncogenes and tumor suppressor genes. Introduction to cell signalling and cell –cell interaction. **Sex determination and sex linkage:** Mechanisms of sex determination, Environmental factors and sex determination, sex differentiation, Barr bodies, dosage compensation, genetic balance theory. **15 hrs.**

Unit-IV

Genetic inheritance: Mendel's laws of inheritance and their exceptions; allelic (incomplete dominance, co-dominance, lethality) and non-allelic interactions (complementary genes, epistasis and duplicate genes); Multiple allelism (ABO blood groups in men); Quantitative inheritance (Grain color in wheat). **Cytoplasmic inheritance:** Plastid inheritance (different types of leaves in *Mirabilis jalapa*); Mitochondrial inheritance (Cytoplasmic male sterility in plants). **Evolution and population genetics:** Hardy Weinberg law (prediction, derivation), allelic and genotype frequencies, changes in allelic frequencies, evolutionary genetics, natural selection. **15 hrs.**

Suggested Laboratory Exercises:

- Study of cell structure from Onion, *Hydrilla* and *Spirogyra*.
- Study of electron microphotographs of eukaryotic cells for various cell organelles.
- Study of electron microphotographs of virus, bacteria and eukaryotic cells for comparative study of cellular organization.
- Study of different stages of mitosis and meiosis in root-tip cells and flower buds respectively of onion.
- Demonstration of Sex chromatin in buccal smear.
- Karyotype preparation.
- Preparation of polytene chromosomes from salivary gland of Chironomous larvae.
- Genetic experiment – Drosophila model
- To solve genetic problems based upon Mendel's laws of inheritance: Monohybrid, Dihybrid, Back cross and test cross
- Permanent slides/photographs of different stages of mitosis and meiosis, sex chromosomes, polytene chromosome and salivary gland chromosomes,
- Emasculation, bagging & tagging techniques
- Any other exercise related to syllabus

Suggested Readings

1. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2014). **Molecular Biology of the Cell** (6th Ed.). New York: Garland Science
2. Cooper, G. M., and Hausman, R. E. (2013). **The Cell: a Molecular Approach** (6th Ed.). Washington: ASM ; Sunderland.
3. Karp, G. **Cell and Molecular Biology. Concepts and experiments.** John Harris, D., Wiley & sons, New York
4. Lodish, H F. Berk, A. Kaiser, CA, Krieger, M. Bretscher, A. Ploegh, H. Aman, A. Martin, K. (2016). **Molecular Cell Biology** (8th Ed.). New York: W.H. Freeman
5. Gupta P.K. **Cell and Molecular Biology** 2018. 5th edition Rastogi Publication India.
6. Hartl, D. L., & Jones, E. W. (1998). **Genetics: Principles and Analysis**. Sudbury, MA: Jones and Bartlett.
7. Pandey BP(2022) Cell Biology and Genectics ,S Chand Publication
8. Tamarin, R. H., & Leavitt, R. W. (1991). **Principles of Genetics**. Dubuque, IA: Wm. C. Brown.
9. Smith, J. M. (1998). **Evolutionary Genetics.** Oxford: Oxford University Press Genetics: Principles and Analysis – Hartl and Jones.
10. Gardner EJ, Simmons MJ, Sunstad DP. **Principles of Genetics**. 8th Edition. John Wiley and Sons.

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11. Snustand DP, Simmons MJ. **Principles of Genetics.** (2016) 7th Edition. John Wiley and Sons.
12. Verma PS, Agarwal VK. **Cell Biology, Genetics, Molecular Biology, Evolution and Ecology**. (2004). S Chand and Company Ltd.
13. Stephen R. Bolsover, Andrea Townsend-Nicholson, Greg FitzHarris, Elizabeth A. Shephard, Jeremy S. Hyams, Sandip Patel **Cell Biology: A Short Course, 4th Edition (2022)** Wiley-Blackwell

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BTH-UG-A02 Microbiology

Objectives

- Understand the basics of classification, types of microbes and its existence
- Understand the requirements of bacteria for its growth and will be able to quantify it by various techniques and methods of controlling it.
- Learn the application of microbes in industries and other bioremediation strategies.

Course Outcomes:

At the completion of the course, the student would be able to:

	BTH A03
Cognitive level	**Course outcomes**
1. Understanding	➢ Understand the Morphology, cell structure, growth and metabolism of Micro organisms
2. Memorizing	➢ Demonstrate the ubiquity and diversity of microorganisms in the environment. ➢ Differentiate the various types of microorganisms.
3. Applying	➢ Identify the importance of microbes in applied microbiology and biotechnology.

Unit-I

An introduction to microbiology: History of microbiology, concepts of microbial diversity, scope and applications of microbiology. Microbial Diversity, Basic concept of Taxonomy; Prokaryotes types of microorganism; Classification System: Three kingdom Classification,Five Kingdom Classification; Characteristic & Structure of Microbes-Algae, Fungi, Mycoplasma, Virus, Protozoa, Helminthes.

Virus: General characteristics, Nomenclature, classification, Structure of TMV, Pox virus and bacteriophage. Lytic and Lysogenic cycle. **15 hrs**

Unit-II

Morphology and Ultra structure of Bacteria ;Structure of Cell Wall: Bacterial Cell Wall (Gram Positive Bacteria & Gram Negative Bacteria), Archebacteria Cell Wall (Gram Positive Bacteria & Gram Negative Bacteria). Plasmid, Chromosome, mesosomes. Bacterial Endospore- structure formation and germination, Cillia & Flagella – Structure and Function, Carboxysomes, Microbial Diversity of Nutritional Classification : Heterotrophic, Autotrophic. General characters and multiplication of Mollicutes. **15 hrs**

Unit-III

Growth of Microbial Population and its genetics: Principles of growth and growth curve, Batch culture, Continuous Culture, Effects of Environmental Microbial Growth, pH, Temperature, Radiation & atmosphere, Microbial Metabolism. Pure culture techniques. Gene Transfer in bacteria: Mechanism of Conjugation, Transformation, Transduction. **15 hrs**

Unit- IV

Applied Microbiology: Economic importance of virus, bacteria, mollicutes and other microbes. Microbes in Wastewater treatment – aerobic and anaerobic digestion; Biogas; bioremediation; leaching of ores by microorganisms. Applications of microbial enzymes in dairy industries, Microbial production of Plastics (PHB, PHA). **15hrs**

Suggested Laboratory Exercises:

- Laboratory safety and sterilization techniques
- Microscopic Methods- Identification of Microorganisms
- Preparation of culture media– nutrient broth and nutrient agar
- Culturing of microorganisms in broth and in plates(pour plates, streak plates and preservation of bacterial cultures)
- Staining techniques – simple and grams'
- Motility Test- Hanging drop technique
- Serial Dilution method and pour plate method
- Growth kinetics- Growth curve of Bacteria and Yeast

Suggested Reading

1. Atlas RM. (1997). **Principles of Microbiology**. 2nd edition. WM.T. Brown Publishers.
2. Madigan MT, and Martinko JM. (2014). **Brock Biology of Micro-organisms**. 14th edition. Parker J. Prentice Hall International, Inc.
3. Pelczar Jr MJ, Chan ECS, and Krieg NR. (2004). **Microbiology**. 5th edition Tata McGraw Hill.
4. Stanier RY, Ingraham JL, Wheelis ML and Painter PR. (2005). **General Microbiology**. 5th edition McMillan.
5. Tortora GJ, Funke BR, and Case CL. (2008). **Microbiology**: An Introduction. 9th edition Pearson Education.
6. Willey JM, Sherwood LM, and Woolverton CJ. (2013). **Prescott's Microbiology**. 9th edition. McGraw Hill Higher Education.
7. Cappucino J and Sherman N. (2010). **Microbiology: A Laboratory Manual**. 9th edition. Pearson Education Limited
8. **Fundamentals of Microbiology** –Frobisher, Saunders & Toppan Publications
9. **General Microbiology** –C.B. Powar
10. Karen C. Carroll, Michael A. Pfaller **Manual of Clinical Microbiology, 4 Volume Set, 13th Edition (20** ASM Press.
11. Michele S. Swanson, Elizabeth A. Joyce, Rachel E. A. Horak **Microbe, 3rd Edition(2022)** ASM Press.

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BTH-UG-A03 Bioprocess Technology

Objectives

- To understand the basics of traditional and modern industrial fermentation process.
- To gain the knowledge about the primary and secondary microbial metabolites
- To learn about the production process of pharmaceutically important bioproducts.

Course Outcomes:

At the completion of the course, the student would be able to:

	BTH A05
Cognitive level	**Course outcomes**
1. Understanding	➢ Understand the basics of fermentation process which helps to develop new microbial product. ➢ Gain the knowledge about the steps and operations involved in microbial primary metabolites production. ➢ Illustrate the secondary metabolites production with flow-sheeting
2. Memorizing	➢ Acquire knowledge about the industrially relevant microbial strains and processes for production of enzyme, biopolymer and food products
3. Applying	➢ Learn about the use of recombinant technology in pharmaceutically important microbial bioproducts production.

Unit I

Introduction to industrial bioprocess: Biotechnology: Scope and importance, Commercial potential of Biotechnology in India. Historical overview of industrial fermentation process -traditional and modern Biotechnology. Industrial Fermentation- microorganisms, mode of operation, fermentation processes-pictorial representation. Basic principle of Biochemical engineering: Isolation, screening and maintenance of industrially important microbes. Microbial growth and death kinetics with reference to industrially useful microorganisms. Strain improvement for increased yield and other desirable characteristics.

Unit II

Concepts of basic mode of fermentation processes: Bioreactor designs and types of fermentation and fermentors. Concepts & basic modes of fermentation - Batch, fed batch and continuous fermentation. Conventional fermentation versus biotransformation. Solid substrate, surface and submerged fermentation. Fermentation economics and fermentation media. Fermenter design - mechanically agitated, pneumatic and hydrodynamic fermenters. Large scale animal and plant cell cultivation and air sterilization.

Unit III

Upstream processing: Media formulation, sterilization, aeration and agitation. Measurement and control of bioprocess parameters, scale up and scale down process. **Downstream processing**: Bioseparation - filtration, centrifugation, sedimentation, flocculation, microfiltration, sonication. Cell disruption – enzymatic lysis and liquid-liquid extraction. Purification by precipitation (ammonium sulfate, solvent), electrophoresis and crystallization. Extraction (solvent, aqueous two phase, super critical) and chromatographic techniques. Reverse osmosis and ultra filtration. Drying, crystallization, storage and packaging. Treatment of effluent and its disposal.

Unit IV

Applications of Microbes in food processing and production: Fermented foods and beverages, food

ingredients and additives used in fermentation and their purification. Fermentation in preparing and preserving foods. Microbes and their use in pickling, producing colours and flavours, alcoholic beverages and other products. A brief outline of processes for the production of some commercially important organic acids (citric acid, lactic acid & acetic acid); amino acids (glutamic acid & tryptophan) and alcohols (ethanol & butanol).

Suggested Laboratory Exercises:

- Isolation of microorganism and screening of industrially important microorganism
- Study of growth substrate utilization and product formation kinetics in shake flask cultures
- Cell disruption techniques-Detergent and enzyme
- Membrane based filteration-Ultrafilteration and micro filteration
- Centrifugation and sedimentation

Suggested Reading

1. Lee, S.Y., Nielsen, J. and Stephanopoulos, G., "**Industrial Biotechnology: Products and Processes**", John Wiley & Sons, 2016.
2. Waites, M.J., Morgan,N.L., Rockey,J.S., Higton, G., "**Industrial Microbiology: An Introduction**" Blackwell, 2001.
3. Cruger, W., Cruger, A., "**A Textbook of Industrial Microbiology**", Panima Publishing Corporation, 2nd Edition, 2005.
4. Pandey, A., Negi, S., Soccol, C.R., "**Current Developments in Biotechnology and Bioengineering: Production, isolation and purification of industrial products**", Elsevier, 2016
5. Okafor, N., "**Modern Industrial Microbiology and Biotechnology**", CRC Press, 2007
6. Presscott and Dunn's "**Industrial Microbiology**", CBS Publisher, 1987.
7. Casida Jr, L. E., "**Industrial Microbiology**", Wiley, 1968.
8. Ashok Pandey, Ranjna Sirohi, Christian Larroche, Mohammad Taherzadeh **Current Developments in Biotechnology and Bioengineering** ,Advances in Bioprocess Engineering 1st Edition - August 18, 2022

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BTH-UG-A04- Molecular Biology

Objectives

- To learn and understand the important discoveries that are made in the field of molecular biology.
- To learn key molecular events that occur during the DNA replication, transcription, translation and regulation of gene concept.
- gain knowledge on the foundation of genetic engineering and their applications in biological research as well as in biotechnology industries.

Course Outcomes:

At the completion of the course, the student would be able to:

	BTII A07
Cognitive level	**Course outcomes**
1. Understanding	• learn and understand the important discoveries that are made in the field of molecular biology. • learn key molecular events that occur during the DNA replication, transcription, translation and regulation of gene concept.
2. Memorizing	• understand molecules involved in cell functioning and their importance.
3. Applying	• acquainted with gene organization and regulation of gene expression and its importance in biology

Unit- I

Genes and DNA: Genome, Gene, Double helical structure of DNA, DNA supercoiling, Gene structure, Non-coding DNA and RNA. **DNA replication:** Mechanisms of prokaryotic DNA replication: Initiation, Elongation and Termination; DNA polymerases, helicase, other enzymes and accessory proteins involved in DNA replication. Fidelity of replication and coordinating synthesis of the leading and lagging strands, Okazaki fragments. **15 hrs**

Unit- II

DNA damage and repair: Causes of DNA damage and molecular mechanisms of repair= excision repair system in bacteria and eukaryotes, base excision, recombination repair systems and SOS repair. Transcription and post transcriptional changes. 15 hrs.

Unit- III

Transcription: Types of RNA, mRNA structure, prokaryotic and eukaryotic RNA polymerases, Transcriptional factors, promoter sequences, binding sites for RNA polymerase, transcription initiation, elongation, termination, attenuation and antitermination. **15 hrs.**

Unit- IV

Translation: Structure of tRNA, ribosome, Genetic Code, Translation-formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, aminoacylation of tRNA, aminoacyl tRNA synthatase, and termination in Prokaryotes and Eukaryotes.Co and post translational modification of protcins. **15 hrs.**

Suggested laboratory Exercises

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1. Building of a model of B-DNA

2. Isolation of plant DNA and its quantitation by a spectrophotometric method.

3. Separation and visualization of DNA fragments by Agarose gel electrophoresis.

4. Demonstration of SDS PAGE

5. Determination of denaturation and renaturation of DNA double helix.

6. Isolation of RNA and quantitation by a spectrophotometric method.

8. Polymerase Chain reaction.

9. Southern blot analysis using a gene specific probe.

Suggested Readings:

1. Lewis, B. 2001. Genes X Oxford University Press, New York.

2. Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K. and Watson, J.D. 1999. Molecular Biology of the Cell. Garland Publishing, Inc., New York.

3. Wolfe, S.L. 1993. Molecular and Cellular Biology. Wadsworth Publishing Co., California, USA.

4. Lodish, H., Berk, A., Zipursky, S.L., Matsudaira, P., Baltimore, D. and Darnell, J. 2000. Molecular Cell Biology (4th Edition).W.H. Freeman and Co., New York, USA.

5. Glick, B.R. and Thompson, J.E. 1993. Methods in Plant Molecular, Biology and Biotechnology.CRC Press, Boca Raton, Florida.

6. Albert B. Bray, D., Lewis, J., Raff, M., Robert, K. and Watson, J.D. 1989., Molecular Biology of the Cell (2nd editions), Garland Publishing Inc., new York.

7. Malacinski, G.M. and Freifelder, D. 1998 : Essentials of molecular Biology (3rd edition). Jones and B Artlet Publishers, Inc., London.

8. Jordanka Zlatanov 2023. Molecular Biology Structure and Dynamics of Genomes and Proteomes (2nd edition)

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BTH-UG-A05 Bioinformatics and Biostatistics

Objectives

The aim of this module to provide practical training in bioinformatics including accessing the major public sequence databases, use of the different computational tools to find sequences, analysis of protein and nucleic acid sequences by various software packages

Course Outcomes:

At the completion of the course, the student would be able to:

	BTH A10
Cognitive level	**Course outcomes**
1. Understanding	➢ Various resources or tools available for bioinformatics ➢ Sequence similarity and alignment using the bioinformatic tools ➢ The principal concepts about biostatistics. ➢ Compute statistical problems using computer and graphical means. ➢ Solve mean and variance of discrete and continuous distribution.
2. Memorizing	➢ Sequence alignment for various molecules and phylogenetic analysis
3. Applying	➢ The students will be knowing the diagnostic procedures and collection and processing of specimen ➢ Appraise statistical tests, t-distribution, and the standard error formulas

Unit-I

Concepts of Bioinformatics: Introduction and future prospects; Applications in genomics and proteomics; Public databases; Gene bank; Database searches: sequence retrieval systems; Similarity searching: BLAST, FASTA; Multiple sequence alignment: Databases and online tools: Biological Databases:- Types and applications; Sequence databases:- GenBank, EMBL, DDBJ, PIR-PSD, SWISS-PROT; Structure Databases:- PDB, SCOP, NDB; Derived Databases:- PROSITE, PRINTS, TIGR. **15 hrs**

Unit II

Applications of Bioinformatics: Computational methods for sequence analysis: Dot blot and dynamic programming methods; Phylogenetic analysis; Virtual and electronic cell; Internet tools for DNA sequence translation; Restriction enzyme mapping; Prediction of secondary structure of proteins; Application tools- primer designing, molecular mapping and concept and tools of computer aided drug designing **15 hrs**

Unit III

Fundamentals of statistics: Scope of statistics for biological research. Types of Data, Arithmetic mean, median, mode: theory and simple numerical problems; Measures of variation: standard deviation, variance, coefficient of variation; Correlation, types and methods: simple, multiple, linear and nonlinear correlation, Regression: linear and curvilinear regression (for two variable X and Y only). **15 hrs**

Unit IV

Tests of significance: Null hypothesis; Standard error; Level of significance; Degrees of freedom; Significance of mean for large samples; Significance in means for small samples (students t-test); Significance in ratio of two samples; F test (for difference between variance of two samples); Chi square test; Analysis of variance test (ANOVA) for one and two way classification. Laws of probability, theorem of total probability **15 hrs**

Suggested Laboratory Exercises

1. Introduction to bioinformatics databases (any three): NCBI/PDB/DDBJ, Uniprot, PDB etc.

2. Sequence retrieval using BLAST

3. Sequence alignment

4. Protein structure prediction

5. Prediction of different features of a functional gene

6. Determination of Statistical averages/ central tendencies

a) Arithmetic mean b) Median c) Mode

7. Determination of measures of Dispersion a) Mean deviation b) Standard deviation and coefficient of variation c) Quartile deviation

8. Tests of Significance-Application of following a) Chi- Square test b) t- test c) Standard error

9. To learn graphical representations of statistical data with the help of computers (e.g. MS Excel).

Suggested Readings

1. Introduction to Bioinformatics, Arthur M. Lesk, Oxford University Press.

2. Introduction to Bioinformatics, Attwood, Pearson Education.

3. A Textbook of Systems Biology, E. Klipp, W. Liebermeister, C. Wierling, Axel Kowald, H. Lehrach, R. Herwig (2009), Wiley-VCH Verlag GmbH & Co.

4. Bioinformatics: Sequence and Genome Analysis, David W. Mount (2001), Cold Spring Harbor (CSH) Laboratory Press.

5. Plant System Biology, Coruzzi, G.M. (2009), Wiley Publishing House.

6. Bioinformatics - A Practical Guide to the Analysis of Genes and Proteins. 2nd Edition by Baxevanis.

7. Practical Statistics for experimental biologist by Wardlaw, A.C. (1985).

8. Statistical Methods in Biology - 2000 by Bailey, N.T. J. English Univ. Press.

9. Biostatistics - 7th Edition by Daniel 8. Fundamental of Biostatistics by Khan

10. Introduction to Biostatistics, Le and Chap (2009), Wilay and Sons.

11. New Frontiers of Biostatistics and Bioinformatics, (ICSA Book Series in Statistics) 1st ed. 2018 Edition, springe

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BTH-UG-A06 Instrumentation and Biotechniques

Objectives

- The objective of the course is to introduce various techniques to the students, which are used in biological research as well as to provide them with an understanding of the underlying principles of these techniques and experimental skills in the form of practical exercises so that students can apply this knowledge to improve their understanding of the subject and better execution of these techniques

Course Outcomes:

At the completion of the course, the student would be able to:

	BTH A04
Cognitive level	**Course outcomes**
1. Understanding	➢ Various spectroscopic techniques and their application ➢ Define various principles and applications of various chromatography, electrophoresis and of centrifuge techniques. ➢ The principle of various microscopy
2. Memorizing	➢ Define various principles of various techniques
3. Applying	➢ Define various applications of various techniques

Unit- I

Buffers- Preparation and principle of pH meter

Microscopy – Principle and application of Dissecting and compound Microscope, phase contrast, Fluorescence and Electron microscopy (SEM and TEM)

Spectroscopy : basic principle ,instrumentation, application, UV visible spectrophotometer, NMR.

IR & Raman spectroscopy – Basic principle, theory and qualitative interpretation of I.R. spectra, quantitative methods **15 hrs**

Unit II

Fluorescence spectroscopy- Principle, Instrument Design, Methods & Applications

Centrifugation & Ultracentrifugation-Basic principles, Forces involved, RCF Centrifugation, techniques-principal, types and applications.

Chromatography-Basic Concepts of Adsorption & Partition Chromatography; TLC, Paper, GC, GLC, HPLC, Ion exchange. **15 hrs**

Unit III

Electrophoresis: Principle Electrophoretic mobility(EPM) estimation, factors affecting EPM, Instrument design & set-up, Methodology & Applications of Free & Zone (Paper, Cellulose acetate, Agarose& Starch gel, Pulse-field, PAGE, SDS-PAGE, Capillary) Applications isoelectric focusing, 2D electrophoresis **15 hrs**

Unit IV

General Biophysical methods – Measurement of pH, Radioactive labeling & counting, Autoradiography. X-Ray Crystallography – X-ray diffraction, Bragg equation, Reciprocal lattice, Miller indices & Unit cell, Concept of different crystal structure, determination of crystal structure [concept of rotating crystal method, powder method].

Suggested Laboratory Exercises:

- Ph Meter- Standardization of pH meter
- Preparation of buffers
- Verification of Beer Lambert law using UV-Visible spectrophotometer
- Principle of TLC and Paper chromatography
- Column chromatography for protein /pigment
- Microscopy- compound Light microscope: principle, parts and functions
- Sterilization: principles and operations autoclave, Hot air oven , filteration, laminar air flow,
- Principles and operations of Incubators & shakers
- Principles and operations of centrifuge

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Suggested Reading

1. Biochemistry-J. L. Jain
2. V.K. Sharma
3. Instrumental methods of chemical Analysis-Chaitwal and Anand
4. Biochemistry and Molecular Biology-Wilson and Walker
5. Biophysical Chemistry, Part II: Techniques for the study of biological structure and function- Cantor & Schimmel
6. The tools of Biochemistry- Terrance G.Cooper
7. Bioinstrumentation - Veerakumari
8. Biological Instrumentation and methodology – Dr P K Bajpai
9. Tools and techniques of biotechnology – Mousumi debnath
10. Instrumental method of analysis in biotechnology – Dinesh kumar chatanta
11. Introduction to Instrumentation in Life Sciences- Prakash Singh Bisen, Anjana Sharma

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