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DR. B.R. AMBEDKAR CENTER FOR BIO MEDICAL RESEARCH

(ACBR)

SEMESTER – II

B.SC. (Hons.) Biomedical Sciences

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Semester II
Biochemistry
Unique Paper
Code

Discipline Specific Core (DSC)

Credit: 4 (3T+1P)

Theory **Total**

Lectures: 45

LEARNING OBJECTIVES

The objective of this course is to effectively incorporate the fundamentals of metabolism through key biochemical pathways and make learners appreciate the requirement for the stringency of their regulation; introduce various biochemical techniques used in the characterization of the proteins and a detailed account on how enzymes function: their kinetics, regulation and inhibition.

COURSE OUTCOMES

- Students will gain an understanding of fundamental biochemical principles of metabolism of biomolecules (Carbohydrates, Proteins, Lipids and Nucleic acids) and the associated bio- energetics. They will learn the biochemical reactions in metabolic pathways and understand their interrelations, logics and patterns.

- They will also understand the role of enzymes in the biochemical reactions and the connection between biochemical defects and metabolic disorders. Students would additionally gather a firm understanding and relevance of stringent regulation of metabolic pathways.

- Having understood the structural architecture of proteins in earlier semesters, students shall learn how biological molecules (especially proteins) are characterized through various analytical techniques such as types of column chromatography methods, Polyacrylamide Gel Electrophoresis (PAGE) that are used in contemporary biochemistryresearch laboratories.

- Students will get a grasp on central concepts underlying enzyme catalysis, kinetics and their mechanism of action. Effects of different kinds of enzyme-inhibitors will also be learned.

- Students would learn how coenzymes assist enzymes in catalyzing biochemical reactions and what is the criterion for their classification.

- Having studied the role of enzymes that regulate metabolic pathways in the third unit, students would learn the general properties of regulatory enzymes, their activity and kinetics.

COURSE CONTENT:

Unit I: Metabolic pathways and their allosteric regulation	**(22 hrs)**
Carbohydrates- Glycolysis, Gluconeogenesis, Tricarboxylic acid cycle and their regulation, Cori cycle, Hexose monophosphate shunt. **Lipids**- Mobilization of triglycerides, Metabolism of glycerol, Biosynthesis and β-oxidation of saturated fatty acids (palmitic acid) and their regulation. Significance of ketone bodies. **Proteins**- General over view, Transamination, Deamination, Glucose-Alanine cycle, Urea cycle and its regulation. **Nucleic acid**- General overview, an outline of purine and pyrimidine metabolism. Electron transport chain, Oxidative phosphorylation and Substrate-level phosphorylation.	
Unit II: Analytical methods in protein characterization	**(08)**
Introduction to spectrophotometry & Lambert-Beer's law, Column chromatography: Ion exchange chromatography, Gel filtration and Affinity chromatography, SDS-PAGE	
Unit III: Enzymes	**(07)**
Introduction to enzymes, Concept of Lock & key and 'Induced fit theory, Concept of activation energy and binding energy. Enzyme kinetics: Michaelis-Menten equation and its physiological significance. Concept of enzyme inhibition: types of inhibitors (competitive & non-competitive) and their examples.	
Unit IV: Coenzymes	**(04)**
Classification: various types and their function.	

Unit V: Regulatory Enzymes	**(04)**
General properties of allosteric enzymes. Enzyme regulation by covalent modification. Zymogens.	

PRACTICAL (12 Sessions x 2 hrs)

(Wherever wet lab experiments are not possible, the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Measurement of absorbance & %transmittance of a solution using spectrophotometer/colorimeter.
2. Preparation of standard plot and estimation of protein concentration by any one method: Biuret/Lowry/Bradford.
3. Estimation of glucose concentration by an enzymatic/non-enzymatic method.
4. Separation of biomolecules (sugar/amino acids) by thin-layer chromatography (TLC).
5. Separation of biomolecules by gel filtration/Calculation of void volume of Sephadex G-25 column, using Blue Dextran.
6. Analysis of SDS-PAGE as a separation technique (gel analysis).
7. To perform an assay of an enzyme under optimal conditions.
8. Determination of Km, Vmax and Kcat value of a given enzyme from the provided experimental data.

SUGGESTED READINGS:

- Nelson, D. L., & Cox, M. M. (2021). *Lehninger: Principles of Biochemistry* (8th ed.). Macmillan. ISBN:9781319322328
- Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology (2018). 8th ed. Hofmann A. and Clokie S.(Eds.) Cambridge University Press, Cambridge, U.K.
- Plummer, D.T. (2012). *An Introduction to Practical Biochemistry.* New Delhi, India: McGraw-Hill College.
- S. K. Sawhney / Randhir Singh. (2009): Introductory Practical Biochemistry, Narosa Publishers, ISBN-13 : 978-8173193026
- Donald Voet, Judith G. Voet (2021) Voet's Biochemistry, Adapted ed 2021, ISBN: 9789354243820.

BOOK FOR BASIC CONCEPTUAL READING

- Berg, J., Gatto, G., Stryer, L. and Tymoczko, J. L. (2019). *Biochemistry*. New York, USA: W. H. Freeman and Company.
- Devlin, (2011). *Textbook of biochemistry with clinical correlations*. UK: Wiley T & Sons.

Semester II
Principles of Genetics
Unique Paper Code:
Discipline Specific Core (DSC)Credit: 4
(3T+1P)

Theory **Total**
Lectures: 45

LEARNING OBJECTIVES:

The course intends to introduce students to Mendelian principles of inheritance, deviations from Mendelian inheritance and extra-nuclear inheritance, Introduction to pedigree analysis for autosomal and X-linked traits, Understanding of differences between prokaryotic and eukaryotic genome organization, transposons, and basic cytogenetics and Understanding of mechanisms of sex determination.

COURSE OUTCOMES:

- The flavour of genomics as a progression from Mendelian genetics will be introduced to the students. They will learn about classical experiments that led to discovery of the genetic material. They will also learn the structure of DNA.
- Students will be able to explain Mendelian laws of inheritance, deviations from monohybrid ratio (incomplete dominance, codominance, multiple alleles and lethal genes) and deviations from dihybrid ratio (gene-gene interactions, linkage). They must be able to distinguish sex-linked, sex-limited and sex-influenced traits. Students must also be able to interpret patterns of inheritance for autosomal and X-linked traits from pedigrees.
- Students would learn the concept of extra-nuclear inheritance.
- Students would learn the differences in genomes of prokaryotes and eukaryotes. They would also learn about transposable genetic elements with examples from prokaryotes and eukaryotes.
- The lectures will cover details of the structure of the chromosomes, the abnormalities that commonly occur at chromosomal level. Discussion of various types of mutations at the DNA level (deletion, addition, substitution), their consequence on gene structure/product and the diseases associated with these abnormalities.
- Students wouldgain insights into genetic and environmental sex determination mechanisms.

COURSE CONTENT:

Unit I: Overview of Changing Paradigms in Genetics	**(05hrs)**
A brief overview of how genetic principles took shape, leading to the concept of a blueprint of life within the cell to the physical entity of DNA. Basic structure of DNA, salient features of the double helix, semi-conservative replication– Meselson and Stahl experiment. Also mention the surprises we have from genomics such as genetic variation between individuals. There are popular videos/presentations that can be used. The purpose is to ignite the curiosity of the students.	
Unit II: Concept of Genetic Inheritance	**(15)**
Concept of alleles, haploid and diploid status, phenotype and genotype, Mendel's laws of inheritance, dominant and recessive inheritance, test, back and reciprocal crosses with two examples each. Chromosomal theory of inheritance. Concept of linkage and crossing over, cytological proof of crossing over, genetic mapping: two and three-point cross over. Distinguishing recombination and complementation. Allelic interactions- dominance relationships- complete, incomplete and co-dominance, gene-gene interactions. Sex linked, sex-limited and sex-influenced traits. Gathering family history, pedigree symbols and construction of pedigrees for autosomal and sex linked traits (dominant and recessive).	
Unit III: Extra Nuclear Inheritance	**(05)**
Criteria for extra nuclear inheritance, plastid inheritance in *Mirabilis jalapa*, kappa particles in *Paramecium*, maternal effect- snail shell coiling, cytoplasmic inheritance (mitochondria and chloroplast).	
Unit IV: Genome Organization	**(07)**
Organization of Genomes in prokaryotes and eukaryotes. Establishing the Central Dogma. Nucleosomes organization and assembly. Euchromatin, heterochromatin- constitutive and facultative heterochromatin. Structure and significance of polytene and lampbrush chromosomes. Transposable genetic elements: Prokaryotic transposable elements- IS elements, Composite transposons; Eukaryotic transposable elements- Ac-Ds system in maize; Uses of transposons.	
Unit V: Cytogenetics and Mutations	**(08)**

Chromosome: Structure- centromere and telomere, types of chromosomes based on centromere. Karyotyping- banding pattern and nomenclature (G and Q banding). Structural abnormalities (Duplication, Insertion, Deletion, Translocation-Reciprocal and Non-Reciprocal) and associated syndromes. Numerical abnormalities (Aneuploidy and Euploidy) and associated syndromes. Spontaneous and induced mutations. Types of mutations: Point (Non-sense, miss-sense, silent, frameshift, insertion, deletion). Effects on the Gene products- loss of function and gain of function.	
Unit VI: Introduction to Mechanisms of Sex Determination	**(05)**
Chromosomal theory of sex determination, mechanisms of sex determination, environmental factors and sex determination in human and *Drosophila*. Barr bodies and dosage compensation.	

PRACTICAL (12 Sessions x 2 hrs)

(Wherever wet lab experiments are not possible, the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Observation of wild type and mutant phenotypes in *Drosophila*.
2. Preparation of culture media for *Drosophila* and study different stages of the life cycle of *Drosophila.*
3. Verification of Mendelian laws through *Drosophila*/ seeds – dominant, recessive and sex-linked
4. Study of Barr bodies.
5. Karyotyping with the help of photographs (normal and abnormal karyotypes).
6. Pedigree charts of some common characters like blood group, color blindness and PTC tasting.
7. Study of diploidy in onion root tip.
8. Study of polyploidy in onion root tip by colchicine treatment.
9. Study of polytene chromosomes.

SUGGESTED READINGS:

- Klug, W. S., Cummings, M., Spencer, C. A., Palladino, M. A., Darrell K. (2019*).* 12th Edition. *Concepts of genetics.* San Francisco, NY:Pearson ISBN-13: 9780134604718.
- Snustad, D.P. and Simmons, M.J. (2019). 7th Asia Edition. *Principles of genetics.* New York, USA: John Wiley and Sons. ISBN-13: 9781119657552.
- Gardner E. J., Simmons M. J. and Snustad D. P. (2006). 8th edition *Principles of genetics.* USA. Wiley. ISBN-13: 978-8126510436.

BOOK FOR BASIC CONCEPTUAL READING

- Cooper, G. M. and Hausman, R. E. (2019). 8th Edition. *The cell: A molecular approach.* Massachusetts, USA: Sinauer Associates. ISBN-13: 978-1605358635.
- Hardin, J., Bertoni, G. P., Becker, W.M. (2017). 9th Edition. *Becker's world of the cell.*NY:Pearso. ISBN-13: 978- 0805393934.
- Karp, G., Iwasa, J., Marshall W. (2018). 8th Edition. *Karp's Cell Biology.* New Jersey, USA: Wiley. ISBN-13: 978-1119456292.
- Kornberg, A. (2005). 2nd Edition. *DNA replication.* California, USA: University Science Books. ISBN-13: 978-1891389443.
- Griffith A. J. F., Wessler S. R., Carroll S. B. and Doebley J. (2011). 9th edition. *Introduction to Genetic Analysis.* W H Freeman & Co. ISBN-13 : 978-0716768876.
- Elrod, S and Stansfield, W. (2010). 5th edition. *Schaum's Outline of Genetics.* McGraw Hill. ISBN-13: 978-0071625036

Semester II

Human Physiology and Anatomy-II

Unique Paper Code:

Discipline Specific Core (DSC)
Credit: 4 (3T+1P)

Theory **Total Lectures: 45hrs**

LEARNING OBJECTIVES:

- The course curriculum is a systematic presentation of physiological concepts to ensure appropriate depth and breadth of basic functioning of the human body and its interrelations with respect to heart, lung, kidney, gonads, endocrine glands and digestive system.
- It would give students exposure of physiological concepts needed as foundations for further studies in pharmacology, pathology and pathophysiology etc.
- It would provide a base to understand body defenses and the mechanisms of deranged function of human body
- The curricular objectives are focused primarily on normal body function. Accordingly, wherever possible clinical examples have been illustrated to the underlying physiological principles**.**

COURSE OUTCOMES:

Having successfully completed this course, students shall be able to learn and appreciate:

- The students will learn appreciate the structure and functioning of heart, pattern and significance of bloodflow in the blood vessels, heart sounds, ECG and purpose of lymph and lymphatic circulation.

- The students would correlate how structure and function of lungs are so intricately designed and how they function with its blood flow and help giving vital oxygen to body. They would develop understanding for neural control and other regulators of respiration and understand daily phenomenon like coughing, sneezing, yawning etc.

- Kidneys are vital organs and students would learn the functional anatomy of a nephron and how it contributes in removing the toxic waste from our body in from of urine. The

curriculum would outline the process of micturition and abnormalities associated with it. It would also highlight the role of kidney in controlling pH of the body and preventing acidosis/alkalosis

- The students would have insight into the anatomy of the female and male reproductive systems, including their accessory structures. The student would understand the role of hypothalamic and pituitary hormones in reproductive system. Trace the route of a sperm mother cell from its production till it can fertilize an oocyte. Explain the events in the ovary prior to ovulation, development and maturation of the sex organs and the emergence of secondary sex characteristics during puberty.

- The students would be able to integrate the role of the endocrine system to maintain homeostasis in human body. Understand the chemicalcomposition mechanisms of hormone action, their site of production, regulation, and effects of hormones of the pituitary, thyroid, parathyroid and adrenal, glands. Hormonal regulation of the reproductive system. The role of the pancreatic endocrine cells in the regulation of blood glucose In addition the contributions of hormones released by the heart, kidneys, and other organs with secondary endocrine functions. The student would be aware of several common diseases associated with endocrine system dysfunction.

- Students would be able to understand the organs of the alimentary canal from proximal to distal, and understand their function. Identify the accessory digestive organs and their functions. Describe the histology that is four fundamental tissue layers of the digestive tract. Contrast the contributions of the enteric and autonomic nervous systems to alimentary tract functioning. Gain awareness about common dysfunctions of digestive system like constipation, gastritis, ulcers, diarrhea etc.

COURSE CONTENT:	
Unit-I: Cardiovascular System	**(09hrs)**
Functional Anatomy of heart, The Cardiac Cycle, Electrocardiogram. Circulatory system: Bloodvessels, hemodynamics and regulatory mechanisms, Lymphatic circulation - hemodynamics and regulation, micro-circulation	

Unit-II: Respiratory system	**(09)**
Functional Anatomy of the respiratory system. Mechanisms of pulmonary ventilation, alveolarventilation, gaseous exchange, transport of gases, respiratory and nervous control and regulation of respiration	
Unit-III: Renal Physiology	**(06)**
Body fluid and electrolytes: their balances and imbalances. Functional Anatomy of kidney, Histology of nephron and its physiology, Urine formation, renal regulation of urine volume and osmolarity, acid-base balance. Urinary bladder: structure, micturition and its regulation	
Unit-IV: Reproductive System	**(06)**
Structure and function of male and female reproductive organ. Function and regulation of testicularand ovarian hormones. Gametogenesis (oogenesis and spermatogenesis), fertilization, implantation, parturition and lactation, menopause and basic concepts of infertility.	
Unit-V: Endocrine System	**(09)**
General mechanism of hormone action, Structure, function and regulation of the following glands and their secretions: Pituitary, Hypothalamus, Thyroid, Parathyroid, Adrenal, and Pancreas. Basic concepts about hypo and hyper secretion of hormones.	
Unit-VI: Gastrointestinal system	**(06)**
Anatomy and histology of digestive tract, gastrointestinal physiology: General principles of gutmotility secretion, digestion, absorption and assimilation. Gastrointestinal hormones: their formation and action. Physiological anatomy and functions of liver and pancreas.	

PRACTICAL (12 Sessions x 2 hrs)

(Wherever wet lab experiments are not possible, the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Physiological data acquisition based experiments (ECG).
2. Physiological data acquisition-based experiments (EMG).
3. Physiological data acquisition-based experiments (PFT).
4. Blood Pressure recordings in humans.
5. Determination of specific gravity of blood.
6. Determination of osmotic fragility of RBC.
7. To study various types of contraceptives (condoms, IUD‟s, oral and injectable contraceptives)
8. To study different human organs and their sections through permanent slides. T. S. of thyroid, liver, thymus, spleen, ovary, artery, vein, capillaries, testis, pancreas, esophagus, adrenal, kidney (cortex and medulla), urinary bladder, urethra, fallopian tubes, epididymis, prostate glands, lungs, trachea, bronchioles, pituitary, heart. (Minimum 8 slides covering the systems mentioned in theory.)

SUGGESTED READINGS:

- Guyton and Hall Textbook of Medical Physiology, 14th edition (2020), J. E. Hall; W B Saunders and Company, ebook ISBN: 978-0-3236-4003-9; Hardcover ISBN: 978-0-3235-9712-8
- Human Physiology, 16th edition (2011), Stuart I. Fox; Tata McGraw Hill, ISBN10: 1260720462; ISBN13: 978-1-26-072046-4.
- Principles of Anatomy and Physiology, 16th edition (2020), Gerard J. Tortora and Bryan H. Derrickson; Wiley and Sons, ISBN: 978-1-119-66268-6. (e book), ISBN: 978-1-119-70438-6 (for print book).
- Textbook of Practical Physiology, 9th edition (2019), CL Ghai; Jaypee Publication, ISBN-9789352705320.

BOOK FOR BASIC CONCEPTUAL READING

- Ganong's Review of Medical physiology, 26th edition (2019), K. E. Barett, S. M. Barman, S. Boitano and H. Brooks; Tata McGraw Hill, ISBN 978-1-26-012240-4 (for ebook) ISBN:978-1-26-012241-1 (for print Book)

Semester I and II

Generic Elective (GE)

B.Sc. (Hons) Course in Biomedical Science

Semester I/II
Concepts in Biotechnology
Unique Paper Code:

Generic Elective (GE)
Credit: 4 (3T+1P)

Theory **Total Lectures: 45hrs**

LEARNING OBJECTIVES:

The purpose of this course is to introduce students to importance of Biotechnology in allied fields. It will enable students from diverse backgrounds to understand basic concepts in Gene Cloning and DNA Analysis, and appreciate applications of Biotechnology in everyday life. The course will provide students with an insight into the various molecular biology techniques commonly used in Biotechnology, and some of the relevant bio-safety issues and ethical concerns.

COURSE OUTCOMES:

- Learn about basic biotechnology techniques and key concepts that are used in isolation and characterization of biomolecules (DNA and proteins).
- Develop basic understanding of the robust techniques with wide applications (such as PCR, DNA sequencing) and appreciate their contribution in development of biotechnology.
- Comprehend the importance of gene cloning in biotechnology and learn the intricacies of gene cloning using plasmids and bacteriophages as cloning vectors.
- Understand the importance of construction of genomic libraries and their specialized screening methods to identify gene of interest.
- Learn the concept and application of DNA fingerprinting, recombinant protein expression, biopharmaceutical protein production, and gene therapy.
- Gain an insight of safe handling of GMO's, their environmental release and ethical practices.

COURSE CONTENT:	
Unit I: Techniques Used in Biotechnology	**(13 hrs)**

Brief history of biotechnology and its importance. Isolation and purification of plasmid DNA. Agarose and Polyacrylamide gel electrophoresis (Native and SDS). Southern and Western hybridization. Polymerase Chain Reaction (PCR): Principle, DNA polymerases in PCR, Primer Designing, Types of PCR - Hot Start, Multiplex and Reverse Transcription and their Applications. Sequencing: Enzymatic (Sanger's dideoxy) method, Introduction to Automated Sequencing.	
Unit II: Process of Gene Cloning, Expression and Protein Purification	**(13)**
Restriction endonucleases: Restriction and Modification Systems, Nomenclature and Types of Restriction Enzymes (Type I-IV), Recognition of Restriction Sites. Joining of DNA Molecules: Sticky End and Blunt End Ligations, Role of DNA Ligase, Adaptors, Linkers, Homopolymer Tailing. Vectors: Plasmids (pUC Vectors), Bacteriophage (Lambda Phage Derived Replacement And Insertion Vectors), Cosmids, *In Vitro* Packaging, Expression Vectors (One example each of prokaryotic and eukaryotic expression vectors). Bacterial Transformation, Antibiotic Selection and Blue/White Screening of Transformants. Challenges in Expression of Eukaryotic Proteins in Prokaryotic Hosts.	
Unit III: Genomic and cDNA Libraries	**(06)**
Construction of Genomic and cDNA Libraries, their Screening by Nucleic Acid Hybridization (Colony and Plaque Hybridization).	
Unit IV: Applications of Biotechnology	**(07)**
DNA Fingerprinting. Using the Example of Human Insulin learn the Importance of Various Applications of Biotechnology: Recombinant Protein Expression, Biopharmaceutical Protein Production and Gene Therapy.	
Unit V: Biosafety and Ethical Issues	**(06)**

Safe Handling and Disposal of GMOs and Relevant Ethical Issues. Impact of GMOs on the Environment (Bt. Toxin).	

PRACTICALS (12 Sessions x 2 = 24 hrs)

(Wherever wet lab experiments are not possible, the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. To prepare laboratory reagents.
2. To perform plasmid DNA isolation.
3. To perform agarose gel electrophoresis of isolated plasmid DNA.
4. To perform restriction digestion of plasmid DNA.
5. To perform agarose gel electrophoresis of digested DNA.
6. To study restriction mapping.
7. To amplify DNA using PCR.
8. To perform agarose gel electrophoresis of amplified DNA.

SUGGESTED READINGS:

- Glick, B. R. and Patten, C. L. (2022). 6thEdition. *Molecular Biotechnology: Principles and Applications of Recombinant DNA*. USA: ASM press, ISBN-13: 978-1683673668.
- Brown, T. A. (2020). 8thEdition. *Gene cloning and DNA analysis: An introduction*. New York, USA: John Wiley and Sons, ISBN-13: 978-1119640783.
- Karp, G. (2016). 8th Edition. *Cell and Molecular Biology: Concepts and Experiments*. United states: Wiley. ISBN-13: 9781538832462.
- Primrose, S. B. and Twyman, R. B. (2014). 7th Edition. *Principles of Gene Manipulation and Genomics*. New York, USA: John Wiley and Sons. ISBN-13: 978-1118653883.
- Green, M. R. and Sambrook, J. (2012). 4th Edition. *Molecular Cloning: A Laboratory Manual* (three-volume set). New York, USA: Cold Spring Harbor Laboratory Press ISBN-13: 978-1936113422.

BOOK FOR BASIC CONCEPTUAL READING

- Cantor, C. R. and Smith, C. L. (2004). 1st Edition. *Genomics: The science and technology behind the human genome project*. New York, USA: John Wiley and Sons. ISBN-13: 978-0471461869.
- Old, R. W. and Primrose, S. B. (1994). 7th Edition. *Principles of Gene Manipulation: an Introduction to Genetic Engineering.* Boston: Wiley. ISBN-13: 978-0632037124.
- Joseph Sambrook, E.F. Fritsch, T. Maniatis. (1989). 2nd Edition. *Molecular Cloning: A Laboratory Manual. New York, USA: Cold Spring Harbor Laboratory*. Press ISBN- 978-0879693732.

Semester I/II
Landmark Discoveries in Science
(Unique Paper Code:

General Elective (GE)
Credit: 4 (3 T + 1 P)

Theory **Total Lectures: 45hrs**

LEARNING OBJECTIVES:

The objective of the course is to ensure students appreciate the convenience and comfort that they have is all because of discoveries and inventions of the past. Meticulous execution of historical experiments in very little resources would also motivate them towards doing valuable research with enormous facilities that they have. The historical accounts of science provide grounds for interpretation and may be useful in arousing appreciation of science. The course would provide: Detailed analysis of classically designed and executed experiments in Life Sciences over the years. It will provide a foundation of biology by uncovering various players in the machinery of biological processes. I will also be helpful in technical, scientific analysis with historical background for a robust understanding of various discoveries. Critical analysis of the history of biology would surely help students comprehend futuristic scientific discoveries.

COURSE OUTCOMES

- Students will be able to learn how was light manipulated during the past to peer into previously invisible world—those too small or too far away to be seen by the naked eye.
- Students will learn about experiments that had fundamental contribution to our present understanding of key molecular elements of life. They will understand how to examine microbial cells and colonies, using various techniques to manipulate color, size, and contrast in ways that helped Scientists to identify species and diagnose disease.
- Studying this unit, students would come to know that there were three group of Naturalists working simultaneously to find answers to inheritance, evolution and basic composition of life.

Students will be divulged with hereditary aspects of life. They will get familiar with genes and their roles in living organisms.

- Having understood the relationship of genes and inheritance, students would find interesting to learn the mystical molecule that make up these genes. Sequential study of these experiments would step by step unravel the mystery of genetic material.
- Students at this point of course would be curious to know the structure of molecule that forms the genetic material. They would learn how the information present on DNA manifests itself as specific characteristic features and help in diversity among organisms.
- Students will be explained how the in depth knowledge about DNA became the most important tool for *in vitro* research, modification and applications thereof.
- Students will be briefed about some landmark discoveries which helped the field of medicine to grow tremendously and played a significant role in improving the overall health of the human population.
- Students can be given small projects to write discoveries done in conventional way.
- They will be required to provide a descriptive view of the topics assigned to them. Students should highlight the research topic with reference to current understanding.

COURSE CONTENT:	
Unit I: View of the invisible Biology	**(04 hrs)**
Rudimentary microscopes to magnify objects; Use of eye glasses as simplest microscopes - Flea or fly glasses; Observing nature in the new world under lens; Book of Optics; Scientific use of Microscopes; Importance of Malphigi microscope that used field lens; Compound Microscope; Robert Hooke's observations in Micrographia; Foldscope by Manu Prakash	
Unit-II: Origin of Life – A question	**(03)**
Spontaneous generation versus biogenesis; Problem of spores; Microbiology and Medicine - Germ theory of Disease; Recognition of agents of infection – Koch's Postulates.	
Unit-III: Understanding Biology by observations	**(04)**

A) Study of evolution of life: Darwins Theory (B) Study of Inheritance of Life: classical era with contributions of Aristotle, Epicurus, and others; Modern genetics: Gregor Johann Mendel, his work on pea plants, theory of Mendelian inheritance (C) Study of composition of Life : Levels of cellular and molecular organization; Cells, tissues and organs in our body; Pioneers of chromosome studies; Discovery of nucleic acids; Nuclein verified as a distinct chemical entity; Early identification of purines and pyrimidines; building blocks of Nucleic acids and proteins; Chemistry of Nucleic acids; Levene's tetranucleotide hypothesis.	
Unit-IV: DNA as the hereditary material – An experimental view	**(06)**
Transformation: Classic work of Frederick Griffith; DNA as the Pneumococcal Transforming Factor; *In vitro* Transformation system; Announcement that the transforming Principle was DNA; Mirsky's Criticism; The Avery, MacLeod and McCarty proclamation; Additional experiments that supported DNA as the transforming principle; Hershey and Chase clinched the role of DNA as the Genetic Material	
Unit-V: Solving the puzzle of DNA structure	**(07)**
Early studies of diffraction of X Rays by DNA fibers – contributions of Rosalind Franklin; Use of X – rays in medicines and research; Erwin Chargaff's discovery of base complementarity in DNA; Watson and Crick model of DNA; Contribution of Linus Pauling; DNA is replicated in Semi-conservative Fashion; Deciphering the Genetic Code; One Gene One Enzyme Edict.	
Unit-VI: Technical advancements in biology	**(07)**
Polymerase Chain Reaction – a revolution in modern biology; DNA Manipulations using Restriction enzymes; Discovery of reverse transcriptase leading to development of RT-PCR for RNA amplification; Work of Stanley Cohen and Herbert Boyer; Advent of gene cloning - History and current applications	
Unit-VII: Research as a backbone of modern medicine	**(07)**

(A) Discovery of antimicrobial agents; Contribution of Joseph Lister and later by Alexander Flemming leading to Discovery of Magic bullets; (B) Control of Infectious Diseases – Variolation, mithridatism and vaccination from the view of Edward Jenner; Vaccine production strategies – with examples of BCG and SARS-CoV2 vaccines; Historical timeline of vaccination strategies;(C) Marie Curie – Use of radiation in medicine.	
Unit VIII: Project Work [On any one topic]	**07**
Study historical research papers and provide a descriptive view of research that was carried out by Scientists as Minor Project. (A) Ancient system of medicine (B) Contribution of any one Indian Scientists in Biology (C) Contribution of any Physicists or Chemists in Biology (for topics listed above)	

PRACTICAL (12 Sessions x 2 = 24 hrs)

(Wherever wet lab experiments are not possible, the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Comparison of invisible life under the view of microscopes versus foldscope.
2. Cells as a unit of life and observation under the microscopes.
3. How do the cells divide – a view under the microscope: (mount of an onion root tip, onion bud cells or grasshopper testis).
4. Mendel's laws of inheritance – clues from nature.
5. Extraction of genomic DNA
6. Use of electric field to analyse DNA and other biomolecules.
7. Sneak Peek through the discovery of Polymerase chain reaction (PCR): Demonstration of original method and comparison with today's sophistication.
8. To test Flemming's hypothesis that the mold killed the bacteria.
9. Group Discussion on Research Topics assigned to students.

SUGGESTED READINGS:

- Watson, J. D. (2011) *The Double Helix – A personal account of the discovery of the structure of DNA.* Scribner. ISBN 9780743219174.
- Cooper, G. M. and Hausman, R. E. (2013). 6th Edition. *The cell: A molecular approach*. Massachusetts, USA: Sinauer Associates. ISBN-13:978-1605351551
- Karp, G. (2013). 7th Edition. *Cell and molecular biology: Concepts and experiments.* New Jersey, USA: Wiley Publishers. ISBN-978-0470483374.
- Cox, M. M. Doudna J. A. and Donnell, M. O. (2012). 1st Edition. *Molecular Biology: Principles and Practice.* London, United Kingdom: W H Freeman & Co Publishers, ISBN-13: 978-0-716- 7998-8.
- Watson, J. D. Baker T. A. Bell, S. P. Gann, A. Levine, M. and Losick, R. (2013). 7th Edition. *Molecular Biology of the Gene.* New York, United States: Cold Spring Harbor Laboratory Press, ISBN-13: 978-0-321-76243-6.

BOOK FOR BASIC CONCEPTUAL READING

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