

BIOCHEMISTRY**SEMESTER V****CORE COURSES:** Molecular Biology**ELECTIVE COURSES:** Concept of Genetics, Regulation of Gene Expression, Industrial Microbiology, Bioinformatics**BCH-V.C-7: MOLECULAR BIOLOGY (THEORY)**

MODULE	TOPICS	CONTACT HOURS	TOTAL HOURS
MODULE 1: Chemical Nature of Genetic Materials	<p>1.1: Nucleic Acids, bonds, types of DNAs, DNA packaging and model organisms Structural components of nucleic acid: Sugar, Phosphate, Nucleosides and Nucleotides; Structure of DNA: Watson – Crick Model, Different forms of DNA (B, Z), Forces stabilizing the structure of DNA, Unusual structures of DNA (palindromic, mirror repeat, hairpin bent, cruciform); Structure of RNA, Different forms of RNA (mRNA, rRNA, tRNA); Differences between DNA and RNA Chargaff's experiments and Law</p> <p>1.2: Chromosome Fundamental functions of DNA. Chromosomal DNA and its packaging in the chromatin fibre. Chromatin structure, structural features (Telomere, Centromere and Repetitive sequences) of chromosomes and their functions, prokaryotic chromosomes, plasmids.</p>	<p>10</p> <p>05</p>	15
MODULE 2: DNA/RNA a genetic material and DNA Replication	<p>2.1: DNA/RNA as genetic material DNA as genetic material: Griffith's transforming principle, and Avery, Hershey and Chase Experiment proving DNA as genetic material RNA as the genetic material of some viruses</p> <p>2.2: DNA Replication Experimental evidence for semi-conservative DNA replication in E.coli - Messelson and Stahl's experiment DNA template, Enzymes - DNA polymerases, ligase, DNA gyrase, Structure and function, Ancillary proteins</p>	<p>08</p> <p>07</p>	15

	<p>associated with replication Mechanism of replication: Initiation, Elongation and Termination; Introduction to theta and rolling circle models DNA Proof reading.</p>		
<p>MODULE 3: DNA damage, repair and recombination</p>	<p>3.1: DNA Damage and its Repair Types of DNA damage (spontaneous and induced). AMES Test Mechanisms/pathways to repair DNA: Excision repair, mismatch repair, recombination repair in <i>E. coli</i> and SOS Repair. Role of <i>RecA</i> in DNA damage repair, Photoreactivation repair in <i>E.coli</i> involving photolyase.</p> <p>3.2: Mechanisms of Genetic Recombination General and site specific recombination. Heteroduplex DNA formation (Homologous recombination). Synaptonemal Complex, Bacterial <i>RecBCD</i> system and its stimulation of chi sequences. Role of <i>RecA</i> protein, homologous recombination, Holliday junctions.</p>	<p>08</p> <p>07</p>	<p>15</p>

BCH-V.C-7: MOLECULAR BIOLOGY (PRACTICAL)

SR. NO.	PRACTICAL	NO. OF PRACTICALS
1.	Isolation of genomic DNA from prokaryotes and eukaryotes	05
2.	Isolation of RNA from prokaryotes	02
3.	Agarose gel electrophoresis of genomic DNA and its elution	05
4.	Mutagenesis in <i>E.coli</i> cells – UV	03
	Total	15

REFERENCES for BCH-V.C-7 (Latest Editions)

Mandatory Reading

- David, C., Nanette, P. and Michelle, M. Molecular Biology. Elsevier Academic Press.

Supplementary Reading

- Murray, R., Granner, D., Mayes, P. and Rodwell, V. Harper's Illustrated Biochemistry. Mc Graw Hill.
- Watson, J. D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R.M. Molecular biology of the gene. Menlo Park, CA: Benjamin-Cummings.
- Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K. and Walter, P. Molecular biology of the cell. New York: Garland Science.
- Gardner, M. J., Simmons D.P. Snustad. Principles of Genetics. John Wiley & Sons.
- Dubey, R.C. Advanced Biotechnology. S. Chand Publishing.

Web References:

- <https://www.khanacademy.org/science/high-school-biology/hs-molecular-genetics>
- <https://vlab.amrita.edu/?sub=3&brch=73&sim=1105&cnt=1>
- http://textbookofbacteriology.net/growth_3.html
- <https://openstax.org/details/books/biology-2e>
- [https://bio.libretexts.org/Bookshelves/Introductory_and_General_Biology/Book%3A_Concepts_in_Biology_\(OpenStax\)/9%3A_Molecular_Biology](https://bio.libretexts.org/Bookshelves/Introductory_and_General_Biology/Book%3A_Concepts_in_Biology_(OpenStax)/9%3A_Molecular_Biology)

BCH-V.E-9: CONCEPTS IN GENETICS (THEORY)

MODULE	TOPICS	CONTACT HOURS	TOTAL HOURS
MODULE 1: Mendelian Genetics, Model Organisms and Gene transfer mechanisms	1.1: Mendelian Genetics History of Mendelian Genetics, First Law of Inheritance, Second Law of Inheritance, Monohybrid and Dihybrid cross, Test cross and Back cross and their significance. Deviations in Mendel's Laws: Dominance, Co- dominance, Incomplete dominance; Multiple alleles: ABO blood group, Rh incompatibility Gene interaction - Epistasis: Dominant and Recessive epistasis with example; Non-epistatic gene interactions	08	15
	1.2: Model Organisms used in Genetics Study Model organisms: <i>Escherichia coli</i> , <i>Saccharomyces cerevisiae</i> , <i>Neurospora crassa</i> , <i>Drosophila melanogaster</i> , <i>Caenorhabditis elegans</i> , <i>Arabidopsis thaliana</i>	03	
	1.3: Genetic exchange in bacteria	04	

	Mechanism of genetic exchange – Conjugation, Transformation and Transduction		
MODULE 2: Chromosomal Linkage and Crossing-over and Human Genetics	2.1: Chromosomal Linkage and Crossing-over Sutton-Boveri chromosome theory of heredity; Bateson and Punnet’s coupling and repulsion hypothesis, Morgan’s views on linkage, Theory of linkage; Kinds of linkage: Complete linkage, incomplete linkage; Significance of linkage Types of crossing over: Somatic or mitotic crossing over, Germinal or meiotic crossing over Mechanism of meiotic crossing over: Synapsis, Duplication of chromosomes, Crossing over by breakage and union, Terminalisation, Significance of crossing over; Transposable elements.	09	15
	2.2: Human Genetics Importance of human genetics study, techniques involved: Amniocentesis, CVS, Pedigree analysis; Human traits; Disorders due to mutant genes: PTC tasters, Huntington’s chorea, Tongue rolling; Hemophilia	06	
MODULE 3: Chromosomal aberrations, Determination of Sex and Sex differentiation and Population Genetics	3.1: Chromosomal Mutations Concept of gene doses, Barr bodies, Types of structural changes (Deletion, Duplication, Inversion, Translocation, Variation in chromosome morphology) Disorders – Down’s syndrome, Klinefelter’s syndrome Types of numerical changes (Euploidy and Aneuploidy) - Monosomy and Trisomy of Sex and Autosomes Disorders – Turner’s Syndrome, Cri-du-chat syndrome. Disorders due to inborn errors of metabolism — Phenylketonuria (PKU), Alkaptonuria, Sickle-cell anaemia	06	15
	3.2: Genetically controlled sex determination and differentiation Mechanisms: (Heterogametes); Types: Heterogametic males, Heterogametic	06	

	<p>females; Genic balance mechanism; Sex determination in <i>Drosophila melanogaster</i> and man; Male haploidy or haplodiploidy mechanism; Hormonally controlled sex determining mechanism eg. Sex in <i>Bonellia</i>; Environmentally controlled sex determining mechanism- eg. Marine annelid <i>Ophryotrocha</i></p> <p>3.2: Population Genetics Hardy-Weinberg law, Factors affecting Hardy Weinberg theory, Predicting allele and Genotype frequencies and exceptions to Hardy-Weinberg principle, Speciation: types and examples.</p>	03	
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BCH-V.E-9: CONCEPTS IN GENETICS (PRACTICAL)

SR. NO.	PRACTICAL	NO. OF PRACTICALS
1.	Study of a Dissection microscope	01
2.	Study of Mendelian traits in Human Population	03
3.	Pedigree analysis and problem solving	03
4.	Karyotype analysis of chromosomal abnormalities	03
5.	Smear technique to demonstrate sex chromatin in buccal epithelial cells	01
6.	Study of Barr bodies in sex determination	01
7.	Problem solving on Mendel's laws and Hardy-Weinberg's law	03
	Total	15

REFERENCES for BCH-V.E-9

Mandatory Reading

- Tamarin, R.H. (2017). Principles of Genetics (7th Edition). Tata McGraw-Hill Publishing Company Ltd.
- Verma, P. S. and Agarwal, V. K. (2013). Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, S. Chand and Company Pvt. Ltd.

Supplementary Reading

- Stryer, L; Berg, J; Tymoczko, J & Gatto, G. (2019). Biochemistry (9th Edition). W. H. Freeman and Co., New York, USA.
- Murray, R. K, Granner, D. K., Mayes, P. A. & Rodwell, V. W. (2018). Harper's Illustrated Biochemistry (31st Edition). McGraw-Hill Companies.
- Jain, J. L.; Jain S. & Jain N. (2016). Fundamentals of Biochemistry (7th Edition). S.Chand and Company, Ltd., New Delhi.
- Verma, P. S. and Agarwal, V. K. (2013). Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, S. Chand and Company Pvt. Ltd.
- Harvey, R.A. & Ferrier, D.R. (2017). Lippincott's Illustrated Reviews, Biochemistry (7th Edition). Lippincott Williams and Wilkins.
- Voet, D. & Voet, J. G. (2004). Biochemistry (4th Edition). John Wiley & Sons, Inc, USA.

Web References:

- <http://www.biologydiscussion.com/mendel/mendel-study-on-genetics-mendelian-inheritance/38754>
- <https://www.khanacademy.org/science/high-school-biology/hs-classical-genetics/hs-pedigrees/v/pedigrees>
- <https://study.com/academy/lesson/hardy-weinberg-equilibrium-i-overview.html>
- <http://www.biologydiscussion.com/genetics/structural-change-in-the-structure-of-chromosomes/5261>
- <https://www.khanacademy.org/science/high-school-biology/hs-classical-genetics/hs-sex-linkage/a/x-inactivation>
- <https://www.khanacademy.org/science/biology/classical-genetics/chromosomal-basis-of-genetics/a/discovery-of-the-chromosomal-basis-of-inheritance>

BCH-V.E-10: REGULATION OF GENE EXPRESSION (THEORY)

MODULE	TOPICS	CONTACT HOURS	TOTAL HOURS
MODULE 1: Transcription in Prokaryotes and Eukaryotes	1.1: Concept of Central Dogma 1.1: Transcription in Prokaryotes Introduction to genetic code: Features of genetic code, wobble hypothesis Prokaryotes: RNA polymerases, Sigma factor, Bacterial promoters; RNA synthesis, Rho-dependent and Rho-independent termination; Inhibitors of transcription and applications as anti-microbial drugs 1.2: Transcription in Eukaryotes Transcription by RNA polymerase II, RNA polymerase II core promoters, General transcription factors, Various types of RNA	01 07	15

	processing, Transcription by RNA polymerase I and III. Inhibitors of eukaryotic transcription and their Applications Comparison between Prokaryotic and Eukaryotic transcription	07	
MODULE 2: Splicing, Translation, Gene regulation	2.1: RNA Splicing The spliceosome machinery, Group I and group II introns, Alternative splicing, Exon shuffling 2.2: Translation in Prokaryotes and Eukaryotes Ribosomes in Prokaryotes and Eukaryotes; Messenger RNA, Transfer RNA, Attachment of amino acids to tRNA, Ribosomal RNAs in Prokaryotes and Eukaryotes Comparison of Translation in Prokaryotes and Eukaryotes Inhibitors of Translation and Applications as anti-microbial drugs 2.3: Introduction to gene regulation	03 09 03	15
MODULE 3: Regulation of Gene Regulation in Prokaryotes and Eukaryotes	3.1: In Prokaryotes Concept of operon - structural and regulatory genes, Operator, promoter. Negative and positive regulation. Operon; Lactose operon, Tryptophan operon 3.2: Regulation of Gene Expression in Eukaryotes Euchromatin and heterochromatin, Trans-acting molecules, Cis-acting regulatory elements. Regulation by co- and post transcriptional processing of mRNA- Splicing, mRNA editing, RNA interference (RNAi), Regulation of mRNA at translational level Regulation through modifications to DNA	07 08	15

BCH-V.E-10: REGULATION OF GENE EXPRESSION (PRACTICAL)

SR. NO.	PRACTICAL	NO. OF PRACTICALS
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1.	Isolation of RNA from prokaryotes and eukaryotes	04
2.	Northern Blotting and Western Blotting to study gene expression (virtual laboratory)	02
3.	UV absorption spectra and direct spectrophotometric estimation of DNA and RNA	01
4.	Determination of the T _m and GC content of DNA	02
5.	To study the viscosity of DNA solutions	01
6.	To study gene expression by induction of enzyme(s) from suitable sources and confirmation by qualitative/quantitative assay/electrophoresis	05
	Total	15

REFERENCES for BCH-V.E-10

Mandatory Reading

- Nelson, D. L. & Cox, M.M. (2017). Lehninger's Principles of Biochemistry (7th Edition). Worth Publishers, New York, USA.

Supplementary Reading

- Stryer, L; Berg, J; Tymoczko, J & Gatto, G. (2019). Biochemistry (9th Edition). W. H. Freeman and Co., New York, USA.
- Murray, R. K, Granner, D. K., Mayes, P. A. & Rodwell, V. W. (2018). Harper's Illustrated Biochemistry (31st Edition). McGraw-Hill Companies.
- Jain, J. L.; Jain S. & Jain N. (2016). Fundamentals of Biochemistry (7th Edition). S.Chand and Company, Ltd., New Delhi.
- Verma, P. S. and Agarwal, V. K. (2013). Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, S. Chand and Company Pvt. Ltd.
- Harvey, R.A. & Ferrier, D.R. (2017). Lippincott's Illustrated Reviews, Biochemistry (7th Edition). Lippincott Williams and Wilkins.
- Voet, D. & Voet, J. G. (2004). Biochemistry (4th Edition). John Wiley & Sons, Inc, USA.

Web References:

- <https://courses.lumenlearning.com/suny-wmopen-biology1/chapter/regulation-of-gene-expression/>
- <https://www.khanacademy.org/science/biology/gene-regulation>
- <https://www.nature.com/scitable/topic/gene-expression-and-regulation-15/>
- [https://bio.libretexts.org/Bookshelves/Genetics/Book%3A_Working_with_Molecular_Genetics_\(Hardison\)/Unit_IV%3A_Regulation_of_Gene_Expression](https://bio.libretexts.org/Bookshelves/Genetics/Book%3A_Working_with_Molecular_Genetics_(Hardison)/Unit_IV%3A_Regulation_of_Gene_Expression)
- [https://bio.libretexts.org/Bookshelves/Human_Biology/Book%3A_Human_Biology_\(Wakim_and_Grewal\)/06%3A_DNA_and_Protein_Synthesis/6.07%3A_Regulation_of_Gene_Expression](https://bio.libretexts.org/Bookshelves/Human_Biology/Book%3A_Human_Biology_(Wakim_and_Grewal)/06%3A_DNA_and_Protein_Synthesis/6.07%3A_Regulation_of_Gene_Expression)

BCH-V.E-11: INDUSTRIAL MICROBIOLOGY (THEORY)

MODULE	TOPICS	CONTACT HOURS	TOTAL HOURS
MODULE 1: Introduction to Industrial Microbiology	1.1: Introduction Overview of industrial fermentation technology, scope and applications.	01	15
	1.2: Industrial bioreactor Fermenters: Structure of an Ideal fermentor Parts of the fermentor and their uses – Impellers, Spargers, Baffles, Headspace, Controls and Sensors (temperature, pH, antifoam) Types of reactors (definition, description, diagram and uses) - Bubble columns, Airlift, Fluidized bed, Packed bed, Tray bioreactors, Photo-bioreactors Sterilization of bioreactors	08	
	1.3: Fermentation Media Characteristics of an ideal fermentation medium, types of media – crude and synthetic, composition of fermentation media. Sterilization of media	06	
MODULE 2: Fermentation, fermentors and Screening of microorganisms	2.1: Types of fermentation Submerged, Surface/Solid state, Batch, Fed-batch, Continuous. Lab scale, Pilot Scale and Industrial scale fermentors	07	15
	2.2: Screening of microorganisms Characteristics of microorganisms, strain improvement, Screening procedures: Primary screening: Definition, Methods of primary screening – Crowded plate, Auxanography, Enrichment, Indicator dye Secondary screening: Definition and features, Example of secondary screening (giant colony method)	08	
	3.1: Detection and Assays of Fermentation products Physical and Chemical assays - Titration	05	

MODULE 3: Fermentation products	and gravimetric assay, Turbidity analysis and Cell determination, Spectrophotometric assay, Chromatographic method Biological assays - Diffusion assays, Turbidometric and Growth assay	10	15
	3.2: Industrial production of economically important products Citric acid, Vinegar, Ethanol, SCP, Beer, Wine, Yogurt, Penicillin, Amylase, Steroids		

BCH-V.E-11: INDUSTRIAL MICROBIOLOGY (PRACTICAL)

SR. NO.	PRACTICAL	NO. OF PRACTICALS
1.	Study and handling of a fermentor	02
2.	Media preparation for batch fermentation process	01
3.	A study on the phases of growth of microorganisms during fermentation	02
4.	Isolation of antibiotic producing bacteria – crowded plate technique and secondary screening using giant colony technique	03
5.	Production of wine (from fruit) using yeast	02
6.	Production of vinegar	02
7.	MIC of Penicillin for Gram positive bacteria (S. aureus or Bacillus)	01
8.	Production of amylase in solid state fermentation	02
	Total	15

REFERENCES for BCH-V.E-11

Mandatory Reading

- Stanbury P. F, Whitaker A. and Hall. (1997). Principles of fermentation technology, 2nd Edition, Aditya Books Pvt. Ltd, New Delhi.
- Casida L. E. (2009). Industrial Microbiology, New Age International (P) Ltd. New Delhi.

Supplementary Reading

- Okafor N. (2007). Modern Industrial Microbiology and Biotechnology, Science Publishers Enfield, NH, USA.
- Patel A. H. (2012). Industrial Microbiology, MacMillan Publishers India Ltd.

- Prescott and Dunn. (1982). Industrial Microbiology, 4th edition, AVI Publishing Co.
- Ratledge C. and Kristiansen B. (2001). Basic Biotechnology, 2nd edition. Cambridge university press.

Web References:

- <http://www.biologydiscussion.com/fermentation/fermentation-technology-meaning-methodology-types-and-procedure/17492>
- <https://study.com/academy/lesson/bacterial-fermentation-process-products.html>
- <https://study.com/academy/lesson/alcohol-fermentation-definition-equation-process.html>
- <http://www.biologydiscussion.com/biotechnology/bioprocess-technology/media-used-for-the-growth-of-microorganisms/10096>
- <http://www.biologydiscussion.com/industrial-microbiology-2/fermentation-industrial-microbiology-2/production-of-ethanol-microbiology/66072>

BCH-V.E-11: BIOINFORMATICS (THEORY)

MODULE	TOPICS	CONTACT HOURS	TOTAL HOURS
MODULE 1: Introduction to Bioinformatics; Information resources	1.1: Introduction to Bioinformatics Definition, Scope of bioinformatics Introduction to use of computers in biology, Internet and software in biology, Medicine and research, Historical developments in biology Bioinformatics: Components and applications	10	15
	1.2: Information resources Introduction, Aim and objectives (NCBI, NLM, NIH, EBI and SRS)	05	
MODULE 2: Types of Databases	2.1: Types of Databases Biological databases: Primary databases – Gen Bank and EMBL, DDBJ; Secondary databases - Swiss-PROT, PDB and PIR; Composite databases – OWL and PROSITE Structural databases: PDB, MMDB, CATH and SCOP; Visualization of proteins – Cn3D and Rasmol Literature databases: Pubmed, MedLINE and OMIM		15
MODULE 3: Sequence Alignment tools & phylogeny;	3.1: Sequence Alignment Tools and Phylogeny Introduction to sequence alignment and	10	15

HGP	phylogeny; BLAST and FASTA, and their types; ORF Pairwise sequences alignment, Multiple sequence alignment using Clustal-W Omega Phylogenetic tree: Introduction, Definition, Structure, Types and Construction Cladogram and differences with phylogenetic tree 3.2: Human Genome Project Introduction to Human Genome Project (HGP), Objectives, Ethical and social issues	05	
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BCH-V.E-12: BIOINFORMATICS (PRACTICAL)

SR. NO.	PRACTICAL	NO. OF PRACTICALS
1.	Usage of NCBI resources for biological databases – Protein or amino acid sequences – DNA or gene sequences	05
2.	Usage of NCBI resources for – Structure databases – Literature databases	03
3.	Database search and Pairwise sequence alignment using NCBI BLAST: BLASTp, BLASTn	02
4.	Multiple sequence alignment using Clustal-W	01
5.	Construction of phylogenetic tree using Clustal-W	01
6.	DNA sequence analysis to find restriction enzymes sites using NEB cutter	01
7.	Visualization of protein structures using Cn3D/ Rasmol	02
	Total	15

REFERENCES for BCH-V.E-12

Mandatory Reading

- Harisha, S. (2007). Fundamentals of Bioinformatics, I. K. International Publishing House, Mumbai.

Supplementary Reading

- Ignacimuthu, S. (2005). Basic Bioinformatics, Narosa Publishing House, New Delhi.
- Mount, D. W. (2004). Bioinformatics – sequence and Genome analysis, CBS Publishers.
- Murthy, C. S. V. (2003). Bioinformatics, Himalaya Publishing House, Mumbai.
- Rastogi, S. C., Mendiratta, N. and Rastogi, P. (2004). Bioinformatics: Concepts, Skills and Applications, CBS Publishers.
- Xiong, J. (2006). Essential Bioinformatics, Cambridge University Press.

SEMESTER VI**CORE COURSES:** Clinical Biochemistry**ELECTIVE COURSES:** Introduction to Pharmacology, Food Biochemistry, Genetic Engineering and Biotechnology, Environmental Chemistry**BCH-VI.C-8: CLINICAL BIOCHEMISTRY (THEORY)**

MODULE	TOPICS	CONTACT HOURS	TOTAL HOURS
MODULE 1: Laboratory Analysis of clinical samples	1.1: Blood, Serum and Urine Composition of Blood, Serum, Cerebrospinal Fluid and Urine. Collection, Preservation, Handling and Processing of clinical samples. Blood Bank	02	15
	1.2: Analysis of Blood, Serum, Urine and CSF Blood: Haemoglobin, Total cell and Differential cell (TC/DC) counts, Erythrocyte sedimentation Rate (ESR); Clotting time, Glucose tolerance test, Urea; Gases: Oxygen and Carbon dioxide levels; pH. Serum: Proteins, Albumin/Globulin Ratio; Bilirubin; Creatinine; Uric acid; Electrolytes. Urine: Colour, Odour, Sediment, Crystals, Glucose; Protein/Albumin CSF: Colour, Ph, microscopic examination (lymphocytes), chemical examination (protein, glucose, calcium), microbiological examination.	13	
MODULE 2: Congenital and Metabolic disorders	2.1: Congenital disorders Disorders associated with: a) Carbohydrate metabolism- Glycogen storage diseases, Galactosemia. b) Protein metabolism – Phenylketonuria, Alkaptonuria. c) Lipid metabolism – Niemann – Pick disease, Tay- Sach’s disease. Disorders due to chromosomal aberrations: Down syndrome, Turner syndrome, Klinefelter syndrome	09	15
	2.2 : Metabolic disorders Carbohydrate – Diabetes mellitus Type I and Type II; Ketosis. Lipids – Dyslipidemia.	06	

	Proteins – Albuminuria Blood – Anaemia: Haemolytic, Pernicious, Sickle Cell Anaemia, Iron deficiency. Heart – Hypertension, Atherosclerosis Liver – Wilson’s disease, Gaucher disease Kidney –Diabetes insipidus		
MODULE 3: Infectious diseases and Diagnostic Tests	3.1: Infectious diseases: Viral infection: Polio, Measles, Mumps, HIV, Influenza Bacterial infection: Diphtheria, Tuberculosis, Typhoid, Cholera. 3.2: General Diagnostic tests Blood: Total and differential blood count, Blood groups and Rh factor incompatibility. Liver disorders and Liver function tests: Bilirubin metabolism. Renal function tests: Glomerular filtration rate, Renal threshold and clearance values. Heart: Role of enzymes and other proteins in assessment of myocardial infarction.	15	15

BCH-VI.C-8: CLINICAL BIOCHEMISTRY (PRACTICAL)

SR. NO.	PRACTICAL	NO. OF PRACTICALS
1.	Identification of blood collection tubes and preparation of blood, plasma and serum	01
2.	Sample collection and processing – blood and urine	01
3.	Blood staining	01
3.	Bleeding and Clotting time	01
4..	Erythrocyte Sedimentation Rate	01
5.	Glucose Tolerance Test	01
6.	PCV Test	01
7.	Physical & Chemical Examination of Urine	02
8.	Liver function test	03

9.	Renal function test	02
10.	Cholesterol test	01
	Total	15

REFERENCES for BCH-V.C-8

Mandatory Reading

- Pattabiraman R. N. Text book of Biochemistry, All India Publisher distribution.

Supplementary Reading

- Chatterjee M. N., Shinde, R. Text book of Medical Biochemistry, Jaypee Publishers.
- Vasudevan, D. M., Sreekumari S., Text book of Biochemistry for Medical Students, Jaypee Publishers.
- Berg, Jeremy M., Tymoczko, John L., Stryer Lubert. Biochemistry, W.H. Freeman, N. York.
- David, L. N., Michael, M. C., Lehninger, Albert, Biochemistry, Kalyani Publications, N.

Web References:

- George, F. Hoffmann., Johannes, Z., William, L. Nyhan. Inherited Metabolic Disorders: A clinical approach, Springer.
- Fernandes, J., Saudubray, J.M., van Den Berghe, G. Inborn Metabolic Diseases. Springer.

BCH-VI.E-13: INTRODUCTION TO PHARMACOLOGY (THEORY)

MODULE	TOPICS	CONTACT HOURS	TOTAL HOURS
MODULE 1: Principles of pharmacology, Pharmacodynamics and Pharmacokinetics	1.1: General Principles Of Pharmacology Introduction to Pharmacology, Therapeutics; History – Traditional & Modern Medicine; Concepts of Pharmacology; Common terminologies used in pharmacology Nature of drugs; Sources of drugs, Scientific basis of use of drugs in humans Introduction to Pharmacopeia	05	15
	1.2: Pharmacodynamics & Pharmacokinetics Introduction; Pharmacodynamics: -	10	

	<p>Transport across biological membranes; Absorption of drugs, Bioavailability Pharmacokinetics: - Biotransformation, Excretion, Prolongation of drug action Mechanism of drug action, Placebo effect Receptors & Signal Transduction; Agonists, Antagonism; Slow processes, Non-receptor mechanism Constant Rate infusion; Single bolus dose, Repeated (multiple) dosing</p>		
<p>MODULE 2: Drug Absorption & Routes of Administration; Drug Development</p>	<p>2.1: Drug Formulation and its administration Bioavailability, Bioequivalence and generic vs. Proprietary prescribing; Prodrugs; routes of administration – Oral, Buccal & Sublingual, Rectal route, Skin, Lungs, Nose, Eye, Ear & Vagina, Intramuscular Injection, Subcutaneous injection, Intravenous injection, Intrathecal injection</p> <p>2.2: Drug Development Introduction to drug development, processes involved in drug development, Toxicity, Clinical trials</p>	<p>10</p> <p>05</p>	<p>15</p>
<p>MODULE 3: Types of drugs for different applications</p>	<p>2.2: Drugs for the Nervous and Musculoskeletal Systems (Include brief pathophysiology of diseases wherever necessary) Mechanism of drugs against Insomnia, Anxiety, Schizophrenia, Depressive illnesses, Parkinson's, Myasthenia gravis, Alzheimer's, Migranes. Anesthetics & Muscle relaxants, Analgesics Anti Inflammatory drugs</p> <p>3.1: Drugs for the Circulatory & Respiratory system (Include brief pathophysiology of diseases wherever necessary) Antihypertensive drugs, drugs used in ischaemic heart disease, Anticoagulants & antiplatelet drugs, drugs for heart failure Drugs used to treat asthma, bronchitis, cough</p> <p>3.2: Drugs for the Gastrointestine (Include brief pathophysiology of diseases wherever necessary) Drugs for peptic ulceration & Oesophageal disorders Diarrhoea, Irritable bowel</p>	<p>05</p> <p>05</p> <p>03</p>	<p>15</p>

	syndrome, Liver diseases, Drugs that modify appetite		
	3.3: Antimicrobial drugs Antibacterial, Antiviral, Antifungal drugs	02	

BCH-VI.E-13: INTRODUCTION TO PHARMACOLOGY (PRACTICAL)

SR. NO.	PRACTICAL	NO. OF PRACTICALS
1.	Study of efficiency of any antibacterial and antifungal against standard organisms	04
2.	MIC of store purchased antibiotic	02
3.	Determining shelf life of a drug	02
4.	Estimating the quantity of active ingredient in a store brought drug (Vitamins, etc.)	02
5.	Study of mode of action of any commonly used drug and route of administration	04
6.	Study of dosage forms of drugs	01
	Comprehensive study of the Indian Pharmacopeia	
	Study on Clinical trials	
	Total	15

REFERENCES for BCH-VI.E-13

Mandatory Reading

- Tripathi K. D. (2019). Essentials of Medical Pharmacology (8th Edition). Jaypee Brothers Medical Publishers (P) Ltd., London.

Supplementary Reading

- Ritter J. M., Lewis L. D., Mant T. GK., and Ferro A., (2008). A Textbook of Clinical Pharmacology and Therapeutics (5th Edition). Hachette Livre, U.K.
- Katzung B., (2017). Basic and Clinical Pharmacology (14th Edition). McGraw-Hill Education/Medical.
- Whalen K., (2018). Lippincott Illustrated Reviews: Pharmacology (Sangeeta Sharma & Thirumurthy Velpandian edition). Wolters Kluwer India Pvt. Ltd.

Web References:

- <https://www.ncbi.nlm.nih.gov/books/NBK12815/>
- <https://www.youtube.com/watch?v=tobx537kFaI>
- <https://www.ncbi.nlm.nih.gov/books/NBK507791/>
- <https://www.youtube.com/watch?v=NKV5iaUVBUI>

BCH-VI.E-14: FOOD BIOCHEMISTRY (THEORY)

MODULE	TOPICS	CONTACT HOURS	TOTAL HOURS
MODULE 1: Introduction to Food Biochemistry and spoilage	1.1: Introduction to Food biochemistry Definition and composition of food. Food as a substrate for microorganisms	02	15
	1.2: Spoilage of food Intrinsic and Extrinsic factors - Hydrogen-ion concentration, moisture requirement, oxidation-reduction potential, nutrient content, inhibitory substances and biological structure. Enzymatic browning, Non – Enzymatic browning, Maillard reaction, Caramelization reaction, Ascorbic acid oxidation Classification of foods by ease of spoilage, Factors affecting kinds, numbers and growth of microorganisms in food, temperature, pressure Chemical changes caused by microorganisms	13	
MODULE 2: Principles of Food Preservation	2.1: Principles of Food preservation Preservation by high temperature – Factors affecting heat resistance (Thermal Death Time), Determination of heat resistance (Thermal Death Time), Heat treatments employed in food processing, Chemistry of canning Preservation by low temperature – Temperature employed in low-temperature storage. Principle of freezing, freezing curve, changes occurring during freezing, types of freezing i.e. slow freezing, quick freezing, Introduction to thawing, Mechanism of changes during thawing and its effect on food.	15	15

	<p>Preservation by drying – Methods of drying, Factors in the control of drying</p> <p>Preservation by radiation – kinds of ionizing radiations used in food irradiation, mechanism of action, uses of radiation processing in food industry, concept of cold sterilization.</p>		
<p>MODULE 3: Food Quality, New Product Development</p>	<p>3.1 : Food Quality</p> <p>Objectives, type of food panels, characteristics of panel members, layout of sensory evaluation laboratory, sensitivity tests, threshold value, paired comparison test, duotrio test, triangle test, hedonic scale, chemical dimension of basic tastes, Amoore’s classification of odorous compounds. Sherman and Szczniak classification of food texture.</p> <p>Sensory attributes of cheese, cream, butter, ghee, juices.</p> <p>Application of texture measurement in cereals, fruits and vegetables, dairy, meat and meat products.</p> <p>Dimensions of colour and attributes of colour; gloss etc. Perception of colour, Colour Measurement: Munsell colour system, CIE colour system, Hunter colour system, etc.</p> <p>Grading of Milk, MBRT, Resazurin (include more tests for other foods)</p> <p>FSSAI and other Regulatory Bodies</p>	<p>11</p>	<p>15</p>
	<p>3.2: Product Development</p> <p>Importance, Need of product development, Steps of product development, Product development tools, Reasons for failure</p>	<p>04</p>	

BCH-VI.E-14: FOOD BIOCHEMISTRY (PRACTICAL)

SR. NO.	PRACTICAL	NO. OF PRACTICALS
1.	Screening and evaluation of fresh and spoiled fruits and vegetables	02
2.	Texture evaluation of various processed food sample	01
3.	Processing and sensory evaluation of milk and milk products (milk, flavoured milk, curd, cheese, condensed milk, khoya)	05
4.	TDT of an organism isolated from spoilt fruit	01

5.	Spoilage of bakery product (bread, biscuits)	01
6.	Estimation of salt content in butter	01
7.	Study quality characteristics of foods preserved by drying/ dehydration/ freezing.	02
8.	Visit to a food industry or food research institute and preparation of report	02
	Total	15

REFERENCES for BCH-VI.E-14

Mandatory Reading

- Frazier, W. C. and Westhoff, D. C., Food Microbiology. TMH Publication, New Delhi.

Supplementary Reading

- Ramaswamy, H. and Marcott, M. Food Processing Principles and Applications. CRC Press.
- Ranganna, S. Handbook of Analysis and Quality Control for Fruits and Vegetable Products, TMH Education Pvt. Ltd.
- Potter, N.H. Food Science, CBS Publication, New Delhi.
- Owen, F. R. Food Chemistry, Marcell Dekker, New York.
- Gordon, F. W. New Product Development From Concept to Marketplace, CRC Press.
- Norman, D.W. and James, D. N. The technology of food preservation, Westport.
- Pomeranz, Y. and Meloan, C.E. Food Analysis – Theory and Practice, CBS Publishers and Distributors, New Delhi.

Web References:

- <https://www.youtube.com/watch?v=LUQxrEFzB0>
- <https://www.slideshare.net/natrajdurgannavar/sensory-evaluation-of-food>
- <http://ecoursesonline.iasri.res.in/mod/page/view.php?id=6091>

BCH-VI.E-15: GENETIC ENGINEERING AND BIOTECHNOLOGY (THEORY)

MODULE	TOPICS	CONTACT HOURS	TOTAL HOURS
MODULE 1: Introduction of	1.1: Introduction to Genetic Engineering and Biotechnology	03	15

<p>Genetic Engineering & the basic Tools required for it</p>	<p>General features and mechanisms of genetic engineering, Concept of biotechnology, Applications and ethical issues of recombinant DNA technology, Gene cloning</p> <p>1.2: DNA Modifying enzymes and Vectors for Gene Cloning Nucleases- Endonucleases (Restriction enzymes recognition sequences, Cleavage pattern), Exonucleases, Host control restriction and modification, DNA ligases, Reverse Transcriptases, Polynucleotide kinases, Alkaline phosphatases, Nucleotidyl transferases Vectors, Properties of ideal cloning vectors, Types of cloning vectors; Plasmid vectors: Properties, Classification, pBR322, pUC 18 Bacteriophage vectors, Lambda phage: Features, Insertional vectors and Replacement vectors, M13 Bacteriophage Hybrid vectors: Cosmids, Phagemids and Phasmids; Shuttle vectors; Plant vectors</p>	<p>12</p>	
<p>MODULE 2: Transformation methods and Blotting techniques for DNA & RNA</p>	<p>2.1: Transformation methods and identification of recombinants DNA insertion into vectors: Ligation, Use of linkers and Adaptors, Homopolymer tailing Competence (transformation in bacteria): Microinjection, Lipofection, Electroporation, Macroinjection, Sonication, DNA co-precipitation, Ultrasonication, Laser induced Identification of Recombinants: Principle and importance of identification of recombinants: Antibiotic resistance (amp, tet resistance), lac Z selection, Colony hybridization</p> <p>2.2: Blotting Techniques for DNA and RNA Isolation of Genomic DNA and RNA, Agarose gel electrophoresis, Southern blotting: Blotting of DNA from agarose gel by capillary action onto nitrocellulose membrane, Denaturing of DNA, Hybridisation with radiolabelled P 32 , Autoradiography Northern blotting: Blotting of RNA from agarose gel onto nitrocellulose membrane,</p>	<p>10</p> <p>05</p>	<p>15</p>

	Hybridisation with radiolabelled probe, Autoradiography		
MODULE 3:	3.1: DNA Amplification and Sequencing DNA amplification: Polymerase chain reaction (PCR) – Principle, Components, Method and Applications DNA sequencing: Significance and importance, Basic methods: Maxam Gilbert's method, Sanger's method. Advanced method: Shotgun method, Automatic DNA sequencer	08	15
	3.2: Genomic and cDNA libraries Preparation of genomic library, cDNA library, Screening of Libraries	02	
	3.3: Applications in agriculture Flavr Savr tomato, Golden rice, Plant resistance to desiccation, cold, heat, pests, herbicides	02	
	3.4: Applications in pharmaceuticals Recombinant insulin, Blood clotting factor VIII, Edible vaccines	02	
	3.5: Applications in environment Bioremediation and Superbug	01	

BCH-VI.E-15: GENETIC ENGINEERING AND BIOTECHNOLOGY (PRACTICAL)

SR. NO.	PRACTICAL	NO. OF PRACTICALS
1.	Isolation of plasmid DNA by alkaline lysis and boiling prep method, and molecular weight determination by gel electrophoresis	04
2.	Restriction digestion of plasmid DNA and analysis by gel electrophoresis	02
3.	Preparation of competent cells in bacteria	02
4.	Transformation in bacteria using plasmid vector (pUC 18)	04
5.	Deciphering the DNA sequence from a sequencing gel photograph by Maxam and Gilbert's method and Sanger's method	02
6.	Blotting techniques (virtual laboratory)	01

	Total	15
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REFERENCES for BCH-VI.E-15

Mandatory Reading

- Singh, B. D. (2008). Biotechnology: Expanding Horizons, Kalyani Publishers.

Supplementary Reading

- Primrose, S. B. and Twyman, R. M. (2009). Principles of Gene Manipulation and Genomics, Blackwell Publishing.
- Jogdand, S. N. (2008). Gene Biotechnology, 2nd edition, Himalaya Publishing House, Mumbai.
- Purohit, S. S. (2009). Biotechnology: Fundamentals and Applications, Student Edition.
- Watson, J. D., Tooze, J. and Kurtz, D. T. (1983). Recombinant DNA: A short Course, Scientific American Books (WH Freeman), New York.

Web References:

- <https://www.khanacademy.org/science/high-school-biology/hs-molecular-genetics/hs-biotechnology/v/introduction-to-genetic-engineering>
- [https://bio.libretexts.org/Bookshelves/Microbiology/Book%3A_Microbiology_\(Bruslind\)/18%3A_Genetic_Engineering](https://bio.libretexts.org/Bookshelves/Microbiology/Book%3A_Microbiology_(Bruslind)/18%3A_Genetic_Engineering)
- [https://bio.libretexts.org/Bookshelves/Microbiology/Book%3A_Microbiology_\(Boundless\)/7%3A_Microbial_Genetics/7.23%3A_Genetic_Engineering_Products/7.23B%3A__Applications_of_Genetic_Engineering](https://bio.libretexts.org/Bookshelves/Microbiology/Book%3A_Microbiology_(Boundless)/7%3A_Microbial_Genetics/7.23%3A_Genetic_Engineering_Products/7.23B%3A__Applications_of_Genetic_Engineering)
- <https://www.slideshare.net/gnsk143/gene-transformation-methods>
- https://www.brainkart.com/article/Identification-of-Recombinants---Recombinant-DNA-Technology_21278/

BCH-VI.E-16: ENVIRONMENTAL CHEMISTRY (THEORY)

MODULE	TOPICS	CONTACT HOURS	TOTAL HOURS
MODULE 1: Ecological Concepts and Pollutants	1.1: Basic ecological concept Biogeochemical cycles (C, N, O, P, S, Water), Food chain and food webs, Ecological pyramids; Productivity and eco-energetic (10% law)	09	15
	1.2: Pollutants Pollutants of water, air and soil and their sources Eco-toxicology: concept of permissible limits, ED50 & LD50; acute and chronic exposures.	06	

	3.4: Hospital waste management	01	
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BCH-VI.E-16: ENVIRONMENTAL CHEMISTRY (PRACTICAL)

SR. NO.	PRACTICAL	NO. OF PRACTICALS
1.	Water quality by MPN method for sewage water	02
2.	Routine analysis of potable water sample using Presumptive, Confirmatory and Confirmed tests for coliform	04
3.	Determination of Dissolved Oxygen concentration of water sample by Winkler's method	01
4.	Determination of Biological Oxygen Demand (BOD) of the water sample	01
5.	Determination of Chemical Oxygen Demand (COD) of the water sample	01
6.	Determination of Total Solids (TS) of the given water sample	01
7.	Isolation of xenobiotic degrading bacteria by selective enrichment	03
8.	Visit to an effluent treatment plant (report)	02
	Total	15

REFERENCES for BCH-VI.E-16

Mandatory Reading

- Dara, S.S. A text book of Environmental Chemistry and Pollution Control. S. Chand Publishers

Supplementary Reading

- Khopkar, S. M. Environmental Pollution Analysis. John Wiley and Sons.
- Mitchell, R. and Cu, J. D. Environmental Microbiology. Wiley- Blackwell Publication
- Ramesh, K. V. Environmental Microbiology. MJP Publishers, India.
- Maier, R., Pepper, I. and Gerba, C. Environmental Microbiology. Academic Press.
- Moore J. W. and Moore, E. A., Environmental Chemistry. Elsevier.
- Jadhav, H.V. Elements of Environmental Chemistry: For Undergraduate Science Students of Indian University. Himalaya Publishing House.

- Satake, M., Sethi, S. and Eqbal, S.A. Environmental Chemistry. Discovery Publishing Pvt.Ltd,
- Salle, A.J. Fundamental Principles of Bacteriology. McGraw Hill.
- Frobisher, M. and Hinsdale, R.D. Fundamentals of Microbiology. Saunders.

Web References:

- <https://openoregon.pressbooks.pub/envirobiology/>