Syllabus and Scheme of Examination
For

B.Sc. (Honors) component of B.Sc.-M.Sc. Integrated Biochemistry programme

Under

Choice Based Credit System

Effective from October 2021

DEPARTMENT OF BIOCHEMISTRY
SCHOOL OF CHEMICAL AND LIFE SCIENCES

JAMIA HAMDARD
(Deemed to be University)
www.jamiahamdard.edu

Department of Biochemistry

The Department of Biochemistry established in the year 1994, is one of the six Departments of School of Chemical and Life Sciences of Jamia Hamdard. The department is recognized for its excellence in higher education and research in India and abroad. The Department of Biochemistry conducts Integrated BSc-MSc, MSc and PhD programmes. The Department is recognized by its teaching and research, and is also a recipient of prestigious DST-FIST-II, UGC SAP DRS II and DBT-BUILDER grants. The faculty is highly accomplished and is involved in cutting edge research in the field of biological sciences. The department has access to a dedicated animal house for research programs which maintains small animals such as mice, rats, rabbits, and guinea pigs. The university has smart classrooms for studies along with dedicated and well-equipped labs for PG and UG students within the department. The school also has a central instrumentation facility (CIF) for its 6 departments including the department of biochemistry. The CIF has the state-of-the-art equipment such as HPLC, RT-PCR, FTIR, Confocal Microscope, Ultracentrifuge etc. In addition, the department has its own CIF as well. The syllabus is periodically revised in consultation, and with approval from the Board of Studies of the department to keep the students abreast with current trends in Biochemistry. The syllabus is also well aligned with the key national level scholarship programs like CSIR, DBT, ICMR etc. The hands-on training is imparted to students in most of the contemporary areas, which prepares them to undertake research in cutting-edge fields for their PhD within the university or outside. There is a fine balance in class room teaching as well as hands on experimental training.

Thrust Areas of Research

- Biology of *Mycobacterium tuberculosis*; Ribonucleases in human health and disease; Targeted therapy of cancer.
- Innate immunity, Chronic diseases, Tissue injury, Regeneration and repair.
- Cancer Etiology, DNA damage and repair, Nutrigenomics, Proteomics.
- Molecular Immunology, Development of FRET Based Biosensors.
- Host-pathogen interactions; Computational biology.
- Alternative splicing and disease.
- Toxicant mediated metabolic syndrome.
- Role of novel kinase pathways in virus mediated oncogenesis.

Vision

The Department aspires to be a centre of excellence that promotes the understanding of the molecular events that trigger normal and pathological functions in medicine and other allied health sciences. In addition, the Department must be highly skilled in transferring such knowledge and education to students and also educate the general public.

Mission:

The Department of Biochemistry sees as its mission to:

1. Offer a high quality courses in Biochemistry appropriate for students interested in medicine and other allied health studies.
2. Be a leading force for advancing society through the continuous pursuit of educational excellence and cutting-edge research.
3. Encourage industry academia collaboration in the areas of research, knowledge sharing and job placements.
4. Develop public outreach programs (rural schools and colleges) specially on select days like Science day and Earth day.

5. sign MoUs with national and international Universities/Institutes, to improve funding and also provide better exposure to our students. Inter school collaborations within the university would also be encouraged.
6. improve our research in thrust areas of protein biochemistry, drug development, host pathogen interaction and computational biology as a mandate of our departmental grants.

Courses Offered

1. B.Sc.-M.Sc. Integrated Programme (Biochemistry)
Duration: Five years (Ten semesters)

Eligibility: A candidate seeking admission to the BSc-MSc Integrated program must have passed Senior Secondary (12th/Intermediate) examination with Biology/Mathematics from CBSE or any other Board recognized by JH as equivalent thereto, securing at least 50% marks or equivalent CGPA in aggregate.

Selection procedure: Selection will be made purely based on the marks obtained in qualifying examination. The student will have exit option after sixth semester. In such cases the candidate will be awarded B.Sc. (Honours) degree in Biochemistry.

2. M.Sc. Biochemistry
Duration: Two years (Four semesters)

Eligibility: Passed B.Sc. in Biochemistry or equivalent examination in Biological Sciences with Biochemistry or Chemistry as one of the subjects securing at least 50% marks in aggregate.

Selection procedure: Selection for PG programs will be based on the merit in the qualifying examination. Qualifying exam will mean average of three years marks of B.Sc. programme. In case where final year exam result is not out, the average of last two years marks will be counted for provisional selection of candidates.

3. Ph.D. Biochemistry
Ph.D. programme shall be for minimum duration of three years, including course work and ideally 5 years subject to maximum of six years as per the Jamia Hamdard PhD byelaws.

Eligibility and selection procedure: Candidates shall have a Master's Degree or a professional degree declared equivalent to Master's degree by the corresponding statutory body, with at least 55% marks in aggregate or its equivalent Grade 'B' in the UGC 7-point scale. NET-JRF/Individual Fellowship holders/Project Fellows will be preferred for admissions in Ph.D. programs.

Since the inception of Department around 20 batches comprising of >350 students have passed the PG program in Biochemistry. Over the years, the department has developed facilities for high precision analytical work, and has acquired advance equipment and tools for cellular and molecular research including the facility to work on cell lines. Our M.Sc. pass out students are working as scientists and academicians besides taking up jobs in private sectors as well as abroad. In last five years the Department has awarded 39 PhD and published >75 research articles in SCI journals.

Faculty

Dr. Shakir Ali	Ph.D.	Professor
Dr. Rana Zaidi	M.Phil., Ph.D.	Professor and Head
Dr. Janendra K. Batra	Ph.D.	Professor
Dr. Farah Khan	Ph.D.	Associate Professor
Dr. Vikas Sood	Ph.D.	Assistant Professor
Dr. Sayeed ur Rehman	Ph.D.	Assistant Professor
Dr. Mohan Kamthan	Ph.D.	Assistant Professor
Dr. Saurabh Pandey	Ph.D.	Assistant Professor

Contact:

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Structure of B.Sc. (Hons) component of B.Sc.-M.Sc. Integrated Biochemistry under CBCS

Core Courses

BBC-CC01: Basics of Computer Science and Statistics
BBC-CC02: Basics of Chemistry
BBC-CC03: Biomolecules
BBC-CC04: Cell Biology
BBC-CC05: Immunology
BBC-CC06: Enzymes and Proteins
BBC-CC07: Metabolism of Carbohydrates and Lipids
BBC-CC08: Membrane Biology and Bioenergetics
BBC-CC09: Hormone Biochemistry and Human Physiology
BBC-CC10: Plant Biochemistry
BBC-CC11: Molecular Biology and Genetics
BBC-CC12: Basic Microbiology
BBC-CC13: Metabolism of Amino Acids and Nucleotides
BBC-CC14: Genetic Engineering and Biotechnology

Discipline Specific Electives (*Any four*)

BBC-DSE01: Structural Biology
BBC-DSE02: Research Methodology
BBC-DSE03: Chronic Human Diseases
BBC-DSE04: Developmental Biology
BBC-DSE05: Genomics, Proteomics and Metabolomics
BBC-DSE06: Advanced Cell Biology
BBC-DSE07: Introduction to Techniques in Biochemistry
BBC-DSE08: Intermediary Metabolism

Generic Electives (*Any four*)

BBC-GE01-A: Basics of Physics and Biology
BBC-GE01-B: Basics of Physics and Mathematics
BBC-GE02-A: Bioethics and Intellectual Property Rights
BBC-GE02-B: Biotechnology and Human Welfare
BBC-GE03: Systems Biology
BBC-GE04: Introduction to Biological Data Analysis
BBC-GE05: Gene Organization, Expression and Regulation
BBC-GE06: Fundamentals of Cell Biology and Immunology
BBC-GE07: Fundamentals of Genetic Engineering
BBC-GE08: Biochemical Correlations in Diseases

Ability Enhancement Compulsory Courses

BBC-AEC01: English Communication
BBC-AEC02: Environmental Studies

Skill Enhancement Elective Courses (*Any Two*)

BBC-SEC01: Tools and Techniques in Biochemistry
BBC-SEC02: Protein Purification Techniques
BBC-SEC03: Clinical Biochemistry
BBC-SEC04: Recombinant DNA Technology

Course Code	Name of the Paper	Paper Category	IA	EA	Total Marks	Course Credits
SEMESTER–I						
BBC-CC01	Basics of Computer Science and Statistics	Core	25	75	100	4
BBC-CC01 TU	Basics of Computer Science and Statistics- Tutorials	Core	13	37	50	2
BBC-CC02	Basics of Chemistry	Core	25	75	100	4
BBC-AEC01	English Communication	AEC	13	37	50	2
BBC-AEC02	Environmental Studies	AEC	13	37	50	2
BBC-GE01-PB OR BBC-GE01-PM	Basics of Physics and Biology OR Basics of Physics and Mathematics	GE	25	75	100	4
BBC-GE01 TU	Basics of Physics and Biology OR Basics of Physics and Mathematics- Tutorials	GE	13	37	50	2
					Total	**20**
SEMESTER–II						
BBC-CC03	Biomolecules	Core	25	75	100	4
BBC-CC04	Cell Biology	Core	25	75	100	4
BBC-CC05	Immunology	Core	25	75	100	4
BBC-CC06	Enzymes and Proteins	Core	25	75	100	4
BBC-GE02-A OR BBC-GE02-B	Bioethics and IPR OR Biotechnology and Human Welfare	GE	25	75	100	4
					Total	**20**
SEMESTER–III						
BBC-CC07	Metabolism of Carbohydrates and Lipids	Core	25	75	100	4
BBC-CC08	Membrane Biology and Bioenergetics	Core	25	75	100	4
BBC-CC09	Hormone Biochemistry and Human Physiology	Core	25	75	100	4
BBC-CC10	Plant Biochemistry	Core	25	75	100	4
BBC-CC11	Molecular Biology and Genetics	Core	25	75	100	4
BBC-GE03	Systems Biology	GE	25	75	100	4
Choose any one						
BBC-SEC01	Tools and Techniques in Biochemistry	SEC	13	37	50	2
BBC-SEC02	Protein Purification Techniques	SEC	13	37	50	2
BBC-SEC03	Clinical Biochemistry	SEC	13	37	50	2
BBC-SEC04	Recombinant DNA Technology	SEC	13	37	50	2
					Total	**26**
SEMESTER–IV						
BBC-CC02 PR	Basics of Chemistry Practical	Core	13	37	50	2
BBC-CC03 PR	Biomolecules Practical	Core	13	37	50	2
BBC-CC03 PR	Cell Biology Practical	Core	13	37	50	2
BBC-CC05 PR	Immunology Practical	Core	13	37	50	2
BBC-CC06 PR	Enzymes and Proteins Practical	Core	13	37	50	2
BBC-CC12	Basic Microbiology	Core	25	75	100	4
BBC-CC13	Metabolism of Amino Acids and Nucleotides	Core	25	75	100	4
BBC-GE04	Introduction to Biological Data Analysis	GE	25	75	100	4
BBC-GE04 PR	Introduction to Biological Data Analysis Practical	GE	13	37	50	2
Choose any one						
BBC-SEC01	Tools and Techniques in Biochemistry	SEC	13	37	50	2
BBC-SEC02	Protein Purification Techniques	SEC	13	37	50	2
BBC-SEC03	Clinical Biochemistry	SEC	13	37	50	2
BBC-SEC04	Recombinant DNA Technology	SEC	13	37	50	2
					Total	**26**

SEMESTER–V						
BBC-CC14	Genetic Engineering and Biotechnology	Core	25	75	100	4
BBC-CC14 PR	Genetic Engineering and Biotechnology Practical	Core	13	37	50	2
Choose any three (Theory+Practical)						
BBC-DSE01	Structural Biology	DSE	25	75	100	4
BBC-DSE01 PR	Structural Biology Practical	DSE	13	37	50	2
BBC-DSE02	Research Methodology	DSE	25	75	100	4
BBC-DSE02 PR	Research Methodology Practical	DSE	13	37	50	2
BBC-DSE03	Chronic Human Disease	DSE	25	75	100	4
BBC-DSE03 PR	Chronic Human Disease Practical	DSE	13	37	50	2
BBC-DSE04	Developmental Biology	DSE	25	75	100	4
BBC-DSE04 PR	Developmental Biology Practical	DSE	13	37	50	2
BBC-DSE05	Genomics, Proteomics and Metabolomics	DSE	25	75	100	4
BBC-DSE05 PR	Genomics, Proteomics and Metabolomics Practical	DSE	13	37	50	2
BBC-DSE06	Advanced Cell Biology	DSE	25	75	100	4
BBC-DSE06 PR	Advanced Cell Biology Practical	DSE	13	37	50	2
BBC-DSE07	Introduction to Techniques in Biochemistry	DSE	25	75	100	4
BBC-DSE07 PR	Introduction to Techniques in Biochemistry Practical	DSE	13	37	50	2
BBC-DSE08	Intermediary Metabolism	DSE	25	75	100	4
BBC-DSE08 PR	Intermediary Metabolism Practical	DSE	13	37	50	2
					Total	**24**
SEMESTER–VI						
BBC-CC07 PR	Metabolism of Carbohydrates and Lipids Practical	Core	13	37	50	2
BBC-CC08 PR	Membrane Biology and Bioenergetics Practical	Core	13	37	50	2
BBC-CC09 PR	Hormone Biochemistry and Human Physiology Practical	Core	13	37	50	2
BBC-CC10 PR	Plant Biochemistry Practical	Core	13	37	50	2
BBC-CC11 PR	Molecular Biology and Genetics Practical	Core	13	37	50	2
BBC-CC12 PR	Basics of Microbiology Practical	Core	13	37	50	2
BBC-CC13 PR	Metabolism of Amino Acids and Nucleotides Practical	Core	13	37	50	2
BBC-GE02-A PR BBC-GE02-B PR	Bioethics and IPR Practical OR Biotechnology and Human Welfare Practical	GE	13	37	50	2
BBC-GE03 PR	Systems Biology Practical	GE	13	37	50	2
Choose any one (Theory+Practical)						
BBC-DSE01	Structural Biology	DSE	25	75	100	4
BBC-DSE01 PR	Structural Biology Practical	DSE	13	37	50	2
BBC-DSE02	Research Methodology	DSE	25	75	100	4
BBC-DSE02 PR	Research Methodology Practical	DSE	13	37	50	2
BBC-DSE03	Chronic Human Disease	DSE	25	75	100	4
BBC-DSE03 PR	Chronic Human Disease Practical	DSE	13	37	50	2
BBC-DSE04	Developmental Biology	DSE	25	75	100	4
BBC-DSE04 PR	Developmental Biology Practical	DSE	13	37	50	2
BBC-DSE05	Genomics, Proteomics and Metabolomics	DSE	25	75	100	4
BBC-DSE05 PR	Genomics, Proteomics and Metabolomics Practical	DSE	13	37	50	2
BBC-DSE06	Advanced Cell Biology	DSE	25	75	100	4
BBC-DSE06 PR	Advanced Cell Biology Practical	DSE	13	37	50	2
BBC-DSE07	Introduction to Techniques in Biochemistry	DSE	25	75	100	4
BBC-DSE07 PR	Introduction to Techniques in Biochemistry Practical	DSE	13	37	50	2
BBC-DSE08	Intermediary Metabolism	DSE	25	75	100	4
BBC-DSE08 PR	Intermediary Metabolism Practical	DSE	13	37	50	2
					Total	**24**

Th = Theory; PR = Practical; TU = Tutorial
CC = Core Courses AEC = Ability Enhancement Compulsory CoursesSEC = Skill Enhancement Courses DSE = Discipline Specific Elective
GE = Generic Electives

Program Outcomes (POs) related to Bachelor of Science (B.Sc.) and Program Specific outcomes (PSOs) related to B.Sc. (Hons) component of B.Sc.-M.Sc. Integrated Biochemistry

At the end of the programme, students will be able to	
PO 1	Propose novel ideas towards solutions to contemporary problems justifying with relevant facts and data
PO 2	Develop scientific outlook and see the relevance of science concepts in all aspects of life
PO 3	Identify, formulate and analyse complex scientific problems using principles of natural and applied sciences.
PO 4	Comprehend concepts, frameworks and inventions through various learning methods and effectively communicate them to others orally and in writing.
PO 5	Analyse critically the given scientific data ascribe meaning to them and draw objective conclusions.
PO 6	Demonstrate empathetic social concern, skills to effectively participate in civic affairs and democratic decision making.
PO 7	Imbibe ethical, moral and social values to become cultured and civilised global citizens.
PO 8	Apply concepts of sustainable development to make a difference in social and environmental issues.
PO 9	Develop multidimensional skills and habits as lifelong learners.
PSO 01	Acquire interdisciplinary knowledge with strengthened fundamentals of Biochemistry, Molecular Biology and Immunology.
PSO 02	Understand the nuances of basic and applied fields of the subjects offered in the curriculum like Clinical Biochemistry, Cell Metabolism, Cell Biology, Protein Biochemistry, Genetic Engineering and Biotechnology and Biological Data analysis
PSO 03	Comprehend the theoretical and practical aspects for industry and research-oriented future.
PSO 04	Articulate multifaceted career prospects in health, Pharmaceutical, Clinical and research sectors with a sound analysis of the pros and cons of the same
PSO 05	Appertaining the students with the skills of entrepreneurship

MAPPING OF PROGRAMME OUTCOMES, PROGRAMME SPECIFIC OUTCOMES WITH COURSE OUTCOMES

Semester-I

Courses	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4	PSO5
Basics of Computer Science and Statistics		S			S				S	S			M	
Basics of Computer Science and Statistics-Tutorials		S			S									
Basics of Chemistry										S				
English Communication						S			S	S				M
Environmental Studies			S				S	L	S	S				
Basics of Physics and Biology OR Basics of Physics and Mathematics										S			M	
Basics of Physics of Biology-Tutorials					S									

S, Substantial correlation (75-100%); M, Moderate correlation (60-75%); L, Low correlation (40-60%)

Semester-II

Courses	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4	PSO5
Biomolecules	M	M							M	S	S	S	M	
Cell Biology	S	S							M	S	S	S	M	
Immunology	M	M	S				M		S	S	S	S	M	
Enzymes and Proteins	M					S			S	S	S	S	M	
Bioethics and IPR OR Biotechnology and Human Welfare	S		S	S	S			S		S				S

S, Substantial correlation (75-100%); M, Moderate correlation (60-75%); L, Low correlation (40-60%)

Semester-III

Courses	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4	PSO5
Metabolism of Carbohydrates and Lipids		S	M		S				S		S	S	S	L
Membrane Biology and Bioenergetics	S	S	M		M			S	S	S	S	M	S	
Hormone Biochemistry and Human Physiology		S	M		S				S		S	S	S	L
Plant Biochemistry	S	S	M			S			S	S				M
Molecular Biology and Genetics	S	S	M		M			S	S	S	S	M	S	
General Elective (GE) Systems Biology	S		M						S	S		S		
Skill Enhancement Elective (SEC)	S	S	M	S	M	S	S		M			S	S	M

S, Substantial correlation (75-100%); M, Moderate correlation (60-75%); L, Low correlation (40-60%)

Semester-IV

Courses	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4	PSO5
Basics of Chemistry Practical	S	S	S		S				S	S		S		
Biomolecules Practical		S	S		S							S		
Cell Biology Practical			S		S					S		S		
Immunology Practical			S		S	S			S	S		S		
Enzymes and Proteins Practical			S		S							S		
Basic Microbiology	S	S	S								S			
Metabolism of Amino Acids and Nucleotides			S										S	
General Elective (GE)	S	S	S	S		L					S	S	S	M
Skill Enhancement Elective (SEC)	S	S	S	S		L			L		S	S	S	S

S, Substantial correlation (75-100%); M, Moderate correlation (60-75%); L, Low correlation (40-60%)

Semester-V

Courses	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4	PSO5
Genetic Engineering and Biotechnology	S								S	S	M			
Genetic Engineering and Biotechnology Practical	S	S			S					S	M	S		
Discipline Centric Elective (DSE)	S	S	S	M		M	M		S	S	S	S	L	L
Discipline Centric Elective (DSE)	S	S	S	M		M	M		S	S	S	S	L	L
Discipline Centric Elective (DSE)	S	S	S	M		M	M		S	S	S	S	L	L

S, Substantial correlation (75-100%); M, Moderate correlation (60-75%); L, Low correlation (40-60%)

Semester-VI

Courses	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4	PSO5
Metabolism of Carbohydrates and Lipids Practical	S		S		S				S		S	S	S	
Membrane Biology and Bioenergetics Practical	S		S		S				S	S	S	S	S	
Hormone Biochemistry and Human Physiology Practical	S		S		S				S	S		S	S	
Plant Biochemistry Practical	S		S		S				S	S		S	S	
Molecular Biology and Genetics Practical	S		S		S				S	S		S	S	
General Elective Practical	S		S		S				S	S		S	S	M
General Elective Practical	S		S		S				S	S		S	S	M

S, Substantial correlation (75-100%); M, Moderate correlation (60-75%); L, Low correlation (40-60%)

B.Sc. (Honors) component of B.Sc.-M.Sc. Integrated Biochemistry
(CBCS STRUCTURE)

CORE COURSES

BBC-CC01
BASICS OF COMPUTER SCIENCE AND STATISTICS (THEORY)

1. **Course Objectives**

The course aims to provide basic knowledge of computers. Students will be introduced to hardware and software of computers. Students will also be introduced commonly used software in research. Students will also learn basic concept in information technology. In this course students will be taught basic skills of statistics. This will allow them to develop analytical thinking and will also provide knowledge of statistical methods for critical evaluation of data

2. **Course Outcomes:**

1. This is a skill based paper that introduces the students to the basics of computer operations
2. The student is imparted with knowledge on both hardware and software.
3. The student has a better understanding on the use of computers for various applications
4. This course imparts the knowledge of basic statistical methods to solve problems
5. Students are taught to operate various statistical software packages
6. By the end of the course, the students are able to appreciate the importance of statistics in research and prepares them for a career in research

3. **Course Content**

TOTAL HOURS: 50 **CREDITS: 04**

Unit-I: Elements of Computer Systems

Computer: Definition, Characteristics, Hardware & Software, Computer Organization. Operating Systems: Multi-tasking, Multi programming, Multiuser. Types of Operating System: MS-Windows, Unix/Linux, Mac OS. Database Models: Network, Hierarchical, Relational, Object Oriented. MS-Office: MS-Word, MS-Excel, MS-Power Point, MS-Access.

Unit-II: Information Technology

Elements of Computer Network. Network Topologies: Ring, Bus, Star, Mesh, Hybrid. Internet, Intranet, WWW, URL, Email, HTTP, HTML, Website, Portal, Web Browser, E-Commerce, IP Address. Issues and Threats of Cyber & Information Security: Virus, Worms, Trojan, Malware, Ransom ware, Anti-Virus, Basics of Computer Trouble Shooting.

UNIT-III: Statistics

Types of Data, Collection of data; Primary & Secondary data, Classification and Graphical representation of Statistical data. Measures of central tendency and Dispersion. Measures of Skewness and Kurtosis. Probability classical & axiomatic definition of probability, Theorems on total and compound probability, Elementary ideas of Binomial, Poisson and Normal distributions.

UNIT-IV: Advanced Statistics

Confidence level, critical region, testing of hypothesis and standard error, large sample test and small sample test. Problems on test of significance, t-test, chi-square test for goodness of fit and analysis of variance (ANOVA) Correlation and Regression. Emphasis on examples from Biological Sciences.

Suggested Readings

1. Rajaraman V., Adabala, Neeharika, "Fundamentals of Computer" 6th ed., PHI, 2014, ISBN 10: 8120350677
2. Sinha & Sinha, "Computer Fundamentals", 6th ed., BPB Publications, 2007, ISBN 10: 8176567523.
3. Kahate A., "Introduction to Database Management System", Pearson's Education, 2004, ISBN: 813170078X
4. Norton P, "Introduction to Computers", Mc Graw Hills, 2010, ISBN 10: 0070671206
5. Online Tutorial, Jone L. & Curtis F., "Microsoft Office 2016: Step by Step", Microsoft Press, 2015, ISBN: 978-0-7356-9923-6.
6. Le CT (2003) Introductory biostatistics. 1st edition, John Wiley, USA
7. Glaser AN (2001) High Yield TM Biostatistics. Lippincott Williams and Wilkins, USA
8. Edmondson A and Druce D (1996) Advanced Biology Statistics, Oxford University Press.
9. Danial W (2004) Biostatistics: A foundation for Analysis in Health Sciences, John Wiley and Sons Inc.
10. M.V. Ismail (2008) Biostatistics, Ist Edition, Laxmi Publication Pvt. Ltd.

BBC-CC02
BASICS OF CHEMISTRY (THEORY)

1. **Course Objective:**
   The course aims to provide basic knowledge and rules of Chemistry. The values of the elements, how they react, and how we can utilize our knowledge of chemical tools to manipulate chemicals to our advantage. Biochemistry delves into the systems and chemical processes involved in life and organisms. So a sound understanding of basic principles of chemistry is indispensable for the biochemistry students.

   the properties of biological molecules, typically macromolecules, and their, metabolic reactions, within living systems.

2. **Course Outcomes:**
   On successful completion of the course students will be:

   1. Understanding of molecular structures and associated bons
   2. Concepts of energy transductions and transformations
   3. Understanding of basic principles of organic chemistry
   4. Understanding of molecular conformations and stereochemistry
   5. Students learn to critically analyze chemical information, synthesize the information, and present the information to a technical audience

3. **Course Content:**

TOTAL HOURS: 50 **CREDITS: 04**

Unit-I: Chemical Bonding and Molecular Structure Ionic Bonding

Lattice energy and solvation energy. Born-Haber cycle and its applications, polarizing power and polarizability, Fajan's rules, ionic character in covalent compounds, Covalent Bonding: VB Approach, Lewis theory, VSEPR theory to explain the shapes of molecules, salient features of the Valence bond (VB) theory and the concept of hybridization, MO Approach: limitations of the VB approach, salient features of the MO theory. Rules for the LCAO method, bonding and anti-bonding MOs and their characteristics for s-s-, s-p and p-p combinations of atomic orbitals, nonbonding combinations of orbitals MO treatment of homonuclear diatomic molecules of 1st period and heteronuclear diatomic molecules such as CO, HF.

Unit-II: Chemical Thermodynamics

Qualitative idea of thermodynamics. First Law of Thermodynamics: Calculation of work (w), heat (q), changes in internal energy (ΔE) and enthalpy (ΔH) for expansion or compression of ideal gases under isothermal and adiabatic conditions for both reversible and irreversible processes. Calculation of w,q, ΔE, and ΔH for processes involving changes in physical states. Important principles and definitions of thermochemistry. Concept of standard state and standard enthalpies of formation, integral and differential enthalpies of solution and dilution. Calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data. Variation of enthalpy of a reaction with temperature Kirchhoff's equation. Second law of thermodynamics, concept of entropy, Gibbs free energy and Helmoltz free energy. Calculations of entropy change and free energy change for reversible and irreversible processes under isothermal and adiabatic conditions. Criteria of spontaneity, Gibbs Helmholtz equation. Maxwell's relations. Statements of Third Law of thermodynamics: calculation of absolute entropies of substances.

Unit-III: Fundamentals of Organic Chemistry

Hybridization in organic compounds, cleavage of covalent bond, homolysis and heterolysis, Electronic effects: Electronic effects and their applications inductive, resonance and hyperconjugation effects. Structure and relative stability of reactive carbon species – carbocations, carbanions, free radicals and carbenes, Molecular Forces: types of intermolecular and intra-molecular forces and their characteristics: dipole-dipole, dipole induced dipole and dispersion (London) forces. Hydrogen bond (both intramolecular and intermolecular), Effect of inter/intramolecular forces on physical properties such as solubility, vapour pressure, melting and boiling points of different compounds, Aromaticity.

Unit-IV: Stereochemistry

Stereochemistry and its importance. Geometrical isomerism, cis-trans and E/Z nomenclature Optical isomerism – optical activity, plane polarized light, enantiomerism, chirality, specific molar rotation, Stereoisomerism with two chiral centres: Diastereomers, mesoisomers, Resolution of racemic modification. Projection diagrams of stereoisomers: Fischer, Newman and Sawhorse projections. Relative Configuration: D/L designation. Absolute Configuration: R/S designation of chiral centres, Conformational isomerism – ethane, butane and cyclohexane, diagrams and relative stability of conformers.

Suggested Readings

1. J.D. Lee: A New Concise Inorganic Chemistry, E.L.B.S.
2. P.W. Atkins: Physical Chemistry, Oxford University Press
3. R.T. Morrison &R.N. Boyd: Organic Chemistry, Prentice Hall
4. James E. Huheeyetal: Inorganic Chemistry: Principles of Structure and reactivity

BBC-CC03
BIOMOLECULES (THEORY)

1. Course Objectives

The course aims to provide students with an understanding of biomolecules, the basic building blocks of living organisms, focusing on their structural underpinnings, unique properties, biological roles and functions and inter relations. The course will outline the importance of water as a biological solvent and vitamins as vital ingredients of life. Emphasis will be on the association between structure and function of various biomolecules at a chemical level with a biological perspective as well as hands on approach and laboratory techniques.

2. Course Learning Outcomes

On successful completion of the course students will be:

1. Acquainted with chemical and molecular foundations of life and appreciate the role of water in biological systems.
2. Able to comprehend the structure, function and acid base properties of amino acids.
3. Introduced to the structure, properties and roles of carbohydrates, lipids and nucleic acids.
4. Aware of the importance of vitamins in biological systems.
5. Able to independently identify various biomolecules in the laboratory

3. Course Contents

TOTAL HOURS: 50 **CREDITS: 04**

Unit-I: The Foundations of Biochemistry

Cellular and chemical foundations of life. Unique properties, weak interactions in aqueous systems, ionization of water, buffers, water as a reactant and fitness of the aqueous environment.

Unit-II: Carbohydrates and Glycobiology

Monosaccharides - structure of aldoses and ketoses, ring structure of sugars, conformations of sugars, muta-rotation, anomers, epimers and enantiomers, structure of biologically important sugar derivatives, oxidation of sugars. Formation of disaccharides, reducing and non-reducing disaccharides. Polysaccharides – homo- and hetero-polysaccharides, structural and storage polysaccharides. Structure and role of proteoglycans, glycoproteins and glycolipids (gangliosides and lipopolysaccharides). Carbohydrates as informational molecules, working with carbohydrates

Unit-III: Lipids and Amino acids

Building blocks of lipids - fatty acids, glycerol, ceramide. Storage lipids - triacyl glycerol and waxes. Structural lipids in membranes – glycerophospholipids, galactolipids and sulpholipids, sphingolipids and sterols, structure, distribution and role of membrane lipids. Plant steroids. Lipids as signals, cofactors and pigments. Structure and classification, physical, chemical and optical properties of amino acids

Unit-IV: Nucleic Acids and Vitamins

Nucleotides: Structure and properties. Nucleic acid structure: Watson & Crick Model of DNA. Structure of major species of RNA (mRNA, tRNA and rRNA). Nucleic acid chemistry: UV absorption, effect of acid and alkali on DNA. Other functions of nucleotides: Source of energy, component of coenzymes, second messengers. Structure and active forms of water soluble and fat soluble vitamins, deficiency diseases and symptoms, hypervitaminosis.

BBC-CC03 PR
BIOMOLECULES (PRACTICAL)

TOTAL HOURS: 50 **CREDITS: 02**

1. Safety measures in laboratories.
2. Preparation of normal and molar solutions.
3. Preparation of buffers.
4. Determination of pKa of acetic acid and glycine.
5. Qualitative tests for carbohydrates, lipids, amino acids, proteins and nucleic acids.
6. Separation of amino acids/ sugars/ bases by thin layer chromatography.
7. Estimation of vitamin C.

Suggested readings

1. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN:13: 978-1-4641-0962-1 / ISBN:10:1-4292-3414- 8.
2. Textbook of Biochemistry with Clinical Correlations (2011) 7th ed., Devlin, T.M., John Wiley & Sons, Inc. (New York), ISBN:978-0-470-28173-4.

BBC-CC04
CELL BIOLOGY (THEORY)

1. Course Objectives:

The objective of this paper is to offer insights into the basic structure and function of a cell and cellular organelles. The course also aims to impart understanding of cell cycle, cell death, cell renewal processes and various techniques of cell biology.

2. Course Learning Outcomes:

The objective of this paper is to offer insights into the basic structure and function of a cell and cellular organelles. Students will:

1. Learn about cell theory and basic cell structure
2. Be introduced to cell fractionation and cell visualization techniques
3. Gain knowledge about the structure and function of various cell organelles in an Eukaryotic cell.
4. Acquire knowledge about the composition of cytoskeleton and extracellular matrix
5. Acquire insight into cell division and cell death mechanisms

3. Corse Contents:

TOTAL HOURS: 50 **CREDITS: 04**

Unit-I: Introduction and Tools of Cell Biology

Prokaryotic (archaea and eubacteria) and eukaryotic cell (animal and plant cells), cells as experimental models. Light microscopy, phase contrast microscopy, fluorescence microscopy, confocal microscopy, electron microscopy, FACS. Centrifugation for subcellular fractionation.

Unit-II: Structure of Different Cell Organelles

Structure of nuclear envelope, nuclear pore complex. Nuclear protein import and export. ER structure. Targeting proteins to ER, smooth ER. Organization of Golgi. Lysosome. Structure and functions of mitochondria, chloroplasts and peroxisomes. Overview of protein sorting to cell cellular organelles. Endocytosis, Pinocytosis and phagocytosis.

Unit-III: Cytoskeletal Proteins, Cell wall and Cell-matrix

Introduction to cytoskeletal proteins. Organization of cytoskeletal protein RBC and smooth muscle and skeletal muscles. Structure of cilia and flagella. Prokaryotic and eukaryotic cell wall, cell matrix proteins. Cell-matrix interactions and cell-cell interactions. Adherence junctions, tight junctions, gap junctions, desmosomes, hemi desmosomes, focal adhesions and plasmodesmata.

Unit-IV: Cell cycle, Cell death and Cell renewal

Eukaryotic cell cycle, restriction point, and checkpoints. Cell division. Apoptosis and necrosis: Brief outline. Salient features of a transformed cell.

BBC-CC04 PR
CELL BIOLOGY (PRACTICAL)

TOTAL HOURS: 50 **CREDITS: 02**

1. Visualization of animal and plant cell by methylene blue.
2. Identification of different stages of mitosis in onion root tip.
3. Identification of different stages of meiosis in grasshopper testis.
4. Micrographs of different cell components (dry lab).
5. Sub-cellular fractionation.
6. Visualization of nuclear fraction by acetocarmine stain.
7. Staining and visualization of mitochondria by Janus green stain.

Suggested readings

1. The Cell: A Molecular Approach (2009) 5th ed., Cooper, G.M. and Hausman, R.E., ASM Press & Sunderland (Washington DC), Sinauer Associates, MA, ISBN: 978-0-87893- 300-6.
2. Molecular Cell Biology (2012) 7th ed., Lodish, H., Berk, A., Zipursky, S.L., Matsudaira, P., Baltimore, D. and Darnell. J., W.H. Freeman & Company (New York), ISBN: 13:978-1-4641-0981-2 / ISBN: 10: 1-4641-0981-8.
3. Molecular Biology of the Cell (2008) 5th ed., Alberts, B., Johnson, A., Lewis, J., and Enlarge, M., Garland Science (Princeton), ISBN:0-8153-1619-4 / ISBN:0- 8153-1620-8.

BBC-CC05
IMMUNOLOGY (THEORY)

1. Course Objective:

This course describes the molecular and cellular basis of the development and function of the immune system. The course will provide the basic framework in immunology that will cover the major topics including innate and adaptive immunity, antibodies and antigens, the molecular events leading to the generation of antibody, humoral and cell mediated adaptive immune response, hypersensitivity, self-tolerance, autoimmunity and vaccines.

2. Course Learning Outcomes:

Upon completion of this course, a student will be able to:

1. Trace the history and developments in immunology.
2. Have an overview of the immune system including cells, organs and receptors.
3. Describe the basic mechanism, differences and functional interplay of innate and
4. adaptive immunity
5. Understand Antigens & its Recognition, antigen processing and presentation
6. Understand the structure & functions of different classes of Immunoglobulins,
7. and understand the genetic basis of antibody diversity
8. Define the cellular and molecular pathways of humoral and cell-mediated immune
9. responses
10. Describe the mechanisms involved in different types of hypersensitivity
11. Explain the principles of tolerance and autoimmunity
12. Understand Immunotherapies and basic concept of Vaccines
13. Summarize role of immunity in protection against pathogens

3. Course Content:

TOTAL HOURS: 50 **CREDITS: 04**

Unit-I: Overview of Immune System

Hematopoiesis, cells of the immune system, primary and secondary lymphoid organs and tissues (MALT). Anatomical barriers, cell types of innate immunity, soluble molecules and membrane associated receptors (PRR), connections between innate and adaptive immunity. Antigens and haptens, factors that dictate immunogenicity, B and T cell epitopes.

Unit-II: Antibody Structure and Function and Generation of Receptor Diversity

Structure and distribution of classes and subclasses of immunoglobulins (Ig), Ig fold, effector functions of antibody, antigenic determinants on Ig and Ig super family**.** Dreyer-Bennett hypothesis, multigene organization of Ig locus, mechanism of V region DNA rearrangement, ways of antibody diversification.

Unit-III: Humoral and Cell mediated Immune Responses

Antigen independent phase of B cell maturation and selection, humoral response – T-dependent and T-independent response, anatomical distribution of B cell populations. General organization and inheritance of MHC, structure, distribution and role of MHC class I and class II proteins, pathways of antigen processing and presentation. Structure and role of T cell receptor, and co-receptor, T cell development, generation of receptor diversity, selection and differentiation. General properties of

effector T cells, cytotoxic T cells (Tc), natural killer cells; NKT cells and antibody dependent cellular cytotoxicity (ADCC). Complement activation by classical, alternate and MB lectin pathway, biological consequences of complement activation, complement deficiencies.

Unit-IV: Tolerance, Autoimmunity and Transplantation Immunology

Organ specific and systemic autoimmune diseases, possible mechanisms of induction of autoimmunity, Gell and Coombs classification, IgE mediated (Type I) hypersensitivity, antibody mediated cytotoxic (Type II) hypersensitivity, and immune complex mediated (type III) hypersensitivity and delayed type (Type IV) hypersensitivity. Immunological basis of graft rejection, clinical manifestations, immunosuppressive therapy and privileged sites. Vaccines - active and passive immunization, types of vaccines.

BBC-CC05 PR
IMMUNOLOGY (PRACTICAL)

TOTAL HOURS: 50 **CREDITS: 02**

1. Isolation of lymphocytes from blood and spleen.
2. Purification of immunoglobulins.
3. Assays based on precipitation reactions - Ouchterlony double diffusion (ODD) and Mancini radial immunodiffusion.
4. Assays based on agglutination reactions - Blood typing (active) & passive agglutination.
5. Enzyme linked immune-sorbent assay (ELISA).
6. DOT blot
7. Immunoblot

Suggested readings

1. Kuby Immunology (2007) 6th ed., Kindt, T.L., Goldsby, R.A. and Osborne, B.A., W.H Freeman and Company (New York), ISBN:13: 978-0-7167-8590-3 / ISBN: 10:07617-590-0.
2. Immunology: A Short Course (2009) 6th ed., Coico, R and Sunshine, G., John Wiley& sons, Inc (New Jersey), ISBN: 978-0-470-08158-7.
3. Janeway's Immunobiology (2012) 8th ed., Murphy, K., Mowat, A., and Weaver, C.T., Garland Science (London & New York), ISBN: 978-0-8153-4243-4.

BBC-CC06
ENZYMES AND PROTEINS (THEORY)

1. Course Objectives:

The objective of the course is to provide detailed knowledge about enzymes, the biological catalysts with remarkable properties that sustain life, so as to develop an understanding of enzyme kinetics, mechanism of enzyme action and their regulation. The course also aims to outline the diverse applications of enzymes in disease diagnosis and therapy as well as in industry. The course also aims to introduce "proteins" and their importance to modern biochemistry, highlighting their structural features and unique characteristics that help them participate in every physiological process in life, thus also playing important role in disease manifestation and their interventions.

2. Course Learning Outcomes:

1. Students will learn the nature and importance of enzymes in living systems
2. Students will gain insight into the thermodynamic and molecular basis of catalysis by enzymes and the underlying basis of their specificity
3. Students will understand the mechanisms of enzyme action, kinetics of enzyme catalyzed reactions and clinical importance of enzyme inhibitors
4. Students will also learn to appreciate how enzymes are regulated and the physiological importance of enzyme regulation in the cell
5. The course will introduce students to the applications of enzymes in research and medicine as well as in industry, which will bolster their foray into industrial and biomedical research.
6. Understand the diverse functions of proteins in a cell
7. Understand the hierarchy of protein architecture ‑ primary, secondary, tertiary & quaternary structure, with the ability to distinguish features of globular & fibrous proteins
8. Be able to comprehend the fundamental mechanisms of protein folding and stability and their relation to conformational diseases

3. Course Content

TOTAL HOURS: 50 **CREDITS: 04**

Unit-I: Proteins: Introduction, Isolation and Analysis

Polypeptides and proteins. Subunit structures, conjugated proteins, diversity of function. Techniques to isolate and analyze proteins- salt fractionation, ion-exchange chromatography, gel permeation, HPLC, SDS-PAGE, and IEF. Protein primary structure - sequencing by Edman degradation, use of enzymes and chemical reagents to obtain overlap peptides. Synthesis of peptides using Merrifield method.

Unit-II: Introduction to Protein Three-dimensional Structures

Secondary structure- helices and sheets, Ramachandran maps. Nature of non-covalent bonds and covalent bonds in protein folding. Tertiary and quaternary structures. Oxygen binding curves, cooperativity models for hemoglobin.

Unit-III: Introduction to Enzyme Catalysis and Kinetics

Features of enzyme catalysis, superior catalytic power. General mechanisms of catalysis. Nomenclature, Principles of reaction rates, order of reactions and equilibrium constants. Derivation

of Michaelis-Menten equation. Significance of Km and Vmax. Catalytic efficiency parameters. Competitive and mixed inhibitions. Kinetics and diagnostic plots. Types of irreversible inhibitors.

Unit-IV: Mechanisms of Enzyme Action and Regulation

Mechanism of action of chymotrypsin. Inhibitors of enzymes - antibiotics. Regulation of enzyme activity and its importance - aspartate transcarboxylase. Enzymes used in clinical biochemistry as reagents, diagnostics and therapy. Role of immobilized enzymes in industry.

BBC-CC06 PR
ENZYMES AND PROTEINS (PRACTICAL)

TOTAL HOURS: 50 **CREDITS: 02**

1. Protein estimation by UV absorbance and Biuret method.
2. Protein micro assay by Lowry/Bradford method.
3. Ammonium sulphate fractionation of crude homogenate from germinated mung bean.
4. Setting up assay for acid phosphatase and activity measurements of the ammonium sulphate fractions (progress curve and effect of pH).
5. Determination of Km and Vmax of enzyme enriched fraction.
6. Inhibition of acid phosphatase activity by inorganic phosphate.

Suggested readings

1. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN:13; 978-1-4641-0962-1/ISBN:10-14641-0962-1.
2. Fundamentals of Enzymology (1999) 3rd ed., Price, N.C and Stevens, L., Oxford University Press Inc., (New York), ISBN:13: 978-0-19-806439-8.

BBC-CC07
METABOLISM OF CARBOHYDRATES AND LIPIDS (THEORY)

1. Course Objective:
The objective of this course is to provide an understanding of metabolism of carbohydrates and lipids, the enzymes involved in various metabolic pathways and regulation of metabolism in cells. The course also aims to outline the importance of such pathways in relation to metabolic defects.

2. Course Learning Outcomes:
The learners will be able to:

1. Understand the concepts of metabolism, characteristics of metabolic pathways and strategies used to study these pathways.
2. Gain a detailed knowledge of various catabolic and anabolic pathways
3. Understand the regulation of various pathways
4. Gain knowledge about the diseases caused by defects in metabolism with emphasis on
5. the metabolic control

3. Course Content:

TOTAL HOURS: 50 **CREDITS: 04**

Unit-I: Basic Design of Metabolism, Glycolysis and TCA

Autotrophs, heterotrophs, metabolic pathways, catabolism, anabolism, ATP as energy currency, reducing power of the cell. Glycolysis - a universal pathway, reactions of glycolysis, fermentation, fates of pyruvate, feeder pathways for glycolysis, galactosemia. Production of acetyl CoA, reactions of citric acid cycle, regulation of citric acid cycle, glyoxalate pathway, coordinated regulation of glyoxalate and citric acid pathways.

Unit-II: Gluconeogenesis, Pentose Phosphate Pathway and Glycogen Metabolism

Synthesis of glucose from non-carbohydrate sources, reciprocal regulation of glycolysis and gluconeogenesis, pentose phosphate pathway and its importance. Glycogenesis and glycogenolysis, regulation of glycogen metabolism, glycogen storage diseases.

Unit-III: Fatty Acid Oxidation and Synthesis

Digestion, mobilisation and transport of cholesterol and triacylglycerols, fatty acid transport to mitochondria, β oxidation of saturated, unsaturated, odd and even numbered fatty acids, regulation of fatty acid oxidation, peroxisomal oxidation, ω oxidation, ketone bodies metabolism, ketoacidosis. Synthesis of saturated, unsaturated, odd and even chain fatty acids.

Unit-IV: Biosynthesis of Lipids and Starve-feed Cycle

Synthesis of cholesterol, regulation of cholesterol synthesis. Synthesis of membrane phospholipids, respiratory distress syndrome, biosynthesis of triacylglycerol, biosynthesis of sphingolipids and glycolipids, lipid storage diseases. Well-fed state, early fasting state, fasting state, early re-fed state, energy requirements, reserves and caloric homeostasis.

BBC-CC07 PR
METABOLISM OF CARBOHYDRATES AND LIPIDS (PRACTICAL)

TOTAL HOURS: 50 **CREDITS: 02**

1. Estimation of blood glucose.
2. Sugar fermentation by microorganisms.
3. Assay of salivary amylase.
4. Isolation of lecithin, identification by TLC, and its estimation.
5. Isolation of cholesterol from egg yolk and its estimation.

Suggested readings

1. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN:13:978-1-4641-0962-1 / ISBN:10:1- 4641-0962-1.
2. Textbook of Biochemistry with Clinical Correlations (2011) 7th ed., Devlin, T.M., John Wiley & Sons, Inc. (New Jersey), ISBN:978-0-470-28173-4.
3. Biochemistry (2012) 7th ed., Berg, J.M., Tymoczko, J.L. and Stryer L., W.H. Freeman and Company (New York), ISBN:10:1-4292-2936-5, ISBN:13:978-1-4292-2936-4.

BBC-CC08
MEMBRANE BIOLOGY AND BIOENERGETICS (THEORY)

1. Course Objective:
The objective of the course is to provide students with the basic understanding of membrane composition, structure-function relationship and properties of membranes. The course will also provide an understanding of the various types of membrane transporters and their molecular mechanisms. The course will introduce students to the basic tenets of Bioenergetics and detail out the molecular mechanisms of oxidative phosphorylation and photophosphorylation.

2. Course Learning Outcomes:

On successful completion of the course, students will:

1. Understand the general composition and structure of biomembranes.
2. Gain knowledge of the basic properties of membranes such as membrane fluidity.
3. Have knowledge about the various types of membrane transport mechanisms.
4. Understand the basic tenets of Bioenergetics.
5. Be able to imbibe the concept of chemi-osmotic theory and the mechanism of oxidative phosphorylation and ATP synthesis.
6. Understand the basic mechanisms of photophosphorylation in plants and microbes.

3. Course Content

TOTAL HOURS: 50 **CREDITS: 04**

Unit-I: Introduction to Bio Membranes and Membrane Structure

Composition of bio membranes - prokaryotic, eukaryotic, neuronal and subcellular membranes. Study of membrane proteins. Fluid mosaic model with experimental proof. Monolayer, planer bilayer and liposomes as model membrane systems. Polymorphic structures of amphiphilic molecules in aqueous solutions - micelles and bilayers. CMC, critical packing parameter. Membrane asymmetry. Macro and micro domains in membranes; lipid rafts, caveolae and RBC membrane architecture. Role of tight junctions in polarized cells.

Unit-II: Membrane Dynamics and Transport

Lateral, transverse and rotational motion of lipids and proteins. Techniques used to study membrane dynamics - FRAP, TNBS labeling etc. Transition studies of lipid bilayer, transition temperature. Membrane fluidity, factors affecting membrane fluidity. Thermodynamics of transport. Simple diffusion and facilitated diffusion. Passive transport - glucose transporter, anion transporter and porins**.** Primary active transporters - P type ATPases, V type ATPases, F type ATPases. Secondary active transporters - lactose permease, Na+-glucose symporter. ABC family of transporters - MDR, CFTR. Group translocation. Ion channels -voltage-gated ion channels (Na+/K+ voltage-gated channel), ligand-gated ion channels (acetylcholine receptor), aquaporins, bacteriorhodopsin. Ionophores - valinomycin, gramicidin. Types of vesicle transport and their function - clathrin, COP I and COP II coated vesicles. Molecular mechanism of vesicular transport. Membrane fusion. Receptor mediated endocytosis of transferrin.

Unit-III: Introduction to Bioenergetics

Laws of thermodynamics, state functions, equilibrium constant, coupled reactions, energy charge, ATP cycle, phosphorylation potential, phosphoryl group transfers. Chemical basis of high standard energy of hydrolysis of ATP, PEP, 13 BPG and thioesters. Redox reactions, standard redox potentials and Nernst equation. Universal electron carriers.

Unit-IV: Oxidative Phosphorylation

Mitochondria. Electron transport chain - its organization and function. Peter Mitchell's chemiosmotic hypothesis. Proton motive force. Regulation of oxidative phosphorylation. Inhibitors of ETC and uncouplers, Thermogenesis. Alternative respiratory pathways in plants. General features of photophosphorylation, historical background, Hills reaction, photosynthetic pigments, light harvesting systems of plants and microbes and resonance energy transfer. Photophosphorylation in plants, Photosystem I and Photosystem II, photosynthetic electron flow. Cyclic photophosphorylation and its significance.

BBC-CC08 PR
MEMBRANE BIOLOGY AND BIOENERGETICS (PRACTICAL)

TOTAL HOURS: 50 **CREDITS: 02**

1. Effect of lipid composition on the permeability of a lipid monolayer.
2. Determination of CMC of detergents.
3. RBC ghost cell preparation and to study the effect of detergents on membranes.
4. Separation of photosynthetic pigments by TLC.
5. Isolation of mitochondria from liver and assay of marker enzyme SDH.
6. Study photosynthetic O_2 evolution in hydrilla plant.
7. Isolation of chloroplast from spinach leaves, estimation of chlorophyll and photosynthetic activity.

Suggested readings

1. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN: 13:978-1-4641-0962-1 / ISBN:10:1-4641-0962-1.
2. Molecular Cell Biology (2013) 7th ed., Lodish, H., Berk, A., Kaiser, C.A., Krieger, M. Bretscher, A., Ploegh, H., Amon, A. and Scott, M.P., W.H. Freeman &Company (New York), ISBN:13:978-1-4641-0981-2.
3. Biochemistry (2010) 4th ed., Garret, R. H. and Grisham, C.M., Cengage Learning (Boston), ISBN-13:978-0-495-11464-2.
4. Principles of Biochemistry (2008) 3rd ed., Voet, D.J., Voet, J.G. and Pratt, C.W., John Wiley& Sons, Inc. (New York), ISBN: 13: 978-0470-23396-2

BBC-CC09

HORMONE BIOCHEMISTRY AND HUMAN PHYSIOLOGY (THEORY)

1. Course Objectives:

The course is designed to provide an understanding of the process of cellular communication including signal reception, transduction, amplification and response. The course will enable students to understand and appreciate the delicate network and balance of hormones required for the healthy functioning of the human body. The objective of the course in human physiology is to provide a comprehensive study of the molecular and cellular mechanisms that govern the integrative working and regulation of the various organ systems in the human body. The course will provide a foundation of the physiological principles and the application of the same in real-life situations. It also outlines the factors and biochemical events that disrupt homeostasis leading to pathophysiology. The course will also prepare a student for postgraduate studies in any course related to molecular medicine.

2. Course Learning Outcomes:

On successful completion of the course, a student will:

1. Understand and appreciate the different cognate and non-cognate modes of communication between cells in a multi-cellular organism
2. Understand the role of endocrine system in maintaining ionic and glucose homeostasis
3. Be able to describe molecular, biochemical and physiological effects of all hormones and factors on cells and tissues.
4. Understand the integrative communications that regulate, growth, appetite, metabolism and reproduction
5. Be prepared for interpreting clinical parameters in a real life situation.
6. Appreciate and understand the biochemical, molecular and cellular events that orchestrate the coordinate working of the organ systems that regulate life processes.
7. Understand the factors that cause an imbalance to the Homeostatic control in the body and how these lead to disorders and diseases.
8. Perform and analyze various physiological tests that examine the function of various systems of the human body.

3. Course Contents:

TOTAL HOURS: 50 **CREDITS: 04**

Unit-I: Introduction to Endocrinology

Hormones: General Characteristic Features, types and classification of hormones, functions, mechanism of hormone delivery: autocrine, paracrine, neurocrine, endocrine and neuroendocrine hormone delivery, receptors and their types, half-life of hormones, metabolic clearance rate (MCR), Second messengers: Cyclic AMP, Ca^{2+}, IP3, DAG, Cyclic GMP, feedback regulation of hormones, Radioisotopic Techniques for hormonal detection, hormone replacement therapy.

Unit-II: Mechanism of Action of Hormones

Thyroid stimulating hormone, Follicle stimulating hormone, Luteinising hormone, Oxytocin, Vasopressin, T3, T4, Gastrointestinal Hormones: Gastrin, Secretin, Cholecystokinin, Gastrointestinal peptide, adrenal hormones, insulin and glucagon: their mechanism of action and disorders related to

the underproduction and overproduction of mentioned hormones, reproductive medicine and fertility control.

Unit-III: Blood and Heart Physiology

Blood cells, blood groups, blood clotting and blood transfusion, Resistance of the body to infection. Haemostasis and blood coagulation. Physiology of cardiac muscle. Cardiac cycle, Regulation of heart pumping, Rhythmical excitation of heart, Characteristics of normal electrocardiogram, Cardiac arrhythmias, Cardiac output, venous return and regulation, Heart sounds, dynamics of valvular and congenital heart defects, Cardiac failure and circulatory shock.

Unit-IV: Kidney and Body Fluids

Body fluid compartments: Basic principles of osmosis and osmotic pressure: Extracellular and intracellular fluids. Interstitial fluid and edema. Urine formation by kidneys: Glomerular filtration, renal blood flow and their control, Functions of kidneys in homeostasis, Reabsorption and secretion by renal tubules and along various parts of nephron. Regulation of extracellular fluid osmolarity and sodium concentration. Integration of renal mechanisms for control of blood volume and extracellular fluid volume. Renal regulation of potassium, calcium, phosphate and magnesium.

BBC-CC09 PR

HORMONE BIOCHEMISTRY AND HUMAN PHYSIOLOGY (PRACTICAL)

TOTAL HOURS: 50 **CREDITS: 02**

HUMAN PHYSIOLOGY

1. Measurement of blood pressure
2. Haematology: Clotting Time, RBC and WBC counting
3. Histology of liver and brain tissue.

HORMONES

1. Glucose Tolerance Test
2. Estimation of serum Ca^{2+}
3. Estimation of serum T4.

Suggested readings

1. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M. W.H. Freeman & Company (New York), ISBN:13: 978-1-4641-0962-1/ISBN:10-14641-0962- 1.
2. Vander's Human Physiology (2008) 11th ed., Widmaier, E.P., Raff, H. and Strang, K.T. McGraw Hill International Publications, ISBN:978-0-07-128366-3.
3. Endocrinology (2007) 6th ed., Hadley, M.C. and Levine, J.E. Pearson Education (New Delhi), Inc. ISBN:978-81-317-2610-5.
4. The Cell: A Molecular Approach (2009) 5th Ed. Cooper, G.M. and Hausman, R.E. ASM Press & Sunderland, (Washington DC), Sinauer Associates. (MA). ISBN:978-0-87893- 300-6.

BBC-CC10

PLANT BIOCHEMISTRY (THEORY)

1. Course Objectives:

The course aims at providing deep understanding of metabolic processes in plants and the role of different biosynthetic pathways in plant growth and development. The course will also impart basic concepts and applications of plant tissue culture.

2. Course Learning Outcomes:
Successful completion of this course will provide students with the following learning outcomes:

1. Understanding of plant cell structure and organization.
2. Concept of the biochemical processes and metabolic pathways specific to plants, including photosynthesis, photorespiration, cell wall biosynthesis, nitrogen fixation and assimilation and plant secondary metabolism.
3. Insight on how plants have evolved to cope up with the different stress conditions.
4. Knowledge of the basic concepts of plant tissue culture and its application in generating transgenic crops.

3. Course Contents

TOTAL HOURS: 50 **CREDITS: 04**

Unit-I: Plant Cell Structure, Photosynthesis and Carbon Assimilation
Plasma membrane, Vacuole and tonoplast membrane, cell wall, plastids and peroxisomes. Structure of PSI and PSII complexes, Light reaction, Cyclic and noncyclic photophosphorylation, Calvin cycle and regulation; C4 cycle and Crassulacean acid metabolism (CAM), Photorespiration.

Unit-II: Respiration and Nitrogen Metabolism
Regulation of plant glycolysis, Translocation of metabolites across mitochondrial membrane, TCA cycle, Alternative NAD(P)H oxidative pathways; Cyanide resistant respiration. Biological Nitrogen fixation by free living and in symbiotic association, structure and function of enzyme Nitrogenase. Nitrate assimilation: Nitrate and Nitrite reductase. Primary and secondary ammonia assimilation in plants; ammonia assimilation by Glutamine synthetase-glutamine oxoglutarate amino transferase (GS-GOGAT) pathway. Seed storage proteins in legumes and cereals.

Unit-III: Regulation of Plant Growth and Secondary Metabolites
Introduction to plant hormones and their effect on plant growth and development, Regulation of plant morphogenetic processes by light. Representatives alkaloid group and their amino acid precursors, function of alkaloids, Examples of major phenolic groups; simple phenylpropanoids, Coumarins, Benzoic acid derivatives, flavonoids, tannins and lignin, biological role of plant phenolics, Classification of terpenoids and representative examples from each class, biological functions of terpenoids.

Unit-IV: Plant Tissue Culture
Cell and tissue culture techniques, types of cultures: organ and explants culture, callus culture, cell suspension culture and protoplast culture. Plant regeneration pathways: organogenesis and somatic embryogenesis. Applications of cell and tissue culture and somoclonal variation.

BBC-CC10 PR

PLANT BIOCHEMISTRY (PRACTICAL)

TOTAL HOURS: 50 **CREDITS: 02**

1. Induction of hydrolytic enzymes proteinases /amylases/lipase during germination
2. Extraction and assay of Urease from Jack bean
3. Estimation of carotene/ascorbic acid/phenols/tannins in fruits and vegetables
4. Separation of photosynthetic pigments by TLC
5. Culture of plants (explants).

Suggested readings

1. Plant Biochemistry (2008), Caroline Bowsher, Martin steer, Alyson Tobin, Garland science ISBN 978-0-8153-4121-5
2. Biochemistry and molecular Biology of plant-Buchanan. (2005) 1 edition. Publisher: I K International. ISBN-10: 8188237116, ISBN-13: 978-8188237111.
3. Plant Biochemistry by P.M Dey and J.B. Harborne (Editors) (1997) Publisher: Academic Press ISBN-10:0122146743, ISBN-13:978-0122146749

BBC-CC11

MOLECULAR BIOLOGY AND GENETICS (THEORY)

1. Course Objectives:

The objective of the course is to introduce to the students, the basic concepts of genome, DNA structure, genes, chromatin and chromosomes. It provides comprehensive understanding of DNA replication, recombination. The course also provide students with an understanding of both classical and modern concepts in genetics. Students can apply this knowledge in understanding the life processes and develop an interest to pursue high quality research.

2. Course Learning Outcomes:

1. Students will acquire basic information about the structure of DNA and various forms of DNA, about organization of genome in various life forms, supercoiling of DNA and its significance
2. Students will learn about the molecular basis of processes like DNA replication, recombination and transposition and understand the significance of these processes
3. Students will learn about the various ways in which the DNA can be damaged leading to mutations and lesions and different ways to repair DNA damage.
4. Understanding the principles of Mendelian genetics, extensions and applications
5. Learning and appreciating the various factors that confer genotypic and phenotypic variability.

3. Course Content

TOTAL HOURS: 50 **CREDITS: 04**

Unit-I: Genome Organization and Replication
DNA structure, features of the double helix, various forms of DNA. Nucleosome structure and packaging of DNA into higher order structures, DNA Replication in prokaryotes and eukaryotes, mechanism of DNA replication, Semi-conservative, bidirectional and semi-discontinuous replication, RNA priming, replication of telomeres

Unit-II: Biosynthesis of RNA and Protein in Prokaryotes and Eukaryotes
RNA polymerases and transcription cycle in bacteria and eukaryotes, the three stages of RNA synthesis, initiation, elongation and termination. RNA processing, RNA splicing. Features and degeneracy of the genetic code. Initiation, elongation and termination of translation, regulation of translation. Comparison of prokaryotic and eukaryotic protein synthesis.

Unit-III: Regulation of Gene Expression in Prokaryotes and Eukaryotes
Principles of gene regulation, negative and positive regulation, concept of operons, regulatory proteins, activators, repressors, regulation of lac operon and trp operon. Heterochromatin, euchromatin, regulatory RNAs.

Unit-IV: Basic Principles in Genetics
Mendelian Genetics and Extension of Mendelian analysis, Principles of inheritance, Incomplete dominance and co-dominance, Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Sex-linked, sex influenced and sex-limited characters inheritance, Transposition of DNA, transposable elements, importance of transposable elements.

BBC-CC11 PR

MOLECULAR BIOLOGY AND GENETICS (PRACTICAL)

TOTAL HOURS: 50 **CREDITS: 02**

1. Extraction of total nucleic acids from plant tissue.
2. Isolation of mRNA by affinity chromatography.
3. Agarose gel electrophoresis of DNA and RNA.
4. Ultraviolet absorption spectrum of DNA and RNA.
5. Determination of DNA and RNA concentration by A_{260nm}.
6. To study the viscosity of DNA solutions.
7. Isolation of chromosomal DNA from *E. coli* cells.
8. Induction of polyploidy in onion roots.
9. Smear technique to demonstrate exchromatin in buccal epithelial cells.
10. Study of abnormal human karyotype and pedigrees (drylab)
11. Conjugation in bacteria

Suggested readings

1. Molecular Biology of the Gene (2008) 6th ed., Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R., Cold Spring Harbor Laboratory Press, Coldspring Harbor (New York), ISBN:0-321-50781 /ISBN:978-0-321-50781-5.
2. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W. H. Freeman & Company (New York), ISBN:13: 978-1-4292-3414-6 / ISBN:10-14641-0962- 1.
3. Principles of Genetics (2010) 5th ed., Snustad, D.P. and Simmons, M.J., John Wiley & Sons Asia, ISBN: 978-0-470-39842-5.
4. Genetics (2012) 6th ed., Snustad, D.P. and Simmons, M.J., John Wiley & Sons. (Singapore), ISBN: 978-1-118-09242-2.
5. Genetics - A Conceptual Approach (2012), 4th ed., Pierce, B.A., W.H. Freeman & Co. (New York), ISBN: 13:978-1-4292-7606-1 /ISBN: 10:1-4292-7606-1.
6. An Introduction to Genetic Analysis (2010), 10th ed., Griffiths, A.J.F, Wessler, S. R, Carroll, S. B. and Doebley, J., W.H. Freeman & Company (New York), ISBN:10: 1- 4292-2943-8.

BBC-CC12

BASIC MICROBIOLOGY (THEORY)

1. Course Objectives:

The objective of the course is to trace the history of development of the discipline of Microbiology and to emphasize the existence of the immense diversity in the microbial world and maintenance of microbes under laboratory conditions. The course also aims to make the students aware of both pathogenic as well as beneficial microbes to prepare students for higher education in microbiology-related disciplines.

2. Course Learning Outcomes:

On successful completion of this paper, students should be able to:

1. Identify different microbes
2. Perform routine microbiological practices including sterilization, media preparation,
3. maintenance of microbial culture, staining etc.
4. Carry out research using microbes.
5. Test microbial culture for antibiotic resistance.

3. Course Contents:

TOTAL HOURS: 50 **CREDITS: 04**

Unit-I: History of Development of Microbiology

Development of microbiology as a discipline, Spontaneous generation vs. biogenesis. Contributions of Anton von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming. Role of microorganisms in fermentation, Germ theory of disease, Development of various microbiological techniques and golden era of microbiology, Establishment of fields of medical microbiology and immunology through the work of Paul Ehrlich, Elie Metchnikoff, Edward Jenner

Unit-II: Diversity of Microbial World

Binomial Nomenclature, Whittaker's five kingdom and Carl Woese's three kingdom classification systems and their utility. Difference between prokaryotic and eukaryotic microorganisms. General characteristics of different groups: acellular microorganisms (Viruses, Viroids, Prions) and Cellular microorganisms (Bacteria, Archaea, Algae, Fungi and Protozoa) with emphasis on distribution and occurrence, morphology, mode of reproduction and economic importance.

Unit-III: Bacteria, Viruses, Viroids and Prions

An account of typical eubacteria, chlamydiae and rickettsiae (obligate intracellular parasites), mycoplasma, and Archaea. Applications of bacteria and Archaea in industry, environment and food. An introduction to viruses with special reference to the structure and replication of the following: Poxvirus, Poliovirus, HIV, T4 and λ phage, lytic and lysogenic cycles.

Unit-IV: Algae, Fungi and Protozoa

History of phycology; General characteristics of algae including occurrence, thallus organization, algae cell ultra-structure, pigments, flagella, eyespot food reserves and vegetative, asexual and sexual reproduction. Applications of Algae in agriculture, industry, environment and food. Historical developments in the field of Mycology, significant contributions of eminent mycologists. General characteristics of fungi including habitat, distribution, nutritional requirements, fungal cell ultra- structure, thallus organization and aggregation, fungal wall structure and synthesis, asexual reproduction, sexual reproduction, heterokaryosis, heterothallism and parasexual mechanism. Economic Importance of Fungi in Agriculture, environment, Industry, medicine, food, biodeterioration, mycotoxins. General characteristics with special reference to Amoeba

BBC-CC12 PR

BASIC MICROBIOLOGY (PRACTICAL)

TOTAL HOURS:50 **CREDITS: 02**

1. Microbiology Laboratory Practices and Biosafety.
2. To study the principle and applications of important instruments (biological safety cabinets, autoclave, incubator, BOD incubator, hot air oven, light microscope, pH meter)
3. Preparation and sterilization of culture media for bacterial cultivation
4. Study of different shapes of bacteria, fungi, algae, protozoa using permanent slides/ pictographs
5. Staining of bacteria using Gram stain
6. Isolation of pure cultures of bacteria by streaking method.
7. Estimation of CFU count.

Suggested readings

1. Atlas, RM. (1997). Principles of Microbiology. 2nd edition. W.M.T. Brown Publishers
2. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company

BBC-CC13

METABOLISM OF AMINO ACIDS AND NUCLEOTIDES (THEORY)

1. Course Objective:

The main objective of the course is to offer detailed and comprehensive knowledge about the synthesis and degradation pathways of amino acids and nucleotides and their importance in the proper functioning of the cells. This course also interrelates the metabolism of these molecules with respect to health diseases in addition to providing overview of inhibitors of metabolism for treating the diseases of metabolic disorders.

2. Course Learning Outcomes:

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

1. Extend their school level concepts of nitrogen cycle to understand the mechanism by which nitrogen is fixed by microbes and how it's incorporation in diet is critical to human nutrition as well as comprehend the mechanism by which ammonia is incorporated in biomolecules
2. Systematically learn the breakdown and synthesis of amino acids and nucleotides in humans and recognize its relevance with respect to nutrition and human diseases
3. Gain knowledge of how amino acids are converted into a variety of precursors
4. Acknowledge the role of inhibitors of nucleotide metabolism which are potentially being used as chemotherapeutic drugs
5. Comprehend how the amino acid and nucleotide metabolism are integrated with carbohydrate and lipid metabolism

3. Course Content:

TOTAL HOURS: 50 **CREDITS: 04**

Unit-I: Overview of Amino Acid Metabolism
Nitrogen cycle, incorporation of ammonia into biomolecules. Metabolic fates of amino groups. Digestion and absorption of dietary proteins. Protein calorie malnutrition - Kwashiorkar and Marasmus. Nitrogen balance, transamination, role of pyridoxal phosphate, glucose-alanine cycle, Kreb's bicycle, urea cycle and inherited defects of urea cycle.

Unit-II: Biosynthesis and Catabolism of Amino Acids
Overview of amino acid synthesis. Biosynthesis of non-essential amino acids and its regulation. Catabolic pathways of individual amino acids. Glucogenic and ketogenic amino acids. Metabolism of one carbon units. Disorders of amino acids metabolism, phenylketonuria, alkaptonuria, maple syrup urine disease, methyl malonic acidemia (MMA), homocystinuria and Hartnup's disease. Biosynthesis of creatine and creatinine, polyamines (putresine, spermine, spermidine), catecholamines (dopamine, epinephrine, norepinephrine) and neurotransmitters (serotonin, GABA). Porphyrin biosynthesis, catabolism and disorders of porphyrin metabolism.

Unit-III: Biosynthesis of Nucleotides
De novo synthesis of purine and pyrimidine nucleotides, regulation and salvage pathways. Biosynthesis of deoxy ribonucleotides and its regulation, conversion to triphosphates, Biosynthesis of coenzyme nucleotides.

Unit-IV: Degradation of Nucleotides and Integration of Metabolic Pathways

Digestion of nucleic acids, degradation of purine and pyrimidine nucleotides. Inhibitors of nucleotide metabolism. Disorders of purine and pyrimidine metabolism – Lesch-Nyhansyndrome, Gout, SCID, adenosine deaminase deficiency. Integration of metabolic pathways (carbohydrate, lipid and amino acid metabolic pathways), tissue specific metabolism (brain, muscle, and liver).

BBC-CC13 PR

METABOLISM OF AMINO ACIDS AND NUCLEOTIDES (PRACTICAL)

TOTAL HOURS: 50 **CREDITS: 02**

1.Assay of serum transaminases – SGOT and SGPT.
2. Estimation of serum urea.
3. Estimation of serum uric acid.
4. Estimation of serum creatinine.

Suggested readings

1. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN:13:978-1-4641-0962-1 / ISBN:10:1-4641-0962-1.
2. Textbook of Biochemistry with Clinical Correlations (2011) 7th ed., Devlin, T.M., John Wiley & Sons, Inc. (New York), ISBN: 978-0-470-28173-4 / BRV ISBN: 978-0-470-60152-

BBC-CC14

GENETIC ENGINEERING AND BIOTECHNOLOGY (THEORY)

1. Course objectives:

The objective of the course is to teach the basics of theoretical and practical aspects of recombinant DNA technology and various techniques for DNA manipulation in prokaryotes and Eukaryotes. Applications of these techniques in production of recombinant therapeutic proteins and vaccines will also be outlined in this course.

2.Course Learning Outcome:

The students will be able to understand:

1. The process for isolation and engineering of DNA using restriction and modification enzymes.
2. Use of cloning and expression vectors.
3. The methods for creation of genomic and cDNA libraries, their applications and use.
4. Understanding the methods for protein production and their application in industrial
5. production systems.

3. Course Content

TOTAL HOURS: 50 **CREDITS: 04**

Unit-I: Introduction to Recombinant DNA Technology

Overview of recombinant DNA technology. Restriction and modification systems, restriction endonucleases and other enzymes used in manipulating DNA molecules, separation of DNA by gel electrophoresis. Extraction and purification of plasmid and bacteriophage DNA. Plasmids and bacteriophages as vectors for gene cloning. Ligation of DNA molecules. DNA ligase, sticky ends, blunt ends, linkers and adapters. Synthetic oligonucleotides, synthesis and use.

Unit-II: DNA Amplification and Cloning

Fundamentals of polymerase chain reaction, designing primers for PCR. Studying PCR products. Cloning PCR products. Real time PCR. DNA sequencing by Sanger's method, modifications based on Sanger's method. Automated DNA sequencing. Pyrosequencing. Cloning vectors based on *E. coli* plasmids, pBR322, pUC8, pGEM3Z. Cloning vectors based on M13 and λ bacteriophage. Vectors for yeast, higher plants and animals. Vectors for expression of foreign genes in *E. coli*, cassettes and gene fusions.

Unit-III: Introduction of DNA into Cells and Selection for Recombinants

Uptake of DNA by cells, preparation of competent cells. Selection for transformed cells. Identification for recombinants: Insertional inactivation, blue-white selection. Introduction of phage DNA into bacterial cells. Identification of recombinant phages. Introduction of DNA into animal cells, electroporation. The problem of selection, direct selection, marker rescue. Gene libraries, identification of a clone from gene library, colony and plaque hybridization probing, methods based on detection of the translation product of the cloned gene.

Unit-IV: Expression and Applications of Genetic Engineering in Biotechnology

Challenges in producing recombinant protein in *E. coli*. Production of recombinant protein by eukaryotic cells. Fusion tags and their role in purification of recombinant proteins. Site–directed mutagenesis and protein engineering. Applications in medicine, production of recombinant pharmaceuticals such as insulin, human growth hormone, factor VIII. Recombinant vaccines. Gene therapy. Applications in agriculture - plant genetic engineering, herbicide resistant crops, problems with genetically modified plants, safety concerns. Molecular evolution: Analysis of nucleotide and amino acid sequences, molecular phylogenies, homologous sequences, phenotypic evolution and speciation.

BBC-CC14 PR

GENETIC ENGINEERING AND BIOTECHNOLOGY (PRACTICAL)

TOTAL HOURS: 50 **CREDITS: 02**

1. Isolation of plasmid DNA from *E. coli* cells.
2. Digestion of plasmid DNA with restriction enzymes.
3. Amplification of a DNA fragment by PCR.
4. Transformation of *E. coli* cells with plasmid DNA.
5. Hyper expression of poly histidine-tagged recombinant protein and purification using Ni-NTA affinity resin.
6. Complementation of β−galactosidase for Blue and White selection.

Suggested readings

1. Gene Cloning and DNA Analysis (2010) 6th ed., Brown, T.A., Wiley- Blackwell publishing (Oxford, UK), ISBN: 978-1-4051-8173-0.
2. Principles of Gene Manipulation and Genomics (2006) 7th ed., Primrose, S.B., and Twyman, R. M., Blackwell publishing (Oxford, UK) ISBN:13: 978-1-4051- 3544-3.
3. Molecular Biotechnology: Principles and Applications of Recombinant DNA (2010) 4th ed., Glick B.R., Pasternak, J.J. and Patten, C.L., ASM Press (Washington DC), ISBN: 978-1-55581-498-4 (HC).

B.Sc. (Honors) component of B.Sc.-M.Sc. Integrated Biochemistry
(CBCS STRUCTURE)

DISCIPLINE SPECIFIC ELECTIVES

BBC-DSE01

STRUCTURAL BIOLOGY (THEORY)

1. Course Objectives:

This course aims to provide concepts of Structural biology where students will study about the molecular structure and dynamics of biological macromolecules, particularly proteins and nucleic acids, and how alterations in their structures affect their function. The course incorporates the principles of molecular biology, biochemistry and biophysics.

2. Course Outcomes:

1. Students will demonstrate a core knowledge base in the theory and practice of modern Biochemistry and Biophysics (BB).
2. Students will critically evaluate data and design experiments to test hypotheses relevant to the practice of Structural Biology.
3. Students will read and evaluate primary literature in the discipline.
4. Students will effectively communicate scientific data and ideas, using various formats appropriate for different target audiences.
5. Students will use databases, computational tools and other online resources effectively.
6. Students will demonstrate awareness of ethical issues in the practice of science.

3. Course Content:

TOTAL HOURS: 50 **CREDITS: 04**

Unit 1. Introductory concepts of Structure of Biological Macromolecules

Structural analysis of the basic building blocks of biological macromolecules. Interatomic forces and interactions such as electrostatics and hydrophobicity in proteins, Evolution of biological structure and function. Basic introduction to protein folds and the nature of proteins.

Unit 2. Three-Dimensional Structure Determination

Macromolecular Crystallography- Basic Principles of protein purification, crystallization, crystal diffraction and structure determination. Principle of Femtosecond Crystallography, Time-Resolved Crystallography and Neutron Crystallography. Cryo-electron microscopy-sample preparation and 3-D image processing. Structure validation and best practice on the use of protein structures from the protein data bank.

Unit 3. Structural and Functional Dynamics of Macromolecules

Protein conformation dynamics study by Small Angle X-ray Scattering (SAXS) and other biophysical techniques including Isothermal Titration Calorimetry (ITC), Thermal Stability Assay (TSA), Microscale Thermophoresis (MST), FTIR Spectroscopy, Functional interpretation of conformational dynamics of macromolecule.

Unit 4. Structure-Function analysis

Understand structure to function- basis of substrate binding and enzymatic mechanism, discovery of allosteric-site. Understand macromolecular machines and assemblies- RNA Polymerase, DNA polymerase, Ribosome, Kinetochore Dynein and Nucleosome.

BBC-DSE01 PR

STRUCTURAL BIOLOGY (PRACTICAL)

TOTAL HOURS: 50 **CREDITS: 02**

1. Crystallization of lysozyme by hanging vapor diffusion method.
2. Download crystal structure pdb file of lysozyme from PDB databank and understand validation report.
3. Analyze a lysozyme structure in PyMol software.
4. Effect of fructose and glucose on the stability of Lysozyme protein (use differential scanning fluorimetry experiment).

Suggested Readings:

1. Biomolecular Crystallography: Principles, Practice, and Application to Structural Biology by Bernhard Rupp.
2. Fundamentals of Protein Structure and Function by Engelbert Buxbaum.
3. Protein Dynamics. Methods and Protocols by Dennis R. Livesay.

BBC-DSE02

RESEARCH METHODOLOGY (THEORY)

1. Course Objectives

The main objective of this paper is to provide students with a general introduction to the methodological foundations and tools used in research for an understanding of the ways to identify problems, develop hypotheses and research questions and design research projects. The course will expose students to the range of designs used in research in laboratory, field experiments, surveys and content analysis. It will also provide an introduction to the concept of controls, statistical tools and computer applications used in research. In addition, the course will impart knowledge of scientific writing, oral presentation and the various associated ethical issues.

2. Course Learning Outcomes:

By studying this paper students will be able to:

1. Define research, learn the importance of research and its link with theoretical knowledge.
2. Describe the research process and the principle activities, skills and ethics associated with the research process
3. Describe and compare the major quantitative and qualitative research methods Construct an effective research proposal.
4. Understand the importance of research ethics use the computer software for organization and analysis of data.
5. Develop skills in the art of scientific writing and oral presentation

3. Course Contents:

TOTAL HOURS: 50 **CREDITS: 04**

Unit I: Foundations of Research

Meaning, Objectives, Motivation: Research Methods vs Methodology, Types of Research: Analytical vs Descriptive, Primary vs Secondary Research, Quantitative vs Qualitative, Basic vs Applied. Phases of Research: Assessment (situation analysis), planning, implementation and evaluation

Unit II: Research Design

Need for research design: Features of good design, Important concepts related to good design- Observation and Facts, Prediction and Explanation, Development of Models. Developing a research plan: Problem identification, Experimentation, Determining experimental and sample designs

Unit III: Data Collection, Analysis and Report Writing

Observation and Collection of Data-Methods of data collection- Sampling Methods, Data Processing and Analysis Strategies. Statistics in research: Concepts of sample and population, Statistical tests and hypothesis (Standard error, t-test, chi-square test), Data representation: Normal distribution (p-value).

Technical Reports and Thesis writing, Writing a research paper: abstract, introduction, methodology, results and discussion. Citation, Acknowledgement. Preparation of Tables and Bibliography. Review of literature, Data Presentation using digital technology

Unit IV: Bioethics and Plagiarism in Research

Introduction to IPR, Commercialization, Copy Right, Royalty, Patent law, Ethical issues in research: Ethics involving use of animal and human subjects (role of ethics committees), professional ethics, conflict of interests, publication ethics and plagiarism. Protection of environment and biodiversity. Biosafety issues in research: Biosafety levels; biohazards of chemical, radiation, genetically modified organisms, recombinant DNA. Handling of infectious agents and hazardous material used in research. Laboratory waste disposal

Suggested readings

- Anthony, M, Graziano, A.M. and Raulin, M.L. 2009. Research Methods: of Inquiry, Allyn and Bacon.
- Walliman, N. 2011.Research Methods- The Basics. Taylor and Francis, London, New York.
- Wadhera, B.L.: Law Relating to Patents, Trade Marks, Copyright Designs and Geographical Indications, 2002, Universal Law publishing
- C.R.Kothari: Research Methodology, New Age International, 2009
- Coley, S.M. and Scheinberg, C.A. 1990, "Proposal writing". Stage Publications

BBC-DSE02 PR

RESEARCH METHODOLOGY (PRACTICAL)

TOTAL HOURS: 50 **CREDITS: 02**

Based on the teaching above, each student will undertake the following exercises.

1. A teacher (adviser) who would guide the student will discuss with student and identify a topic of mutual interest.
2. The student will collect the literature, collate the information and write the same in the form of a term paper with proper incorporation of references using appropriate software such as EndNote.
3. The student will identify scope of research on the topic and will frame objectives to be addressed in the project through a work plan.
4. The student will write standard operating protocols (SOPs) and identify requirement for equipment and reagents.
5. Each student will be asked to make presentation about the project including literature available, objective sought and work plan including methodologies as described above.

Suggested readings

1. Research in Education (1992) 6th ed., Best, J.W. and Kahn, J.V., Prentice Hall of India Pvt.Ltd. ISBN-978-81-203-3563-9.
2. At the Bench: A Laboratory Navigator (2005) Barker, K., Cold Spring Harbor Laboratory Press (New York), ISBN: 978-087969708-2.
3. Research Methodology - Methods and Techniques (2004) 2nd ed., Kothari C.R., New Age International Publishers. ISBN – 81-224-1522-9
4. Research Methodology: A Step by Step Guide for Beginners (2005) 2nd ed., Kumar R., Pearson Education. ISBN: 978-1-4129-6467-8.
5. Biostatistics: A Foundation for Analysis in the Health Sciences (2013) 10th ed., Daniel W.W., John Wiley and Sons Inc. ISBN-13: 978-1118302798 ISBN-10: 1118302796
6. Statistics at the Bench: A Step-by-Step Handbook for Biologists (2010) Bremer, M. and Doerge, R.W., Cold Spring Harbor Laboratory Press (New York), ISBN: 978-0-879698-57

BBC-DSE03

CHRONIC HUMANDISEASES (THEORY)

1. Course Objective:

This course provides students with knowledge and understanding of various human diseases. It will introduce the concepts of a well-balanced diet, healthy lifestyle, biochemical basis of diseases, treatment strategies, mechanism of action of drugs and drug resistance against various antimicrobials. The course also aims to outline the various strategies that are employed for preventing infectious and non-infectious diseases.

2. Course Learning Outcomes:

1. Students will develop understanding about the importance of balanced diet, regular exercises and healthy lifestyle.
2. Students will gain insight into various disorders associated with imbalanced diet and poor lifestyle.
3. Students will learn various strategies employed for preventing various human diseases.
4. Students will understand the molecular basis of microbial pathogenicity, drug resistance and implications in public health management.
5. Students should be able to handle and solve analytical problems related to theory classes.

3. Course Content:

TOTALHOURS: 50 **CREDITS: 04**

Unit-I: Chronic Human Diseases and Functional Disorders

Chronic and noncommunicable diseases, definition, types, prevention and epidemiology. Communicable chronic diseases – HIV AIDS. Chronic inflammatory diseases. Autoimmune diseases. Functional disorders – irritable bowel syndrome, biochemistry, causes and management. Functional neurological disorder.

Unit-II: Lifestyle-related Metabolic Disorders

Obesity and bulimia nervosa. Diabetes mellitus and its complications – retinopathy, neuropathy, nephropathy, fatty liver, hypertension. Causes and management of diabetes and its complications. Thyroid disorders. Cardiovascular disorders and atherosclerosis - factors that contribute to the syndrome.

Unit-III: Neurodegenerative Disorders and Monogenic Disorders

Protein folding and proteasome removal of misfolded proteins. Etiology and molecular basis for Alzheimer and Prion diseases. Huntington's Chorea. Hemoglobinopathies. Sickle cell anemia. Thalassemia. Inborn errors of metabolism - PKU, Alkaptonuria, Maple syrup urine disease. Transport defects - cystic fibrosis. Familial hypercholesterolemia. Achondroplasia.

Unit-IV: Multifactorial Complex Disorders and Cancer

Multifactorial diseases. Polygenic diseases and the relationship of environmental factors and genetic

makeup. Cancer - causes and stages. Proto-oncogenes and tumor suppressor genes. Molecular approaches to cancer treatment. Chronic physical illness and mood disorders. Polycystic ovarian syndrome. Schizophrenia, dementia, anxiety. Parkinson's disease.

BBC-DSE03 PR

CHRONIC HUMAN DISEASES (PRACTICAL)

TOTAL HOURS: 50 **CREDITS:02**

Clinical Biochemical lab:
Methods for the preparation of serum and plasma, Urine and blood analysis, Clotting time analysis, Preparation of Levy-Jennings's chart.

Chronic Human Diseases and Functional Disorders:
Estimation of glucose, Liver function test, Diagnostic profile for the assessment of diabetes and cardiovascular diseases, Anthropometric measurements (To be demonstrated by a physician)

BBC-DSE04

DEVELOPMENTAL BIOLOGY (THEORY)

1. Course Objectives:

The objective of this course is to provide a comprehensive understanding of the concepts of early animal development. Students taking this course must develop a critical appreciation of methodologies specifically used to study the process of embryonic development in animals. Students will learn different concepts of animal development will be elaborated in one model system or the other. Once the concepts are taught the students will be made familiar with different approaches that have been used to study such concepts.

2. Course Outcomes:

1. Name, describe and order the main stages of development common to most multicellular organisms.
2. Describe the main anatomical changes that occur during development.
3. Identify the cellular behaviors that lead to morphological change during development.
4. Describe the hierarchy of gene activation that occurs in early *C. elegans* development.
5. Understand how gene activation plays a role in differentiation and development.
6. Describe the main signaling pathways that play important roles in development.
7. Explain how embryonic stem cells and their alternatives can be used in medical treatments.

3. Course Content:

TOTAL HOURS: 50 **CREDITS: 04**

Unit-I: Introduction

History, Anatomical tradition, Principles of development-life cycles, Developmental patterns and evolution of differentiation, Experimental embryology, Role of genes in development, Amniocentesis.

Unit-II: Early Embryonic Development

Gametogenesis- Spermatogenesis and oogenesis, Types of eggs, Fertilization- changes in gametes, mono- and polyspermy; The early development of *C. elegans*; The early development of Xenopous-cleavage, Gastrulation, Embryonic induction; The early development of chick-cleavage, Gastrulation.

Unit-III: Later Embryonic Development

Differentiation of germ layers-Formation of neural tube (development of CNS and eye), skin, notochord, somites, coelom and digestive tube (upto rudiments), Extraembryonic membranes in birds and human, Implantation of embryo, Placentation – structure, types and physiology of placenta.

Unit-IV: Post-Embryonic Development

Metamorphosis- changes and hormonal regulation of metamorphosis in insects and amphibians, Regeneration- modes of regeneration-epimorphosis, Morphallaxis and compensatory regeneration (with one example), Ageing- concepts and model (*C. elegans*).

BBC-DSE04 PR

DEVELOPMENTAL BIOLOGY (PRACTICAL)

TOTAL HOURS: 50 **CREDITS:02**

1. Frog - Study of developmental stages - whole mounts and sections through permanent slides – cleavage stages, blastula, gastrula, neurula, tail bud stage, tadpole.
2. Chick - Study of developmental stages - whole mounts and sections through permanent slides- primitive streak, 21h, 24h, 28h, 33h, 36h, 48h, 72h, 96h.
3. Drosophila- Study the developmental stages and the life cycle from fruit fly stock culture.
4. ZebraFish - Study the developmental stages and the life cycle
5. Sections of placenta.

Suggested readings

1. Gilbert, S. F. Developmental Biology, VIII Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA.
2. Balinsky, B.I. An introduction to Embryology, International Thomson Computer Press.
3. Kalthoff. Analysis of Biological Development, II Edition, McGraw-Hill Professional.

BBC-DSE05

GENOMICS, PROTEOMICS AND METABOLOMICS (THEORY)

1. Course Objectives:

The objectives of this course are to provide introductory knowledge concerning genomics, proteomics and metabolomics and their applications.

2. Course Outcomes:

1. Understanding of concepts such as gene regulation, gene networks, proteomics, transcriptomics, metabolomics, their relationships and the role of bio-informatics analyses.
2. The student will be able discern the crucial concepts and techniques applied in genomics, proteomics and Metabolomics.
3. Be able to classify the complexity of genome/ proteome/ metabolome structural and functional organization.
4. Principles of several important analytical methods that are relevant to a functional genomics approach.
5. Formulate and assess experimental design for solving theoretical and experimental problems in Genomics and Proteomics fields.

3. Course Content:

TOTAL HOURS: 50 **CREDITS: 04**

Unit-I: Advances in Genomics

Introduction to genomics and transcriptomics, basic understanding various methods used for DNA Sequencing including Maxam Gilbert sequencing, chain termination sequencing, shotgun sequencing, Massively parallel sequencing, Solexa sequencing, Solid Sequencing, DNA Nanopore sequencing, ion torrent sequencing, Basic understanding different techniques like microarray, RNA-Seq, and miRNA-Seq.

Unit-II: Advances in Proteomics

Introduction to Proteomics, Introduction to Mass Spectrometry, Tandem Mass Spectrometry, Liquid Chromatography-Mass Spectrometry (LC-MS), Shotgun Proteomics, Peptide Mass Spectrometry, Quantitative Proteomics, Protein Identification by Database Searching, 2D separation of proteins (chromatography and electrophoresis).

Unit-III: Advances in Metabolomics

Introduction to metabolomics: what it can and cannot do, Application of NMR in metabolomics, Targeted and untargeted metabolomics, How to identify one metabolite, Quantifying metabolites, Pathway Analysis, Metabolomics databases and resource, From simple statistics to multivariate stats.

Unit-IV: Integrating Omics- Systems Biology

Overview of Gene Control –Introduction to genetic switches with specific example of try- and lac-repressors. Role of genetic switches in drosophila env gene development. Gene regulation at a single cell level- Transcription Networks -basic concepts -coherent Feed Forward Loop (FFL).

BBC-DSE05 PR

GENOMICS, PROTEOMICS AND METABOLOMICS (PRACTICAL)

TOTAL HOURS: 50 **CREDITS: 02**

Introduction to Python
Printing and manipulating text, Reading and Writing Files, List, Tuples and Loops, Functions, Regular Expressions, Dictionary

Analysis of DNA Sequencing Data
Using python script for downloading and manipulating DNA sequencing data, finding reverse complement, finding GC content, finding restriction sites in DNA sequences, trimming adaptor sequences, extraction of exonic and intronic sequences.

In-silico Trypsin Digestion; Serum Protein Separation for Mass Spectroscopy

Suggested readings

6. Python for Biologists by Dr. Martin Jones
7. Principles of Biochemistry, D.L. Nelson & M.M. Cox (2008), 5th ed., W.H. Freeman & Co.
8. Biochemistry, Jeremy M. Berg, John L. Tymockzo, Lubert Stryer (2007), 6th ed., W.H. Freeman and Co.,NY.
9. Protein Structure, Stability and Interactions, John M. Shriver (2009), Humana Press.
10. Introduction to Protein Structure, Carl Branden and John Tooze (1999), 2nd ed.. Garland Publishing Inc.
11. Proteins: Structure and Molecular Properties, T.E. Creighton (1993), 2nd ed.. W.H. Freeman & Co.

BBC-DSE06

ADVANCED CELL BIOLOGY (THEORY)

1. Course Objective:

The course aims to provide advanced knowledge of the function of cellular organelles, the structure and function of cytoskeleton and its role in motility. The course will also provide details of cellular interaction with cells and tissues around and the molecular regulation of cell growth and cell death. The course will outline the molecular details of the origin of cancer and the diagnosis and treatment.

2. Course Learning Outcomes:

The learning outcomes will be as follows:

1. Students will develop understanding of the principle and application of some of the classical and advanced cell biology techniques
2. Students will be able to describe the role of organelles in the secretion of mature proteins and key role of the cytoskeleton in the living cell.
3. Students will be able to understand the factors regulating mitosis, meiosis, apoptosis and necrosis. They will also be able to comprehend the role and therapeutic value of stem cells.
4. Students will be able to understand the genetic basis of development of cancer, the molecular diagnosis and molecular drugs which are used for chemotherapy.

3. Course Content:

TOTAL HOURS: 50 **CREDITS: 04**

Unit-I: Plasma Membrane and Nuclear Transport

Properties and Composition of Cell Membrane; Structure of Nuclear Envelope; Nuclear Pore Complex; Transport Across Nuclear Envelope; Regulation of Nuclear Protein Import and Export. Ultracentrifugation, Fluorescence Microscopy- FACS, FRET, Confocal Microscopy, Electron Microscopy, Plant and Animal Cell Culture, Immunohistochemistry.

Unit-II: Protein Sorting and Secretory Pathway

Overview of The Endomembrane System; Targeting, modification and sorting of Proteins from and into Endoplasmic Reticulum; Synthesis and Targeting Mitochondrial Protein; Chloroplast Proteins And Peroxisomal Proteins; Mechanism Of Vesicular Transport; Coat Proteins And Vesicle Budding; Vesicle Fusion; Targeting Of Proteins To Membranes; Receptor Mediated Endocytosis.

Unit-III: Cytoskeleton, Cell Motility Cell-Cell Interaction

Function and origin of The Cytoskeleton; Organization and Assembly of Actin Filaments and Myosin; Assembly and Dynamics of Microtubules and Intermediate Filaments; Assembly and organization of Cilia and Flagella, Muscle Contractility; Cell Polarization And migration. Cell-Cell Interactions and Cell-Matrix Interactions; Components of Extracellular Matrix: Collagen and Non-Collagen Components; Role of Cell Interaction In Development.

Unit-IV: Cell Cycle, Programmed Cell Death and Cancer Biology

Overview of The Cell Cycle; Eukaryotic Cell Cycle; Events of Mitotic Phase; Cytokinesis; Events of Meiosis And Fertilization; Regulation Of Cell Division And Cell Growth; Apoptosis and Necrosis, Stem Cells And Maintenance of Adult Tissues, Hematopoiesis, Embryonic Stem Cells and Therapeutic Cloning. Development and causes Of Cancer; Genetic Basis of Cancer; Oncogenes, Tumor Viruses; Molecular Approach to Cancer Treatment.

BBC-DSE06 PR

ADVANCED CELL BIOLOGY (PRACTICAL)

TOTAL HOURS: 50 **CREDITS: 02**

1. Isolation of organelles by sub-cellular fractionation.
2. Study of cell viability /death assay by use of trypan blue and MTT assay.
3. Study of apoptosis through analysis of DNA fragmentation patterns.
4. Identification and study of cancerous cells using permanent slides and photomicrographs.

Suggested readings

1. The Cell: A Molecular Approach (2009) 5th ed., Cooper, G.M. and Hausman, R.E., ASM Press & Sunderland (Washington DC), Sinauer Associates, MA, ISBN:978-0-87893-300-6.
2. Molecular Cell Biology (2012) 7th ed., Lodish, H., Berk, A., Zipursky, S.L., Matsudaira, P., Baltimore, D. and Darnell. J., W.H. Freeman & Company (New York), ISBN:13:978-1-4641-0981-2 / ISBN:10: 1-4641-0981-8.
3. Molecular Biology of the Cell (2008) 5th ed., Alberts, B., Johnson, A., Lewis, J.,and Enlarge, M., Garland Science (Princeton), ISBN:0-8153-1619-4 / ISBN:0-8153-1620-8.
4. The World of the cell, 7th edition (2009). Lewis J. Kleinsmith, Jeff Hardin, Gr Wayne M. Becker. ISBN-13: 978-0805393934 ISBN-10: 0805393935.
5. Cell and Molecular Biology: Concepts and Experiments. (2010). Karp, G., 6th edition. John Wiley & Sons. Inc. ISBN: 978-1-118-65322-7

BBC-DSE07

INTRODUCTION TO TECHNIQUES IN BIOCHEMISTRY (THEORY)

1. Course Objectives:

The objective of the course is to introduce to the students, various techniques that are used in a biochemistry lab and to provide them with an understanding of the principle underlying these techniques and laboratory skills in the form of practical exercises so that students can apply this knowledge to pursue research.

2. Course Learning Outcomes:

The course is designed for undergraduate students to learn the basic concepts of various techniques used in Biochemistry. The course will enable students to:

1. Acquire knowledge about the principles and applications of spectrophotometric and chromatography techniques used in a biochemistry lab.
2. Learn about the principle and applications of electrophoresis and centrifugation techniques.
3. Obtain hands-on-experience and laboratory skills expected of any biochemist working in a research lab.

3. Course Content:

TOTAL HOURS: 50 **CREDITS: 04**

Unit-I: Analysis of Biomolecules

Concepts of Biochemical calculations: Molarity, Molality, Normality, ppm, ppb, percent solution, serial dilution. Qualitative analysis of Carbohydrate: Chemical methods (Reduction with amine, strong acids and a phenol),Enzymatic methods (assay of glucose using glucose oxidase, glucose dehydrogenase, hexokinase). Qualitative analysis of Amino Acid**:** Fluorimetric methods (using ninhydrin, o-phthalaldehyde, fluorescamine), Colorimetric methods (using Erhlich's reagent, Pauly's reagent). Qualitative analysis of Proteins:Chemical methods (Bradford's method, Lowry's method, Biuret and Kjeldahl method). Dye-binding methods (using methyl orange, coomassie brilliant blue, bromocresol purple dye). Qualitative analysis of Lipids: Total lipids estimation (Gravimetry, Colorimetry), Solvent and non-solvent extraction of lipids. Qualitative analysis of Nucleic Acids: Chemical methods: Burton method, Diaminobenzoic acid (DABA) fluorescence assay, Enzymatic methods: diphenyl amine test (DNA) and orcinol test (RNA).

Unit-II: Separation and Detection Techniques

Principle and types of Centrifugation, Ultrafiltration, Dialysis Principle and instrumentation of Chromatography, types (Paper chromatography, TLC, partition, size exclusion, affinity, ion exchange and HPLC). Principle and Types of spectroscopy (UV-visible, IR, fluorescence spectroscopy, Atomic Absorption, Nuclear Magnetic Resonance), Concepts of molar extinction coefficient. Immunodiffusion (Radial immunodiffusion, Ouchterlony's Double Immunodiffusion),

Immunoelectrophoresis, Principle and Types of ELISA, Radio immunoassay. Introduction to Flow cytometry and FACS.

Unit-III: Radioisotopic / Tracer Techniques

Radioisotopes; Units of radioactivity; Detection and measurement of radioactivity by gas ionization and scintillation counting; GM Counter; Gamma counter; Autoradiography; Fluorography; Phosphor imaging; Isotope dilution method-pulse chase; RIA; Alternative to radioactivity: Luxometry and chemiluminescence.

Unit-IV: Plant tissue culture (PTC) and Animal Tissue culture (ATC) techniques

PTC: Media preparation (natural and synthetic), micropropogation, Somatic cell hybridization, Haploid culture, Embryo culture, Protoplast fusion, Somatic embryogenesis, Agrobacterium mediated hairy root culture
ATC: Media requirements and preparation, Cell culture techniques (Hanging drop, suspension and monolayer culture), methods of cell preservation, Determination of cytotoxicity.

BBC-DSE07 PR

INTRODUCTION TO TECHNIQUES IN BIOCHEMISTRY (PRACTICAL)

TOTAL HOURS: 50 **CREDITS: 02**

1. Qualitative analysis of carbohydrates, lipids, amino acids, and proteins from biological sample.
2. Quantitative (spectrophotometric) analysis of glucose, protein and cholesterol.
3. Chromatographic separation of sugars, fatty acids, and amino acids by paper and thin layer chromatography.
4. Extraction of lipid/oil from plant material and determination of its saponification value and iodine number.
5. Centrifugation technique: subcellular fractionation, and isolation of nuclei and mitochondria from the tissue.
6. Determination of molecular weight by SDS-PAGE.
7. Plant and Animal tissue culture (demonstration only).

Suggested readings

1. Principles of Biochemistry, Lehninger C Rs. Publ. (1982).
2. Biochemistry: D. Voet, and J.G. Voet (2010), 4 edition, Wiley
3. Harper's Illustrated Biochemistry: R. Murray, V. Rodwell, D. Bender, th K.M. Botham, P.A. Weil and P.J. Kennelly (2009) 28 edition, McGraw Hill-Medical
4. Principles and Techniques of Biochemistry and Molecular Biology 7 th Edn. Keith Wilson and John Walker, Cambridge University Press, (2010).
5. Physical Biochemistry (2009) 2nd ed., Sheehan, D., Wiley-Blackwell (West Sussex), ISBN: 9780470856024 / ISBN: 9780470856031.
6. The Tools of Biochemistry (1977; Reprint 2011) Cooper, T.G., Wiley India Pvt. Ltd. (New Delhi), ISBN: 978-81-265-3016-8.

BBC-DSE08

INTERMEDIARY METABOLISM (THEORY)

1. Course Objectives

The objective of this course is to provide the students an understanding of the major metabolic pathways associated with biomolecules within a cell and their regulation. It will also provide knowledge about the possible correlation between various metabolic pathways.

2. Course Learning Outcomes

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

1. Understand the basics of metabolic pathways
2. Outline the pathways involved in catabolism and biosynthesis of glucose.
3. Describe the mechanism of ATP synthesis.
4. Understand the biosynthesis and degradation of glycogen
5. Comprehend the metabolism of fatty acids, amino acids, and nucleotides
6. Develop an understanding of metabolic integration

3. Course Content

TOTAL HOURS: 50 **CREDITS: 04**

Unit-I: Basic concepts and design of metabolism

The nature of metabolism. Role of oxidation and reduction and coupling of these. ATP as energy currency. Brief role of hormones - catecholamines, insulin, glucagon; metabolic shifts to provide fuel to brain during fasting and starvation, role of cortisol in signalling stress - increase in gluconeogenesis and muscle protein breakdown.

Unit-II: Carbohydrate metabolism

Glycolysis a universal pathway, fructose and galactose oxidation, anaerobic glycolysis, fermentation, Pyruvate dehydrogenase complex, oxidation of acetyl CoA, amphibolic role, regulation and glyoxylate pathway. gluconeogenesis, reciprocal regulation of glycolysis and gluconeogenesis. The respiratory chain in mitochondria, proton gradient powering ATP synthesis, glycerol-3-phosphate and malate-aspartate shuttle, regulation of oxidative phosphorylation.

Unit-III: Lipid, amino acid and Nucleotide metabolism

TAG as energy source, β oxidation of fatty acids in mitochondria and peroxisomes, ketone bodies. Biosynthesis of fatty acids - elongation and unsaturation of fatty acids. Regulation of fatty acid oxidation and synthesis. Protein degradation to amino acids, urea cycle, feeder pathways into TCA cycle. Nitrogen fixation, synthesis of non-essential amino acids. Biosynthesis - *de novo* and salvage pathways, regulation of nucleotide synthesis by feedback inhibition, degradation and excretion.

Unit-IV: Photosynthesis, Calvin cycle and pentose phosphate pathway

The light reaction, chlorophyll, accessory pigments, reaction centres, two photo systems, generation of proton gradient and NADPH, Calvin cycle, synthesis of glucose, starch, sucrose, regulation, C4 pathway. Pentose phosphate pathway, importance and regulation. Glycogenolysis, phosphorylase regulation, role of epinephrine and glucagon for glycogenolysis, glycogenesis; reciprocal regulation of glycogenesis and glycogenolysis.

BBC-DSE08 PR

INTERMEDIARY METABOLISM (PRACTICAL)

TOTAL HOURS: 50 **CREDITS: 02**

1. Alcohol fermentation by yeast.
2. H_2S production, indole production and ammonia production by bacteria.
3. Urea estimation.
4. Uric acid estimation.

Suggested readings

1. Biochemistry (2012) 7th ed., Campbell, M.K. and Farrel, S.O. Brooks/Cole, CengageLearning (Boston), ISBN: 13:978-1-111-42564-7.

B.Sc. (Honors) component of B.Sc.-M.Sc. Integrated Biochemistry
(CBCS STRUCTURE)

GENERIC ELECTIVES

BBC-GE01-A

BASICS OF PHYSICS AND BIOLOGY (THEORY)

1. Course Objectives:

The aim of the course is to provide basic concepts in Physics. The natural laws of physics have shaped the evolution of all bodies, both human and non-human. As a result of this, biologists need to understand physics in order to understand how the human body works. The course also provide basic concepts in biology. This portion will help students coming from diverse background.

2. Course Outcomes:

1. Understand the basic principles of motion
2. Outline the components of electromagnetic spectrum
3. Describe the principles of waves
4. Outline the classification of plants and animals
5. Understand cell components
6. Understand basic principles in physiology of animal and plants
7. Learn basic concepts in genetics

3. Course Content

TOTAL HOURS: 50 **CREDITS: 04**

SECTION A: BASICS OF PHYSICS (02 CREDITS)

UNIT – 1

a) Oscillations: Periodic motion, time period, frequency, Simple Harmonic Motion (SHM) and its equations, phase, restoring force, Kinetic Energy and Potential Energy in SHM.
b) Electromagnetic waves: Electromagnetic Spectrum, Electromagnetic waves and their characteristics, Maxwell's Equations

UNIT – 2

a) Interference due to division of amplitude and division of wave fronts, Young's double slit Experiment, Principle of Superposition, Theory of Biprism, Newtons' Rings.
b) LASER: Introduction, Temporal and Spatial Coherence, Principle of LASER, Stimulated and spontaneous emission. Einstein's Coefficients, He-Ne Laser, Ruby Laser, Applications of Lasers.

SECTION B: BASICS OF BIOLOGY (02 CREDITS)

UNIT– 3

a) **Animal and Plant Kingdom**
Salient features and classification of plants into major groups - Algae, Bryophyta, Pteridophyta, Gymnospermae and Angiospermae. Salient features and classification of animals, non-chordates up to phyla level and chordates up to class.

b) **Cell-The Unit of Life**
Cell as the basic unit of life: Structure of prokaryotic and eukaryotic cells; Plant cell and animal cell; Cell envelope, cell membrane, cell wall; Cell organelles - structure and function. Elementary idea of cell cycle, mitosis, meiosis and their significance.

c) **Biomolecules**
Chemical constituents of living cells: biomolecules, structure and function of proteins, carbohydrates, lipids, nucleic acids.

UNIT– 4

a) Human and Plant Physiology
Plant: basic concepts of transport, photosynthesis, respiration and reproduction in higher plants.
Human: Basic concepts of digestion and absorption; respiration, body fluids and circulation; excretion, nervous system, and reproduction.

b) **Basic Principles of Inheritance and Variation**
Mendelian Inheritance; Deviations from Mendelism-Incomplete dominance, Co-dominance, Multiple alleles and Inheritance of blood groups, Pleiotropy; Elementary idea of polygenic inheritance; Chromosome theory of inheritance; Chromosomes and genes;

Suggested Reading:

1. AjoyGhatak, Optics, TMH
2. D.S.Mathur, Mechanics
3. Griffith, Electrodynamics
4. Brij Lal and Subramaniyam, Optics

BBC-GE01-B

BASICS OF PHYSICS AND MATHEMATICS (THEORY)

1. Course Objectives:

The aim of the course is to provide basic concepts in Physics. The natural laws of physics have shaped the evolution of all bodies, both human and non-human. As a result of this, biologists need to understand physics in order to understand how the human body works. The course also provide basic concepts in math. Mathematics plays a key role in many disciplines of science, primarily as a mathematical modelling tool. New innovations and developments in physics are by the influence of mathematics.

2. Course Outcomes:

1. Understand the basic principles of motion
2. Outline the components of electromagnetic spectrum
3. Describe the principles of waves
4. Understand basic concepts in Matrices and Determinants
5. Learn principles of differentiation and integration

3. Course Contents:

TOTAL HOURS: 50 **CREDITS: 04**

SECTION A: BASICS OF PHYSICS (02 CREDITS)

UNIT – 1

c) Oscillations: Periodic motion, time period, frequency, Simple Harmonic Motion (SHM) and its equations, phase, restoring force, Kinetic Energy and Potential Energy in SHM.
d) Electromagnetic waves: Electromagnetic Spectrum, Electromagnetic waves and their characteristics, Maxwell's Equations

UNIT – 2

c) Interference due to division of amplitude and division of wave fronts, Young's double slit Experiment, Principle of Superposition, Theory of Biprism, Newtons' Rings.
d) LASER: Introduction, Temporal and Spatial Coherence, Principle of LASER, Stimulated and spontaneous emission. Einstein's Coefficients, He-Ne Laser, Ruby Laser, Applications of Lasers.

SECTION B: BASICS OF MATHEMATICS (02 CREDITS)

UNIT– 1: **Matrices and Determinants**

Matrices: Concept, notation, order, equality, types of matrices, zero and identity matrix, transpose of a matrix, symmetric and skew symmetric matrices. Operation on matrices: Addition and multiplication and multiplication with a scalar. Simple properties of addition, multiplication and scalar multiplication.
Determinants: Determinant of a square matrix (up to 3 x 3 matrices), properties of determinants, minors, co-factors and applications of determinants in finding the area of a triangle. Adjoint and inverse of a square matrix.

UNIT – 2: Calculus

Continuity and Differentiability: Continuity and Derivative, derivative of composite functions, chain rule, derivative of implicit functions. Concept of exponential and logarithmic functions.
Derivatives of logarithmic and exponential functions. Logarithmic differentiation, derivative of functions expressed in parametric forms. Second order derivatives.
Integrals: Integration as inverse process of differentiation. Integration of a variety of functions by substitution, by partial fractions and by parts, Evaluation of simple integrals of the following types and problems based on them. Definite integrals as a limit of a sum, Basic properties of definite integrals and evaluation of definite integrals.
Differential Equations: Definition, order and degree, general and particular solutions of a differential equation. Formation of differential equation whose general solution is given.

Suggested Reading

1. Ajoy Ghatak, Optics, TMH
2. D. S. Mathur, Mechanics
3. Griffith, Electrodynamics
4. Brij Lal and Subramaniyam, Optics

BBC-GE02-A

BIOETHICS AND INTELLECTUAL PROPERTY RIGHTS (THEORY)

1. Course Objective

Through this course students will learn the Significance and Framework of Intellectual Property Rights and to understand the protocols of Patenting. Students will also learn the importance of Biosafety protocols and Bioethics.This course helps to adhere to the ethical practices appropriate to the discipline at all times and to adopt safe working practices relevant to the bioindustries & field of research.

2. Course outcomes:

1. Students will gain awareness about Intellectual Property Rights (IPRs) to take measure for the protecting their ideas
2. They will able to devise business strategies by taking account of IPRs
3. They will be able to assists in technology upgradation and enhancing competitiveness.
4. Understand the basics of biosafety protocols.
5. Employ biosafety protocols in experimental research.
6. Differentiate between ethical concerns.

3. Course Content:

TOTAL HOURS: 50 **CREDITS: 04**

UNIT – 1: Fundamentals of bioethics

Definition, historic evolution, codes and guidelines, universal principles of bioethics. Codes, agreements, Declarations and Guidelines. Define the term “Bioethics” in relation to profession, society, and biomedicine, learn about gradation of moral and ethical norms and learn about prayers, oaths, agreements, declarations, guidelines and codes which have relevance to bioethics Clinical ethics. Describe the sanctity of human life and the need to preserve human life, explain about issues related to prenatal screening, clinical trials (Phase I/II/III/IV) studies. Informed consent, Ethics committees.

UNIT – 2: Bioethics in practice

Medical errors and Negligence Medical error and medical negligence difference, remedies against medical negligence, protection and compensation related to it. Care in infectious diseases, identify ethical issues in clinical practice of HIV, TB, leprosy and its prevention, research ethics related to infectious diseases Ethical use of animals in the laboratory

UNIT – 3: Introduction to intellectual property rights

Basics of Intellectual Property, History and Evolution of Intellectual Property, Treaty and Convention on IP, World Intellectual Property Organization and International Cooperation, Types of IPR, Economic importance of IPR

UNIT – 4: Intellectual property laws and its role in development

Patents, Trademarks, Copyright, Designs, Geographical Indications, Other related rights, Prosecution of IPR, Infringement and Enforcement of IPRs, Effect of Intellectual Property Protection in Development, Ideal industrial and institutional setup for Intellectual Property Outcomes, Role of Licensing and commercialization, IP Cells and Technology Transfer Offices, Future scope and career in Intellectual Property Field

BBC-GE02-B

BIOTECHNOLOGY AND HUMAN WELFARE (THEORY)

1. Course Objectives:

The course aims to introduce applications of these techniques in production of recombinant therapeutic proteins and vaccines will also be outlined in this course. The course aims to provide an understanding of the applications of biochemistry in forensic sciences through analysis of evidences, which will help students develop analytical and problem solving skills for real life situation. The course also introduces various environmental pollutants that affect human health.

2. Course Outcomes:

1. Understand the concepts in protein engineering
2. Introduces concept in Forensic sciences
3. Understanding of plant microbe introduction
4. Outline the environmental pollutants affecting human health
5. Understand concepts in gene therapy

3. Course Contents:

TOTAL HOURS: 50 **CREDITS: 04**

UNIT I:

Protein engineering; enzyme and polysaccharide synthesis, activity and secretion, alcohol and antibiotic formation. Forensic science: e.g. solving violent crimes such as murder and rape; solving claims of paternity and theft etc. using various methods of DNA finger printing.

UNIT II:

Nitrogen fixation: transfer of pest resistance genes to plants; interaction between plants and microbes; qualitative improvement of livestock.

UNIT III:

Environments: e.g., chlorinated and non-chlorinated organ pollutant degradation; degradation of hydrocarbons and agricultural wastes, stress management, development of biodegradable polymers such as PHB.

UNIT IV:

Health: e.g., development of non-toxic therapeutic agents, recombinant live vaccines, gene therapy, diagnostics, monoclonal in E. coli, human genome project.

BBC-GE03

SYSTEMS BIOLOGY (THEORY)

1. Course Objectives

The aim of this course is to provide concepts in Systems biology. This course explains that biological systems consist of dynamically interacting networks. This holds true for different levels of organization, from gene and protein interaction through microbes interacting with a host and up to species in large ecosystems. At each level there are networks which interact through feedback and crosstalk. Systems biology requires close interaction between dry modelling and wet experimentation. Mathematical models help to identify key elements that describe and predict the biology of real organisms in real environments.

2. Course Outcomes

After successful completion of this minor students are expected to be able to:

1. understand the basics of Systems Biology approaches in biological systems;
2. understand how the whole of a biological system exceeds the sum of the parts;
3. apply systems approaches to the analysis of biological systems;
4. apply model driven experimentation to solve biological questions;
5. analyse biological systems in a systems-wide manner
6. evaluate and describe results concisely in an oral and written presentations

3. Course Content:

TOTAL HOURS: 50 **CREDITS: 04**

Unit-I: Systems Biology: Concepts and Tools

Concepts of biology- Unity and diversity, General introduction to tools of system biology: Genomics, Proteomic, Metabolomics, Bioinformatics and Modelling.

Unit-II: Databases

General Introduction to Databases: Introduction to Genome, Proteome, Metabolome and EST databases. Metabolic regulation and Flux Balance Analysis

Unit-III: Modelling

General Introduction: Basic Mathematics and programming for computer modelling and simulation: Set theory, algebra of matrices, differential equations, Principles of modelling and simulations, Applications of differential equations in biological and kinetic systems. MATLAB programming for data manipulation, modeling and simulation.

Unit-IV: Systems Biology Applications:

Introduction to personalised medicine: Optimising drug therapies, Reducing adverse drug reactions, Personal genomics and disease diagnosis, Introduction to P4 medicine: Strategies for dealing with biological complexity, P4 medicine, Impact of p4 medicine on society, How to bring p4 medicine to society, Basic concept of systems vaccinology, Spread of Infectious Diseases: Contagion phenomenon in Complex social networks, Large scale spreading of infectious Diseases

BBC-GE03 PR

SYSTEMS BIOLOGY (PRACTICAL)

TOTAL HOURS: 50 **CREDITS: 02**

1. Evolution in bacteria/drosophila population
2. Allosteric enzyme inhibitions
3. Coupled enzyme assays
4. Bacterial growth in different carbon sources

BBC-GE04

INTRODUCTION TO BIOLOGICAL DATA ANALYSIS (THEORY)

1. Course Objectives:

The course will provide concepts in PYTHON language. Python is one of the most powerful and widely used programming languages available. Its easily understood syntax makes it a popular choice for new coders, while its' many open source modules for everything from web development to data analysis make it the tool of choice for many data scientists.

2. Course Outcomes:

1. Students will develop relevant programming abilities.
2. Students will demonstrate proficiency with statistical analysis of data**.**
3. Students will develop the ability to build and assess data-based models**.**
4. Students will execute statistical analyses with professional statistical software.
5. Students will demonstrate skill in data management.
6. Students will apply data science concepts and methods to solve problems in real-world contexts and will communicate these solutions effectively

3. Course Contents:

TOTAL HOURS: 50 **CREDITS: 04**

Unit-I: Introduction to Linux

Introduction to unix shell organization, Introduction to command line and file system, essential unix commands like cal, banner, touch, file, wc, sort, cut, grep, dd, write, wall, introduction to piping, loops, regular expressions, decision commands including various forms of if commands, logical operators and loop control structures.

Unit-II: Basic Python for Biology

Introduction and Environment, Printing and Manipulating text, Reading and Writing files, Lists and Loops, Writing customised functions, Conditional Tests, Regular Expressions, Dictionaries, Files, Programs and user input.

Unit-III: Advanced Python for Biology

Introduction, Recursion and Trees, Complex data structures, Object Oriented Python, Functional Python, Iterators, comprehensions and generators and exception handling.

Unit-IV: Python Development for Biology

Introduction, Environments for developing in Python, Organising and Sharing Code, Testing Code, Performance, Building user interfaces.

Suggested readings

1. Unix Shell Programming by Yashwant Kanetkar
2. Python for Biologists by Martin Jones
3. Advanced Python for Biologists by Martin Jones
4. Python Development for Biologists by Martin Jones

BBC-GE04 PR

INTRODUCTION TO BIOLOGICAL DATA ANALYSIS (PRACTICAL)

TOTAL HOURS: 50 **CREDITS: 02**

1. Introduction to DNA sequencing data analysis
2. Manipulating DNA strings
3. Downloading and parsing genome
4. Sequencing reads in FASTA format
5. Working and analysing sequencing reads
6. Introduction to alignment
7. Boyar Moore basics and its use in DNA sequencing
8. Indexing reads, implementation and variations of k mer indexing
9. Introduction to genome assembly, its laws and shortest common superstring

Suggested readings

1. Python for Biologists by Martin Jones
2. Advanced Python for Biologists by Martin Jones
3. Python Development for Biologists by Martin Jones

BBC-GE05

GENE ORGANIZATION, EXPRESSION AND REGULATION (THEORY)

1. Course Objectives:

The objective of the course is to introduce to the students, the basic concepts of genome, DNA structure, genes, chromatin and chromosomes. It provides comprehensive understanding of DNA replication, recombination, mutations and repair processes in a way that students can apply this knowledge in understanding the life processes and develop an interest to pursue high quality research.

2. Course Learning Outcomes:

1. Students will acquire basic information about the structure of DNA and various forms of DNA, about organization of genome in various life forms, supercoiling of DNA and its significance
2. Students will learn about the molecular basis of processes like DNA replication, recombination and transposition and understand the significance of these processes
3. Students will learn about the various ways in which the DNA can be damaged leading to mutations and lesions and different ways to repair DNA damage

3. Course Contents:

TOTAL HOURS: 50 **CREDITS: 04**

Unit-I: Structure of genes and chromosomes; replication

Definition of a gene, chromosomal organization of genes in viruses, bacteria and eukaryotes. Supercoiling of DNA. General features of DNA replication, properties of prokaryotic and eukaryotic DNA polymerases. Replication of DNA and telomeres in linear chromosomes. Replication of RNA genomes. Homologous genetic recombination, Holliday model, proteins and enzymes mediating recombination.

Unit-II: Transcription of genes, Gene mutations and repair

General features of gene transcription, prokaryotic and eukaryotic RNA polymerases, stages of transcription, initiation, elongation and termination. Inhibitors of transcription. Molecular basis of mutations, multiple repair systems, mismatch repair, base excision repair, nucleotide excision repair, direct repair and trans-lesion DNA synthesis.

Unit-III: RNA processing and Protein synthesis

Processing of eukaryotic mRNA, splicing of introns, alternate splicing and editing, ribosomal and tRNA processing. Features of the genetic code, amino acylation of tRNAs, structure and assembly of ribosomes; three stages of protein synthesis - initiation, elongation and termination. Inhibitors of protein synthesis.

Unit-IV: Regulation of gene expression

Regulation of transcription in prokaryotes, concept of operons. Lac operon - control by negative and positive regulatory proteins, Trp operon - control by attenuation. Regulation of transcription in eukaryotes, regulatory sequences - enhancers, silencers response elements, nucleosome alterations, DNA-protein interactions and RNA interference.

BBC-GE05 PR

GENE ORGANIZATION, EXPRESSION AND REGULATION (PRACTICAL)

TOTAL HOURS: 50 **CREDITS: 02**

1. Quantitative determination of DNA and RNA by absorbance at 260 nm and using A_{260}/A_{280}ratio to distinguish between them.
2. Estimation of DNA by DPA method.
3. Estimation of RNA by Orcinol.
4. Isolation of chromosomal DNA from *E. coli.*
5. Isolation of total RNA from yeast cells.

Suggested readings

1. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN:13; 978-1-4641-0962-1 / ISBN:10-14641-0962-1.
2. Biochemistry (2012) 7th ed., Berg, J.M., Tymoczko, J.L. and Stryer, L., W.H Freeman and Company (New York), ISBN: 13:978-1-4292-7635-1.

BBC-GE06

FUNDAMENTALS OF CELL BIOLOGY AND IMMUNOLOGY (THEORY)

1. Course Objectives

The objective of this paper is to offer insights into the basic structure and function of a cell and cellular organelles. The course will also provide the basic framework in immunology that will cover the major topics including innate and adaptive immunity

2. Course Outcomes:

1. Learn about cell theory and basic cell structure
2. Be introduced to cell fractionation and cell visualization techniques
3. Gain knowledge about the structure and function of various cell organelles in an Eukaryotic cell.
4. Have an overview of the immune system including cells, organs and receptors.
5. Describe the basic mechanism, differences and functional interplay of innate and
6. adaptive immunity
7. Understand Antigens & its Recognition, antigen processing and presentation
8. Understand the structure & functions of different classes of Immunoglobulins,
9. and understand the genetic basis of antibody diversity

3. Course Contents:

TOTAL HOURS: 50 **CREDITS: 04**

Unit-I: Cells and Organelles

Prokaryotic and eukaryotic cells. Plasma membrane, the nucleus, intracellular membranes and organelles, mitochondria, chloroplast, endoplasmic reticulum: rough and smooth, Golgi complex: Role of Golgi in protein glycosylation and protein trafficking, lysosome, peroxisome, cytoskeleton, extracellular matrix, cell wall. Mitosis and meiosis.

Composition of membranes, membrane lipids, membrane proteins, isolation and characterization. Integral, peripheral and lipid anchored protein. Transport across membranes, simple and facilitated diffusion, active transport.

Unit-II: Signalling Mechanisms, Messengers and Receptors

Chemical signals and cellular receptors. G-protein linked receptors, protein kinase associated receptors. Hormonal signaling, cell signals and apoptosis. Overview of the cell cycle. Regulation of the cell cycle, cyclin dependent kinases.

Unit-III: Overview of the Immune System

Self versus non-self. Humoral and cellular immunity. Innate and adaptive immunity. Cells of the immune system, primary and secondary lymphoid tissues and organs. Cellular and humoral responses. Defensins. Non-immunological barriers. Cells and soluble mediators of innate immunity. Acute phase proteins. Cytokines. Complement system.

Unit-IV: Humoral and Cell Mediated Immunity

Structure of antibodies, types of immunoglobulins, generation of antibody diversity, B cell activation, theory of clonal selection, formation of plasma and memory cells; T-independent B-response;

antigens, haptens carriers and adjuvants. T-cell development, MHC locus. Structure, function and distribution of MHC glycoproteins. Antigen processing and presentation. Cell mediated immune responses by different T-cell subpopulations. Hypersensitive reactions. Concept of autoimmunity.

BBC-GE06 PR

FUNDAMENTALS OF CELL BIOLOGY AND IMMUNOLOGY (PRACTICAL)

TOTAL HOURS: 50 **CREDITS: 02**

1. Visualization of animal and plant cell by methylene blue.
2. Identification of different stages of mitosis in onion root tip.
3. Isolation of organelles by sub-cellular fractionation.
4. Isolation of IgG from serum by ion exchange chromatography.
5. Antigen-antibody interaction by Ouchterlony double diffusion.
6. Blood group analysis by agglutination.

Suggested readings

1. The World of the Cell (2009), 7th ed., Becker W.M., Kleinsmith, L.J., Hardin., J., Bertoni, and G.P., Pearson Benjamin Cummings (CA), ISBN: 978-0-321-55418-5.
2. Prescott, Harley, Klein's Microbiology (2008) 7th Ed., Willey, J.M., Sherwood, L.M., Woolverton, C.J. Mc Graw Hill International Edition (New York) ISBN: 978-007-126727.
3. Molecular Cell Biology (2013) 7th Ed., Lodish, H., Berk, A., Kaiser, C.A., Krieger, M., Bretscher, A., Ploegh, H., Amon, A. and Scott, M.P., Macmillan International Edition (NewYork), ISBN:13: 978-1-4641-0981-2.
4. Kuby Immunology (2007) 6th ed., Kindt, T.L., Goldsby, R.A. and Osborne, B.A., W.H Freeman and Company (New York), ISBN:13: 978-0-7167-8590-3 / ISBN: 10:0-7617-8590-0.
5. Immunology: A Short Course (2009) 6th ed., Coico, R and Sunshine, G., John Wiley& sons, Inc (New Jersey), ISBN: 978-0-470-08158-7.

BBC-GE07

FUNDAMENTALS OF GENETIC ENGINEERING (THEORY)

1. Course objectives:

The objective of the course is to teach the basics of theoretical and practical aspects of recombinant DNA technology and various techniques for DNA manipulation in prokaryotes. Applications of these techniques in production of recombinant therapeutic proteins and vaccines will also be outlined in this course.

2. Course Learning Outcome

The students will be able to understand:

1. The process for isolation and engineering of DNA using restriction and modification enzymes.
2. Use of cloning and expression vectors.
3. The methods for creation of genomic and cDNA libraries, their applications and use.
4. Understanding the methods for protein production and their application in industrial production systems.

3. Course Contents

TOTAL HOURS: 50 **CREDITS: 04**

Unit-I: Introduction to Recombinant DNA Technology

Overview of recombinant DNA technology. Plasmids and bacteriophage DNA as cloning vectors, pBR322, pUC8. Purification of plasmid and bacteriophage DNA. Enzymes used in manipulating DNA, separation by electrophoresis.

Unit-II: Cloning Vectors for Prokaryotes and Eukaryotes

Plasmids and bacteriophages as vectors for gene cloning. Cloning vectors based on *E. coli*plasmids, pBR322, pUC8, pGEM3Z. Cloning vectors based on M13 and λ bacteriophage. Vectors for yeast, higher plants and animals. Ligation of DNA molecules. Transformation and electroporation, selection for transformed cells. Identification for recombinants, blue-white selection. Identification of recombinant phages. Direct selection, marker rescue. Gene libraries. Identification of a clone from gene library, colony and plaque hybridization probing, methods based on detection of the translation product of the cloned gene.

Unit-III: Polymerase Chain Reaction, DNA Sequencing and Expression of Cloned Genes

Fundamentals of polymerase chain reaction, designing primers for PCR. Analysis of PCRproducts. DNA sequencing by Sanger's method and automated DNA sequencing. Vectors for expression of foreign genes in *E. coli*, cassettes and gene fusions. Challenges in producing recombinant protein in *E. coli*. Production of recombinant protein by eukaryotic cells. Fusion tags and their role in purification of recombinant proteins.

Unit-IV: Applications of Genetic Engineering in Biotechnology

Expression of cloned genes. Vectors for expression of foreign genes in *E coli*, cassettes and gene fusions. Production of recombinant pharmaceuticals such as insulin. Gene therapy. Genetically modified plants such as herbicide resistant crops.

BBC-GE07 PR

FUNDAMENTALS OF GENETIC ENGINEERING (PRACTICAL)

TOTAL HOURS: 50 **CREDITS: 02**

1. Ultraviolet absorption spectrum of DNA and RNA.
2. Isolation of plasmid DNA and restriction digestion.
3. Amplification of a DNA fragment by PCR
4. Virtual lab exercise on recombinant DNA techniques.

Suggested readings

1. Molecular Biology of the Gene (2008) 6th ed., Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R., Cold Spring Harbor Laboratory Press, Cold Spring Harbor (New York), ISBN:0-321-50781 / ISBN: 978-0-321-50781-5.
2. Gene Cloning and DNA Analysis (2010) 6th ed., Brown, T.A., Wiley-Blackwell Publishing (Oxford, UK), ISBN: 978-1-4051-8173-0.
3. Principles of Gene Manipulation and Genomics (2006) 7th ed., Primrose, S. B., and Twyman, R. M., Blackwell publishing (Oxford) ISBN: 13: 978-1-4051-3544-3.
4. Molecular Biotechnology: Principles and Applications of Recombinant DNA (2010) 4th ed., Glick B.R., Pasternak, J.J. and Patten, C.L., ASM Press (Washington DC), ISBN: 978-1-55581-498-4 (HC).

BBC-GE08

BIOCHEMICAL CORRELATIONS IN DISEASES (THEORY)

1. Course Objective

This course provides students with knowledge and understanding of various human diseases. It will introduce the concepts of a well-balanced diet, healthy lifestyle, biochemical basis of diseases, treatment strategies, mechanism of action of drugs and drug resistance against various antimicrobials. The course also aims to outline the various strategies that are employed for preventing infectious and non-infectious diseases.

2. Course Learning Outcomes

1. Students will develop understanding about the importance of balanced diet, regular exercises and healthy lifestyle.
2. Students will gain insight into various disorders associated with imbalanced diet and poor lifestyle.
3. Students will learn various strategies employed for preventing various human diseases.
4. Students will understand the molecular basis of microbial pathogenicity, drug resistance and implications in public health management.
5. Students should be able to handle and solve analytical problems related to theory classes.

3. Course Content

TOTAL HOURS: 50 **CREDITS: 04**

Unit-I: Inborn Errors of Metabolism and Diseases Caused Due to Misfolded Proteins

Alkaptonuria, Phenylketonuria, Glycogen and Lipid storage diseases, SCID, Clotting disorders. Alzheimer's, Huntington's disease, Kuru, Creutzfeldt-Jakob disease, Sickle cell anaemia, Thalessemia.

Unit-II: Nutritional Deficiency Based Diseases and Autoimmune Diseases

Kwashiorkar, Marasmus, Beri-beri, Scurvy, Pellagra, Anaemia, Night blindedness, Rickets, Osteomalacia, Osteoporosis, Wilson's disease. Concepts in immune recognition - self and non self-discrimination, organ specific autoimmune diseases – Hashimoto's thyroiditis, Grave's disease, Myasthenia Gravis;. Systemic diseases -SLE, rheumatoid arthritis; Diabetes Mellitus-I.

Unit-III: Hormonal Imbalances and Life style Diseases

Outline of hormone action and imbalances leading to disease - precocious puberty, hyper and hypopituitarism. Hyper and hypothyroidism. Obesity, Cardiovascular diseases, Atherosclerosis, Diabetes mellitus-II. Inflammatory Bowel Disease (IBD).

Unit-IV: Infectious Diseases

Viral infection (polio, measles, mumps, influenza, HIV); Bacterial infections (tetanus, diphtheria, tuberculosis, typhoid, cholera); Protozoan (*Plasmodium* and *Trypanosoma*) and parasitic infections. Vaccines against diseases. General strategies in the design and development of vaccines.

BBC-GE08 PR

BIOCHEMICAL CORRELATIONS IN DISEASES (PRACTICAL)

TOTAL HOURS: 50 **CREDITS: 02**

1. Glucose tolerance test.
2. Lipid profile: triglycerides and total cholesterol.
3. Obesity parameters; BMI.
4. RBC counting and haemoglobin estimation.
5. Blood pressure measurements.
6. Calcium estimation

Suggested readings

1. Textbook of Biochemistry with Clinical Correlations (2011) Devlin, T.M. John Wiley & Sons, Inc. (New York), ISBN: 978-0-4710-28173-4.
2. Immunology: A Short Course (2009) 6th ed., Coico, R and Sunshine, G., John Wiley& sons, Inc (New Jersey), ISBN: 978-0-470-08158-7
3. Biochemistry (2012) 7th ed., Berg, J.M., Tymoczko, J.L. and Stryer, L., W.H Freeman and Company (New York), ISBN: 13:978-1-4292-7635-1.
4. Genetics (2012) 6th ed., Snustad, D.P. and Simmons, M.J., John Wiley & Sons. (Singapore), ISBN: 978-1-118-09242-2.

B.Sc. (Honors) component of B.Sc.-M.Sc. Integrated Biochemistry
(CBCS STRUCTURE)

ABILITY ENHANCEMENT COMPULSORY COURSE

BBC-AEC01

ENGLISH COMMUNICATION

1. Course Objective:
To enable the students of management to speak and write with a fair degree of grammatical correctness. Upon completion of the course, the students have sufficient knowledge for professional communication to excel in the chosen profession

2. Course Outcomes:

1. Apply tenses during their communication and writing.
2. Apply clauses for better communication.
3. Apply structural items to sentences.
4. Apply knowledge of reported speech for better communication skills.
5. Demonstrate writing kills in English.

3. Course Content:

TOTAL HOURS: 50 **CREDITS: 02**

Unit-I: Communication, Language and Speaking skills

Introduction: Theory of Communication, Types and modes of Communication
Language of Communication: Verbal and Non-verbal (Spoken and Written) Personal, Social and Business Barriers and Strategies Intra-personal, Inter-personal and Group communication
Speaking Skills: Monologue, Dialogue Group Discussion, Effective Communication/ Mis-Communication Interview, Public Speech

Unit-II: Reading and Writing skills

Reading and Understanding: Close Reading, Comprehension, Summary Paraphrasing, Analysis and Interpretation, Translation (from Indian language to English and vice-versa)
Literary/Knowledge Texts
Writing Skills: Documenting, Report Writing, Making notes, Letter writing

Suggested readings

1. Fluency in English - Part II, Oxford University Press, 2006.
2. Business English, Pearson, 2008.
3. Language, Literature and Creativity, Orient Blackswan, 2013.
4. Language through Literature (forthcoming) ed. Dr. Gauri Mishra, Dr. Ranjana Kaul, Dr. Brati Biswas

BBC-AEC02

ENVIORNMENTAL SCIENCES

1. Course Objectives

The objective of the course is to acquaint the student with a basic understanding of the concept and structure of environment. The course will help the student to develop and understanding about the significance of the development of environmental science as a discipline. The global environmental issues and disasters will also be introduced to the students through the course.

2. Course Outcomes

1. Describe natural resources, food resources, land resources and energy resources.
2. Classify various biodiversity and its conservation.
3. Explain different types of pollution, their causes, effects and control measures.
4. Discuss environmental issues, pollution, ethics, water conservation and global warming.

3. Course Content

TOTAL HOURS: 50 **CREDITS: 02**

Unit-I: Natural Resources: Renewable and Non Renewable Resources

Definition, scope and importance, Need for public awareness.

Natural resources and associated problems: Forest resources: Use and over-exploitation, deforestation, case studies, Timber extraction, mining, dams and their effects on forests, and tribal people. Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dam's benefits and problems. Mineral Resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies. Food Resources: World food problems, changes caused by agriculture and over grazing, effects of modern agriculture, fertilizers- pesticides problems, water logging, salinity, case studies. Energy Resources: Growing energy needs, renewable and nonrenewable energy sources, use of alternate energy sources, case studies. Land Resources: Land as a resource, land degradation, man induced landslides, soil erosion, and desertification.

Role of individual in conservation of natural resources.

Equitable use of resources for sustainable life styles.

Unit-II: Eco Systems

- Concept of an eco-system
- Structure and function of an eco-system.
- Producers, consumers, decomposers.
- Energy flow in the eco systems.
- Ecological succession.
- Food chains, food webs and ecological pyramids.
- Introduction, types, characteristic features, structure and function of the following eco systems:

- Forest ecosystem
- Grass land ecosystem
- Desert ecosystem.
- Aquatic eco systems (ponds, streams, lakes, rivers, oceans, estuaries)

Unit-III: Biodiversity and its conservation

- Introduction-Definition: genetics, species and ecosystem diversity.
- Biogeographically classification of India.
- Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values
- Biodiversity at global, national and local level.
- India as a mega diversity nation.
- Hot-spots of biodiversity.
- Threats to biodiversity: habitats loss, poaching of wild life, man wildlife conflicts.
- Endangered and endemic spaces of India.
- Conservation of biodiversity: in-situ and ex-situ conservation of biodiversity.

Unit-IV: Environmental pollution

- Definition Causes, effects and control measures of: Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear hazards
- Solid waste Management: Causes, effects and control measures of urban and industrial wastes
- Role of an individual in prevention of pollution
- Pollution case studies
- Disaster management: Floods, earth quake, cyclone and land slides

Suggested Readings

1. Textbook of Environmental studies, Erach Bharucha, UGC
2. Fundamental concepts in Environmental Studies, D D Mishra, S Chand & Co Ltd

B.Sc. (Honors) component of B.Sc.-M.Sc. Integrated Biochemistry
(CBCS STRUCTURE)

SKILL ENHANCEMENT COURSES
(Three-hour class with one hour theory and two-hour practical)

BBC-SEC01

TOOLS AND TECHNIQUES IN BIOCHEMISTRY

1. Course Objectives:

The objective of the course is to introduce to the students, to preparation of reagents, pH, buffer. The course also describes concepts in spectrophotometric analysis. The course also introduces concepts in virtual lab. These concepts will help in understanding of the techniques and laboratory skills in the field of biochemistry

2. Course Learning Outcomes:

The course is designed for undergraduate students to learn the basic concepts of various techniques used in Biochemistry. The course will enable students to:

1. Acquire knowledge about the principles and applications of spectrophotometric techniques used in a biochemistry lab.
2. Learn about the principle and applications of biochemical reagent preparation.
3. The course also introduces concepts of virtual lab to students
4. Obtain hands-on-experience and laboratory skills expected of any biochemist working in a research lab.

3. Course Contents

TOTAL HOURS: 15 h theory + 30 h practical **CREDITS: 02**

Unit-I: Biochemical Reagents and Solutions

Safety practices in the laboratory. Concepts of solution, Concentration, Stock and working solutions, serial dilutions. Quantitative transfer of liquids. Concept of a pH and buffer, Acid-base equilibrium, Henderson-Hasselbach equation.

Unit-II: Spectrophotometric Techniques and Virtual Lab

Principle and instrumentation of UV-visible and fluorescence spectroscopy. Introduction and importance of virtual labs in biochemistry: Introduction to protein databases and description of PDB file format; In-silico Molecular Visualization tools; Molecular Docking and its application; Retrieval and analysis of DNA and Protein sequences (PubMed and MGI); BLAST and Multiple Sequence Alignment.

Suggested readings

1. Physical Biochemistry: Principles and Applications (2010) 2nd ed., Sheehan, D., WileyBlackwell (West Sussex), ISBN:978-0-470-85602-4 / ISBN:978-0-470-85603-1.
2. Physical Biochemistry: Applications to Biochemistry and Molecular Biology (1982) 2nd ed., Freifelder, D., W.H. Freeman and Company (New York), ISBN:0-7167-1315-2 / ISBN:0-7167-1444-2.
3. An Introduction to Practical Biochemistry (1998) 3rd ed., Plummer D. T., Tata McGraw Hill Education Pvt. Ltd. (New Delhi), ISBN:13: 978-0-07-099487-4 / ISBN:10: 0-07-099487-0.

BBC-SEC02

PROTEIN PURIFICATION TECHNIQUES

1. Course Objectives:

The course aims to provide concepts in protein purification techniques. The course introduces concepts in various types of chromatography techniques used in protein purification. The course also introduces basic concepts in high performance liquid chromatography

2. Course Outcomes:

Upon course completion students should be able to
1. Understand the need for protein purification
2. Learn about concepts and principle of various chromatography techniques
3. Understand the concept and principles of electrophoresis
4. Students will also be introduced to principles and components of HPLC

3. Course Contents:

TOTAL HOURS: 15 h theory + 30 h practical **CREDITS: 02**

Unit-I: Purification and characterization of a protein from a complex mixture (native or heterologous expressed)
Exercises: Preparation of the sample, Ion-exchange chromatography, Gel filtration chromatography, Affinity chromatography, Electrophoresis.

Unit-II: Demonstration of High Performance Liquid Chromatography (HPLC)

Suggested readings

1. Physical Biochemistry: Principles and Applications (2010) 2nd ed., Sheehan, D., Wiley Blackwell (West Sussex), ISBN:978-0-470-85602-4 / ISBN:978-0-470-85603-1.
2. Physical Biochemistry: Applications to Biochemistry and Molecular Biology (1982) 2nd ed., Freifelder, D., W.H. Freeman and Company (New York), ISBN:0-7167-1315-2 / ISBN:0-7167-1444-2.
3. An Introduction to Practical Biochemistry (1998) 3rd ed., Plummer D. T., Tata McGraw Hill Education Pvt. Ltd. (New Delhi), ISBN:13: 978-0-07-099487-4 / ISBN:10: 0-07-099487-0.

BBC-SEC03

CLINICAL BIOCHEMISTRY

1. Course Objectives:

The course aims to train the students to gain concepts of assessing the human physiology using biological fluid. The course also illustrates the mechanism of metabolic disorders at molecular level. It facilitates in employability in diagnostic and research institutes.

2. Course Outcomes:

Discuss the fundamental biochemistry knowledge related to health
1. Explain the clinical significance of the laboratory tests.
2. Diagnosis of clinical disorders by estimating biomarkers
3. Determine various substances including substrates, enzymes, hormones, etc and their use in diagnosis and monitoring of disease are applied.
4. Evaluate the abnormalities which commonly occur in the clinical field
5. Review the information from each category of tests and develop a protocol for disease diagnosis
6. Create awareness of different lifestyle diseases increasingly found in present day

3. Course Content:

TOTAL HOURS: 15 h theory + 30 h practical **CREDITS: 02**

Unit-I: Introduction to Clinical Biochemistry

Organization of clinical laboratory, Introduction to instrumentation and automation in clinical biochemistry laboratories safety regulations and first aid. General comments on specimen collection, types of specimen for biochemical analysis. Precision, accuracy, quality control, precautions and limitations. Collection of blood and storage.
Exercises: Separation and storage of serum.

Unit-II: Evaluation of Biochemical Changes in Diseases

Basic hepatic, renal and cardiovascular physiology. Biochemical symptoms associated with disease and their evaluation. Diagnostic biochemical profile. Clinical significance of variations in blood glucose (Diabetes mellitus).Composition and functions of lipoproteins. Clinical significance of elevated lipoprotein.
Exercises: Estimation of blood glucose by glucose oxidase peroxidase method, Estimation of triglycerides, Estimation of bilirubin (direct and indirect)**,** Use of urine strip / dipstick method for urine analysis**,** Quantitative determination of serum creatinine and urea.

Suggested readings

1. Medical Laboratory Technology - a Procedure Manual for Routine Diagnostic Tests Vol. I(2010), Mukherjee, K.L., Tata Mc Graw–Hill Publishing Company Limited (New Delhi). ISBN:9780070076594 / ISBN:9780070076631
2. Medical Laboratory Technology - a Procedure Manual for Routine Diagnostic Tests VoI. II (2010), Mukherjee, K.L., Tata Mc Graw – Hill Publishing Company Ltd. (New Delhi), ISBN: 9780070076648.

3. Medical Biochemistry (2005) 2nd ed., Baynes, J.W. and Dominiczak, M.H., Elsevier Mosby Ltd. (Philadelphia), ISBN:0-7234-3341-0.
4. Experimental Biochemistry: A Student Companion (2005) Rao, B.S. and Deshpande, V., IK International Pvt. Ltd. (New Delhi), ISBN:81-88237-41-8.

BBC-SEC04

RECOMBINANT DNA TECHNOLOGY

1. Course Objectives:

1. To familiarize the students to versatile tools and techniques employed in genetic engineering and recombinant DNA technology.
2. A sound knowledge on procedural repertoire allows students to innovatively apply these in basic and applied fields of biological research.
3. This course offers theoretical bases to properties and applications of versatile DNA modifying enzymes, cloning strategies, vector types, host genotype specificities for selection and screening of recombinants and/or recombinant transformants.
4. Students will also be introduced to prominent nucleic acid labeling techniques. Introduction to various types of vectors viz.cloning, transformation, expression; and also vectors for genomic and cDNA library and whole genome sequencing will be provided.
5. A critical appraisal of methods for site-directed mutagenesis and sequencing of cloned genomic fragments will also be covered.
6. This course may be deemed as a basic course serving as a platform for introduction of more advanced cutting-edge technologies that essentially are unification of basic techniques combined in diverse forms and sequence; to be introduced later in the program.

2. Course Outcomes:

1. Understand the difference between old biotechnology and modern biotechnology. ¬ Design an experiment with step-by-step instructions to address a research problem.
2. Provide examples of current applications of biotechnology and advances in the different areas like medical, microbial, environmental, bioremediation, agricultural, plant, animal, and forensic.
3. Provide examples on how to use microbes and mammalian cells for the production of pharmaceutical products.
4. Explain the general principles of generating transgenic plants, animals and microbes. ¬ Technical know-how on versatile techniques in recombinant DNA technology.
5. An understanding on application of genetic engineering techniques in basic and applied experimental biology.

3. Course Content:

TOTAL HOURS:15 h theory + 30 h practical **CREDITS: 02**

Unit-I: Bacterial Culture Techniques

Preparation of Media, Antibiotic Solution, Culturing of *E. coli*, Isolation of Single Colonies, Overview of plasmid vectors and methods of isolation, Characterization of plasmid by gel electrophoresis.
Exercises: Preparation of LB broth and agar, Inoculation of medium, Preparation of glycerol stocks of bacterial strains, obtaining isolated colonies by streak plate method, Preparation of stock solutions, Isolation of plasmid by alkaline lysis method, Isolation of plasmid DNA using column chromatography (kit), Digestion of plasmid DNA with restriction enzymes and analysis of the fragments.

Unit II: Cloning of a Gene in a Vector and Functional Analysis

Polymerases chain reaction (parametric optimization, primer designing), ligation, introduction of DNA construct into host cells, selection of recombinants.

Exercises: Amplification of DNA segment/gene of interest by PCR, Purification of PCR product, digestion of insert and vector by restriction enzymes for directional cloning, purification of insert and digested vector by gel extraction, Ligation of vector and insert, Preparation of competent cells of *E. coli* DH5α and transformation with the ligation mixture, Functional selection of recombinants (blue/white selection and eGFP fluorescence).

Suggested readings

1. Molecular Cloning: A laboratory Manual (2012) Vol. 1-3, 4th ed., Green M.R. and Sambrook J., Cold Spring Harbour Laboratory Press (New York). ISBN: 978-1-936113-41-5 / ISBN:978-1-936113-42-2.