Kalinga University Atal Nagar (C.G.)

SCHEME OF EXAMINATION & SYLLABUS

of

B.Sc. Biochemistry

UNDER

Faculty of Science

w.e.f. Session 2021-22

Kalinga University, Naya Raipur
B.Sc. Biochemistry

First Semester					
Paper Code	**SUBJECTS**	**Credits**	**Internal Marks**	**External Marks**	**Total**
BSBC101	Molecules of Life	4	30	70	100
BSBC102	Cell Biology	4	30	70	100
	(Choose Any One) 103A/103B	2	15	35	50
BSBC103A	English				
BSBC103B	NCC				
BSBC104	Metabolism of Carbohydrates and Lipids	4	30	70	100
BSBC106P	Molecules of Life- Lab	1	20	30	50
BSBC107P	Cell Biology-Lab	1	20	30	50
BSBC108P	Metabolism of Carbohydrates and	1	20	30	50
	Total	**17**	**165**	**335**	**500**

Second Semester					
Paper Code	**SUBJECTS**	**Credits**	**Internal Marks**	**External Marks**	**Total**
BSBC201	Proteins and Enzymes	4	30	70	100
	(Choose Any One) 202A/202B	2	15	35	50
BSBC202A	Environmental Science				
BSBC202B	NCC				
BSBC203	Biochemical Correlation of Diseases	4	30	70	100
	Elective-I (Any One)	4	30	70	100
BSBC204A	Biomolecules				
BSBC204B	Techniques in Biochemistry				
BSBC205P	Proteins and Enzymes -Lab	1	20	30	50
BSBC206P	Biochemical Correlation of	1	20	30	50
	Practical Elective-I (Any One)	1	20	30	50
BSBC207P	Biomolecules- Lab				
BSBC204A	Techniques in Biochemistry- Lab				
	Total	**17**	**165**	**335**	**500**

Third Semester					
Paper Code	**SUBJECTS**	**Credits**	**Internal Marks**	**External Marks**	**Total**
BSBC301	Membrane Biology and Bioenergetics	4	30	70	100
BSBC302	Hormone: Biochemistry and Function	4	30	70	100
BSBC303	Fundamental of IT	3	30	70	100
	Elective-II (Any One) BSBC304A, BSBC30B	3	30	70	100
BSBC304A	Biostatistics				
BSBC304B	Research Methodology				
	Elective-III (Any One) BSBC305A,	4	30	70	100
BSBC305A	Intermediary Metabolism				
BSBC305B	Biochemical Applications in				
BSBC306P	Membrane Biology and	1	20	30	50
BSBC307P	Hormone: Biochemistry and	1	20	30	50
BSBC308P	Fundamental of IT-Lab	1	20	30	50
BSBC309P(A)	Biostatistics-Lab	1	20	30	50
BSBC309P(B)	Research Methodology-Lab				
BSBC310P(A)	Intermediary Metabolism-Lab	1	20	30	50
BSBC310P(B)	Biochemical Applications in				
	Total	**23**	**250**	**500**	**750**

Fourth Semester					
Paper Code	**SUBJECTS**	**Credits**	**Internal Marks**	**External Marks**	**Total**
BSBC401	Human Physiology	4	30	70	100
BSBC402	Gene Organization, Replication and Repair	4	30	70	100
BSBC403	Metabolism of Amino Acids and Nucleotides	4	30	70	100
	Elective-IV(Any One) BSBC404A, BSBC404B	3	30	70	100
BSBC404A	Bioinformatics				
BSBC404B	Microbial Techniques				
	Elective-V(Any One) BSBC405A,	4	30	70	100
BSBC405A	Biochemical Techniques				
BSBC405B	Recombinant DNA Technology				
BSBC406P	Human Physiology-Lab				
BSBC407P	Gene Organization, Replication and	1	20	30	50
BSBC408P	Metabolism of Amino Acids and	1	20	30	50
BSBC409P(A)	Bioinformatics Lab	1	20	30	50
BSBC409P(B)	Microbial Techniques Lab				
BSBC410P(A)	Biochemical Techniques Lab	1	20	30	50
BSBC410P(B)	Recombinant DNA Technology-Lab				
	Total	**23**	**230**	**470**	**700**

Fifth Semester					
Paper Code	**SUBJECTS**	**Credits**	**Internal Marks**	**External Marks**	**Total**
BSBC501	Concepts in Genetics	4	30	70	100
BSBC502	Gene Expression and Regulation	4	30	70	100
	Elective-VI (Any Two) BSBC504A, BSBC504B, BSBC504C	6	60	140	200
BSBC503A	Nutritional Biochemistry				
BSBC503B	Advanced Cell Biology				
BSBC503C	Microbiology				
BSBC504P	Concepts in Genetics-Lab	1	20	30	50
BSBC505P	Gene Expression and Regulation-	1	20	30	50
BSBC506P(A)	Nutritional Biochemistry-Lab	2	40	60	100
BSBC506P(B)	Advanced Cell Biology-Lab				
BSBC506P(C)	Microbiology-Lab				
	Total	**18**	**200**	**400**	**600**

Sixth Semester					
Paper Code	**SUBJECTS**	**Credits**	**Internal Marks**	**External Marks**	**Total**
BSBC601	Genetic Engineering and Biotechnology	4	30	70	100
BSBC602	Immunology	4	30	70	100
	Elective-VII (Any Two) BSBC604A, BSBC604B, BSBC604C	6	60	140	200
BSBC603A	Molecular Basis of Infectious Diseases				
BSBC603B	Plant Biochemistry				
BSBC603C	Advanced Methodologies				
BSBC604P	Genetic Engineering and Biotechnology-Lab	1	20	30	50
BSBC605P	Immunology-Lab	1	20	30	50
BSBC606P(A)	Molecular Basis of Infectious	2	40	60	100
BSBC606P(B)	Plant Biochemistry-Lab				
BSBC606P(C)	Advanced Methodologies-Lab				
BSBC607P	Project /Dissertation	**4**	**50**	**100**	**150**
	Total	**22**	**200**	**400**	**600**

Molecules of Life
(BSBC-101)

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.

Course Learning Outcomes

On successful completion of the course students will be:
Acquainted with chemical and molecular foundations of life and appreciate the role of water in biological systems. Able to comprehend the structure, function and acid base properties of amino acids.
Introduced to the structure, properties and roles of carbohydrates, lipids and nucleic acids.
Aware of the importance of vitamins in biological systems. Able to independently identify and quantitate various biomolecules in the laboratory.

UNIT I : The foundations of biochemistry

Cellular and chemical foundations of life, Water: unique properties, weak interactions in aqueous systems, ionization of water, buffering action in biological system, water as a reactant and fitness of the aqueous environment.

UNIT II: Amino Acids

Structural features and classification; Physical properties, optical properties (Stereoisomerism); Chemical properties (acid base properties, titration curve) of amino acids; Uncommon amino acids and their functions

UNIT III: Carbohydrates and Glycobiology

Monosaccharides - structure of aldoses and ketoses; Ring structure of sugars, conformations of sugars, mutarotation, anomers, epimers and enantiomers; Structure of biologically important sugar derivatives, oxidation and reduction of sugars; Formation of disaccharides, reducing and non-reducing disaccharides; Polysaccharides – homo- and heteropolysaccharides, structural and storage polysaccharides; Structure and role of glycoconjugates - proteoglycans, glycoproteins and glycolipids (gangliosides and lipopolysaccharides); Carbohydrates as informational molecules.

UNIT IV: Lipids

Building blocks of lipids - fatty acids, glycerol, ceramide; Storage lipids - triacyl glycerol and waxes; Structural lipids in membranes – glycerophospholipids; Galactolipids and sulpholipids, etherlipids, sphingolipids and sterols, structure, distribution and role of membrane lipids. Plant steroids; Lipids as signals, cofactors and pigments.

UNIT V: Nucleic Acids

Nucleotides - structure and properties of bases, pentoses, nucleosides; Nucleic acid structure – Watson-Crick model of DNA, forms 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 and second messengers.

Vitamins

Structure and active forms of water soluble and fat soluble vitamins; Deficiency diseases and symptoms, hypervitaminosis

References

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.
Textbook of Biochemistry with Clinical Correlations (2011) 7th ed., Devlin, T.M., John Wiley & Sons, Inc. (New York), ISBN:978-0-470-28173-4.

PRACTICALS

Molecules of Life
(BSBC-106P)

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

Cell Biology
(BSBC-102)

Course Outcome

This course presents the types and structural details of the basic unit by which all the living things are made of (the cell). Goals: To make the student to understood the concept of cell and their activities. This course presents the types and structural details of the basic unit by which all the living things are made of (the cell).To make the student to understood the concept of cell and their activities.

UNIT I **(10 Periods)**

Cell: **I**ntroduction and classification of organisms by cell structure, cytosol, Compartmentalization of eukaryotic cells, cell fractionation. Cell Membrane and Permeability: Chemical components of biological membranes, organization and Fluid Mosaic Model, membrane as a dynamic entity,

UNIT II **(15 Periods)**

Cell recognition and membrane transport. Membrane Vacuolar system, cytoskeleton and cell motility: Structure and function of microtubules, Microfilaments, Endoplasmic reticulum: Structure, function including role in protein segregation. Golgi complex: Structure, biogenesis and functions including role in protein secretion.

UNIT III **(15 Periods)**

Lysosomes: Vacuoles and micro bodies: Structure and functions Ribosomes: Structures and function including role in protein synthesis.Mitochondria & Chloroplasts: Structure and function, genomes, Nucleus: Structure and function, chromosomes and their structure.

UNIT IV **(10 Periods)**

Structure and function, Genomes, biogenesis Extracellular Matrix: Composition, molecules that mediate cell adhesion, Membrane receptorsfor extra cellular matrix, Macromolecules,

UNIT V **(10 Periods)**

Regulation of receptor expression and function. Signal transduction. Cancer: Carcinogenesis, agents promoting carcinogenesis, Characteristics and molecular basis of cancer.

SUGGESTED READING

1. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. JohnWiley & Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8thedition.Lippincott Williams and Wilkins, Philadelphia.

3. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition.ASMPress & Sunderland, Washington, D.C.; Sinauer Associates, MA.
4. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009. The World of the Cell. 7thedition. Pearson Benjamin Cummings Publishing, San Francisco.

PRACTICALS

Cell Biology
(BSBC-107P)

List of experiments:

1. Study the effect of temperature and organic solvents on semi permeable membrane.
2. Demonstration of dialysis.
3. Study of plasmolysis and de-plasmolysis.
4. Cell fractionation and determination of enzyme activity in organelles using sprouted seedor any other suitable source.
5. Study of structure of any Prokaryotic and Eukaryotic cell.
6. Microtomy: Fixation, block making, section cutting, double staining of animal tissueslike liver, oesophagus, stomach, pancreas, intestine, kidney, ovary, testes.
7. Cell division in onion root tip/ insect gonads.
8. Preparation of Nuclear, Mitochondrial & cytoplasmic fractions.

English
(BSBC-103A)

Course Objective

The purpose of this course is to introduce students to the theory, fundamentals and tools of communication and to develop in them vital communication skills which should be integral to personal, social and professional interactions. One of the critical links among human beings and an important thread that binds society together is the ability to share thoughts, emotions and ideas through various means of communication: both verbal and non-verbal. In the context of rapid globalization and increasing recognition of social and cultural pluralities, the significance of clear and effective communication has substantially enhanced.

CONTENTS

Unit I: Introduction: **06**

Theory of Communication, Types and modes of Communication, *Mediums and channels of communication, barriers to communication, English as a Global language, the Lingua Franca, Social influences on English*

Unit II: **Language of Communication**: 06

Verbal and Non-verbal (Spoken and Written) Personal, Social and Business Barriers and Strategies Intra-personal, Inter-personal and Group communication, *Varieties of English, Language, Accent, Dialect, Colloquialism, Historical influences on English*

Unit III: **Speaking Skills**: 06

Monologue Dialogue Group Discussion Effective Communication/ Mis- Communication Interview Public Speech, *Regional influences on English, Convergence and divergence, Linguistic Imperialism,*

Unit IV: **Reading and Understanding-** **06**

Close Reading, *Reading analysis of a text - Audience and purpose, Content and theme, Tone and Mood, stylistic devices, structure* Comprehension- Analysis and Interpretation Translation(from Indian language to English and vice-versa) Literary/Knowledge Texts

Unit V: **Writing Skills** 06

Documenting Report Writing Making notes Letter writing, *Writing tabloids, diary entry, open letters, essays, newsletter and magazine articles, skits, short stories, impersonating characters*

Course outcome:

It will enhance Language of communication, various speaking skills such as personal communication, social interactions and communication in professional situations such as interviews, group discussions and office environments, important reading skills as well as writing skills such as report writing, notetaking etc. While, to an extent, the art of communication is natural to all living beings, intoday's world of complexities, it has also acquired some elements of science. It is hoped that after studying this course, students will find a difference in their personal and professional interactions.

Recommended 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

Metabolism of Carbohydrates and Lipids
(BSBC-104)

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.

Course Learning Outcomes

The learners will be able to:

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

UNIT I: Glycolysis, and pentose phosphate pathway

Autotrophs, Heterotrophs, catabolism, anabolism, metabolic pathways, ATP as energy currency, experimental approaches to study metabolism, High energy compounds. Glycolysis: overview, reactions, regulations including hormones, fates of pyruvate, feeder pathways for glycolysis, galactosemia. Lactose intolerance. Cori and Cori cycle. Pentose phosphate pathway and its importance, Relationship between glycolysis and pentose phosphate pathway. Anaerobic ATP production, fermentation.

UNIT II: Additional pathways in carbohydrate metabolism

Glycogen synthesis, glycogen breakdown, regulation of glycogen metabolism, gluconeogenesis. glycogen storage diseases; Von Gierke, Pompe, Cori and McArdle. Gluconeogenesis. Photosynthesis dark reaction: Calvin cycle, regulation, Photo respiration, C4 and CAM pathways in plants.

UNIT III: Citric acid cycle

Overview of citric acid cycle, synthesis of acetyl Coenzyme A, enzymes of citric acid cycle, regulation of citric acid cycle, anaplerotic reactions, amphibolic nature, Malate aspartate shuttle, Glyceraldehyde 3 phosphate dehydrogenase shuttle, Glyoxylate cycle in plants. Signaling pathways, regulation of carbohydrate metabolism by hormones, diseases associated with metabolic irregularities.

UNIT IV: Degradation of lipids

Lipid digestion, absorption and transport. Fatty acid oxidation: transport to mitochondria, activation of fatty acids, β oxidation of saturated, unsaturated, odd and even numbered and branched chain fatty acids, regulation of fatty acid oxidation, peroxisomal β oxidation, ω oxidation and a oxidation. Ketone-body metabolism.

UNIT V: Synthesis of lipids

Transport of mitochondrial Acetyl Co A to cytosol, Fatty acid synthase complex enzyme. Synthesis of saturated, unsaturated, odd and even chain fatty acids, regulation of fatty acid metabolism. Synthesis of glycerophospholipids and sphingolipids. Cholesterol metabolism, diseases associated with abnormal lipid metabolism.

Regulation of metabolism

Well-fed state, early fasting state, fasting state, early re-fed state, energy requirements, reserves and caloric homeostasis.

References

Lehringer's Principles of Biochemistry (2019), Nelson, D.L. and Cox, M.M., W.H.Freeman and Company (New York), ISBN:13:978-1-4641-0962-1 / ISBN-13: 978-1429234146 ISBN-10: 9781429234146

Textbook of Biochemistry with Clinical Correlations, 7th Edition. Textbook of Biochemistry, 7th Edition. Thomas M. Devlin (Editor). ISBN: 978-0-470-28173-4

Biochemistry (2013) 4th ed.,Voet, Donald,Voet, Judith &Pratt, charlotte. Wiley & Sons, Inc. (New Jersey), ISBN:978-1-11809244-6.

PRACTICALS

Metabolism of Carbohydrates and Lipids (BSBC-108P)

1. Estimation of blood glucose.
2. Sugar fermentation by microorganisms.
3. Assay of salivary amylase.
4. Isolation of lipids from egg yolk and separation by TLC.
5. Cholesterol estimation.

Proteins and Enzymes
(BSBC-201)

Course Objectives

The objective of this course is to provide overview of protein biochemistry and enzymology to undergraduate students with diverse science backgrounds, since proteins and enzymes are the most versatile functional entities in life with applications in various life sciences research as well as in industry and biomedicine. The biochemical, structural, functional and aspects of interaction of proteins and enzymes will be introduced in this course.

Course Learning Outcomes

On successful completion of the course students will be:

Familiar with unique features and characteristics of proteins and enzymes and their applications in research, medicine and industry.
Aware of the relationship between three-dimensional structure of proteins and enzymes and their functions.
Able to comprehend the basic mechanism of action of enzymes and their remarkable regulation
Aware of the principles of protein isolation, purification and characterization
Able to gain hands-on-experience in handling proteins and enzymes from various sources, thus improving their ability of learning and imbibing the basic concepts.

UNIT I: Introduction to proteins and their structural organization No. of hours :10

Amino acids and their properties. Peptides and their biological significance - hormones, antibiotics and growth factors. Diversity of proteins and their functions. Protein sequence - Edman degradation. Solid phase peptide synthesis. Organization of protein structure - primary, secondary, tertiary and quaternary structures. Conjugated proteins, multimeric proteins and metalloproteins. Bonds in protein structures - covalent and non-covalent. Dihedral angles. Ramachandran map, Secondary structure - helices, sheets and turns.

UNIT II: Three-dimensional structures and protein folding

Characteristics of tertiary and quaternary structures. Motifs and domains. Structure-function relationship in proteins. 3D structures of myoglobin and hemoglobin. Oxygen binding curves, influence of pH and effector molecules. Concerted and sequential models for allosteric proteins. Hemoglobin disorders. Protein folding - denaturation and renaturation. Role of chaperones.Proteinmisfolding and aggregation diseases.

UNIT III: Isolation, purification and analysis of proteins

Ammonium sulphate fractionation, centrifugation dialysis. Ion-exchange chromatography, molecular sieve chromatography, affinity chromatography. HPLC and FPLC. Gel electrophoresis: SDS-PAGE, IEF and 2-D electrophoresis.

UNIT IV: Introduction to enzymes, their characteristics and kinetics

Nature of enzymes - protein and non-protein (ribozyme, abzymes). Cofactor and prosthetic group, apo- and holo-enzymes. Features of enzyme catalysis. Classification of enzymes and nomenclature. Fischer's lock & key and Koshland's induced fit hypothesis. Enzyme specificity. Enzyme kinetics- Michaelis-Menten equation, Lineweaver-Burk plot. Determination of K_m, V_{max}, K_{cat}. Factors affecting enzyme activity. Enzyme inhibition- Reversible (competitive, uncompetitive, non-competitive) and irreversible inhibition. Mechanism based inhibitors.

UNIT V: Mechanism of enzyme action and enzyme regulation

General mechanisms of action. Acid-base and covalent catalysis (chymotrypsin, lysozyme). Metal activated enzymes and metalloenzymes. Allosteric regulation and feedback inhibition (ATCase). Reversible covalent modification (glycogen phosphorylase). Proteolytic cleavage-zymogen. Multienzyme complex. Coenzymes.

Applications of enzymes

Isoenzymes. Applications of enzymes in research. Application of enzymes in diagnostics (SGPT, SGOT, creatine kinase), Enzyme immunoassay (HRP), Enzyme therapy (Streptokinase). Enzyme immobilization and its applications. Industrial applications.

Proteins and Enzymes-Lab
(BSBC-205P)

Estimation of proteins by Biuret / Lowry / Bradford method and UV absorbance measurements.
Ammonium sulphate fractionation of crude homogenate from germinated mung beans
Enzyme activity assay (acid phosphatase)
Progress curve of enzyme
Effect of pH / temperature on enzyme activity
Determination of K_m and V_{max} using Lineweaver-Burk plot.
SDS-PAGE analysis of proteins

References

Nelson, D. L. and Cox, M.M. Lehninger, Principles of Biochemistry, 5th Ed., W.H. Freeman and Company (N.Y., USA.), 2008.
Voet, D. and Voet, J.G. Biochemistry, 3rd Ed., John Wiley & Sons, Inc. USA, 2004.
Physical Biochemistry (2009) 2nd ed., Sheehan, D., Wiley-Blackwell (West Sussex), ISBN: 9780470856024 / ISBN: 9780470856031.
Fundamentals of Enzymology (1999) 3rd ed., Nicholas C.P. and Lewis S., Oxford University Press Inc. (New York), ISBN:0 19 850229 X.
The Tools of Biochemistry (1977; Reprint 2011) Cooper, T.G., Wiley India Pvt. Ltd. (New Delhi), ISBN: 978-81-265-3016-8.

Environmental Science
(BSBC-202A)

Unit 1 : Introduction to Environmental Studies **(6 Lecture)**

- Multidisciplinary nature of environmental studies;
- Scope and importance; Concept of sustainability and sustainable development.

Ecosystems

- What is an ecosystem? Structure and function of ecosystem; Energy flow in an ecosystem: food chains, food webs and ecological succession. Case studies of the following ecosystems :
  a) Forest ecosystem
  b) Grassland ecosystem
  c) Desert ecosystem
  d) Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

Unit 2 : Natural Resources : Renewable and Non---renewable Resources **(6 Lecture)**

- Land resources and landuse change; Land degradation, soil erosion and desertification.
- Deforestation: Causes and impacts due to mining, dam building on environment, forests, biodiversity and tribal populations.
- Water : Use and over---exploitation of surface and ground water, floods, droughts, conflicts over water (international & inter---state).
- Energy resources : Renewable and non renewable energy sources, use of alternate energy sources, growing energy needs, case studies.

Unit 3 : Biodiversity and Conservation **(5 Lecture)**

- Levels of biological diversity : genetic, species and ecosystem diversity; Biogeographic zones of India; Biodiversity patterns and global biodiversity hot spots
- India as a mega---biodiversity nation; Endangered and endemic species of India
- Threats to biodiversity : Habitat loss, poaching of wildlife, man---wildlife conflicts, biological invasions; Conservation of biodiversity : In---situ and Ex---situ conservation of biodiversity.
- Ecosystem and biodiversity services: Ecological, economic, social, ethical, aesthetic and Informational value.

Unit 4 : Environmental Pollution **(9 Lecture)**

- Environmental pollution : types, causes, effects and controls; Air, water, soil and noise pollution
- Nuclear hazards and human health risks
- Solid waste management : Control measures of urban and industrial waste.
- Pollution case studies.

Environmental Policies & Practices

- Climate change, global warming, ozone layer depletion, acid rain and impacts on human communities and agriculture
- Environment Laws: Environment Protection Act; Air (Prevention & Control of Pollution) Act; Water (Prevention and control of Pollution) Act; Wildlife Protection Act; Forest Conservation Act. International agreements: Montreal and Kyoto protocols and Convention on Biological Diversity (CBD).

- Nature reserves, tribal populations and rights, and human wildlife conflicts in Indian context.

Unit 5 : Human Communities and the Environment **(4 Lecture)**

- Human population growth: Impacts on environment, human health and welfare.
- Resettlement and rehabilitation of project affected persons; case studies.
- Disaster management : floods, earthquake, cyclones and landslides.
- Environmental movements : Chipko, Silent valley, Bishnois of Rajasthan.
- Environmental ethics: Role of Indian and other religions and cultures in environmental conservation.
- Environmental communication and public awareness, case studies (e.g., CNG vehicles in Delhi).

Suggested Readings:

1. Carson, R. 2002. *Silent Spring*. Houghton Mifflin Harcourt.
2. Gadgil, M., & Guha, R.1993. *This Fissured Land: An Ecological History of India*. Univ. of California Press.
3. Gleeson, B. and Low, N. (eds.) 1999.*Global Ethics and Environment*, London, Routledge.
4. Gleick, P. H. 1993. *Water in Crisis*. Pacific Institute for Studies in Dev., Environment & Security. Stockholm Env. Institute, Oxford Univ. Press.
5. Groom, Martha J., Gary K. Meffe, and Carl Ronald Carroll.*Principles of Conservation Biology*. Sunderland: Sinauer Associates, 2006.
6. Grumbine, R. Edward, and Pandit, M.K. 2013. Threats from India's Himalaya dams. *Science*, 339: 36-–37.
7. McCully, P. 1996. *Rivers no more: the environmental effects of dams*(pp. 29-–64). Zed Books.
8. McNeill, John R. 2000. Something New Under the Sun: An Environmental History of the Twentieth Century.
9. Odum, E.P., Odum, H.T. & Andrews, J. 1971.*Fundamentals of Ecology*. Philadelphia: Saunders.
10. Pepper, I.L., Gerba, C.P. & Brusseau, M.L. 2011. Environmental and Pollution Science. Academic Press.
11. Rao, M.N. & Datta, A.K. 1987. *Waste Water Treatment*. Oxford and IBH Publishing Co. Pvt. Ltd.
12. Raven, P.H., Hassenzahl, D.M. & Berg, L.R. 2012.*Environment*. 8th edition. John Wiley & Sons.
13. Rosencranz, A., Divan, S., & Noble, M. L. 2001. *Environmental law and policy in India*. *Tripathi 1992*.
14. Sengupta, R. 2003. *Ecology and economics*: An approach to sustainable development. OUP.
15. Singh, J.S., Singh, S.P. and Gupta, S.R. 2014. *Ecology, Environmental Science and Conservation*. S. Chand Publishing, New Delhi.
16. Sodhi, N.S., Gibson, L. & Raven, P.H. (eds). 2013. *Conservation Biology*: *Voices from the Tropics*. John Wiley & Sons.
17. Thapar, V. 1998. *Land of the Tiger*: *A Natural History of the Indian Subcontinent*.
18. Warren, C. E. 1971. *Biology and Water Pollution Control*. WB Saunders.
19. Wilson, E. O. 2006.*The Creation: An appeal to save life on earth*. New York: Norton.
20. World Commission on Environment and Development. 1987.*Our Common Future*. Oxford University Press.

Biochemical Correlations of Disease
(BSBC-203)

Course Objective

This course provides students with knowledge and understanding of various human diseases. They will understand the concepts of a well-balanced diet, healthy lifestyle, biochemical basis of diseases, treatment strategies, mechanism of action of drugs and drug resistance mechanisms against various antimicrobials. Students will also learn various strategies that are employed for preventing infectious and non-infectious diseases

Course Learning Outcomes

Develop understanding about the importance of balanced diet, regular exercises and healthy lifestyle.
Gain insight into various disorders associated with imbalanced diet and poor lifestyle.
Learn various strategies employed for preventing various human diseases.
Understand the molecular basis of microbial pathogenicity, drug resistance and implications on public health management.
Should be able to handle and solve analytical problems related to theory classes.

UNIT I: Inherited metabolic diseases

Alkaptonuria, Phenylketonuria, Glycogen storage diseases: Von Gierke, Cori and McArdle, Lipid storage diseases: Gauchers diseases, Niemann-Pick disease, SCID: Adenosine Deaminase deficiency.

UNIT II:Nutritional deficiency and lifestyle based diseases

Kwashiorkar, Marasmus, Beri-beri, Scurvy, Pellagra, Anaemia, Night blindness, Rickets, Osteomalacia, Osteoporosis, Obesity, Cardiovascular diseases, Atherosclerosis, Diabetes Mellitus-II, Inflammatory Bowel Disease (IBD).

UNIT III: Hormonal Imbalances

Hormonal imbalances leading to disease: Diabetes Insipidus, Acromegaly, Gigantism, Dwarfism, Goitre, Cretinism, Cushing and Conn's syndrome, Addison's disease.

UNIT IV: Autoimmune diseases

Concepts in immune recognition-self and non-self-discrimination, organ specific autoimmune diseases-Hashimoto's thyroiditis, Graves' disease, Myasthenia Gravis, Diabetes Melitus-I, Systemic diseases: Systemic Lupus Erythropoesis (SLE), Rheumatoid arthritis.

UNIT V:Diseases caused due to misfolded proteins

Alzheimer's, Huntington's diseases, Kuru, Creutzfeldt-Jakob disease, Sickle Cell anaemia, Thalessemia.

Infectious diseases

Viral infection: Polio, Measles, Mumps, influenza, HIV. Bacterial infections: Tetanus, Diphtheria, Tuberculosis, Typhoid, Cholera. Protozoan: Malaria and Trypanosomiasis. Parasitic infections: Leishmania.

References

Textbook of Biochemistry with Clinical Correlations (2011) Devlin, T.M. John Wiley Sons, Inc. (New York), ISBN: 978-0-4710-28173-4

Immunology: A Short Course (2009) 6th ed., Coico, R and Sunshine, G., John Wiley Sons, Inc (New Jersey), ISBN; 978-0-470-08158-7

Biochemistry (2012) 7th ed., Berg, J.M., Tymoczko, J. L. and Stryer, L., W.H Freeman and Company (New York)

Genetics (2012) 6th ed., Snustad, D.P. and Simmons, M.J., John Wiley & Sons. (Singapore) ISBN: 978-1-118-09242-2

Klein's Microbiology, (2008) 7 ed., Prescott, Harley, Wiley, J.M. Sherwood, L.M. Woolverton, C.J. Mc Graw Hill International Edition (New York) ISBN: 978-007-126727

PRACTICALS

Biochemical Correlations of Disease (BSBC-206P)

Lipid Profile: Triglyceride, Cholesterol
Anthrompometric measurements: BMI, Waist/Hip Ratio, Mid Arm Muscle Area (MAMA), Mid Arm Area (MAA).
Haemoglobin Estimation
Blood pressure measurement
Calcium Estimation

Biomolecules
(BSBC-204A)

Course Objective

The objective of the course is to teach students about important biomolecules essential to life. The course also aims to teach organic inorganic and physical aspects of biomolecules

Course Learning Outcomes

Students have knowledge of structure and function of protein, RNA, DNA, Carbohydrates, Coenzymes How structure of biomolecule determine their chemical properties.To have understanding of biochemistry at atomic level
Biological importance of each biomolecule

UNIT I: Biomolecules in their cellular environment

The cellular basis of life, Structure and function of a cell and its subcellular components (eukaryotes, prokaryotes)
Physical properties and structure of water molecule, pH, Buffers, biological buffer systems (body fluids and their principal buffers)

UNIT II: Amino Acid and Peptides

Introduction, general nature of aminoacids, classification of amino acids importance of amino acids, modified and standard amino acids, physical, optical properties of aminoacids, Ionization of amino acids, buffering of amino acids, peptide bond, biologically important peptide

Introduction to chromatography, separation of amino acid by paper chromatography

UNIT III: Carbohydrate Chemistry

Introduction, Definition classification and functions of carbohydrates monosaccharides Disaccharides polysaccharides homopolysaccacharides, heteropolysaccaharides structure of glucose, isomerism; keto aldo, DandL isomerism, optical isomerism, epimerism, anomerism, Mutarotationchemical properties of monosaccharides action of strong acids, alkalies, oxidation, reduction, osazone formation glycoside formation

Derivatives of monosaccharides phosphoric acid ester, amino sugar, deoxy sugar, sugar acids, sugar alcohols, Disaccharides maltose, lactose, sucrose Homopolysaccarides starch, glycogen, cellulose, dextrin Heteropoly-saccaharides types of glycosoaminoglycans and functions glycoproteins

UNIT IV: Chemistry of Lipids

Introduction; Definition, classification and functions of lipids; Fatty acids; Essential fatty; acids; Reactions of lipids; Triacylglycerol or neutral fat; phospholipids glycolipids; cholesterol; Eicosaanoids; prosatglandins; lipoprotein

UNIT V:Chemistry of Nucleic Acid

Introduction
Nucleic Acid
Nucleotide
biologically important Nucleotides
Synthectic analogues of Nucleotides or
antimetabolites DNA structure and function Types of
DNA
Organisation of DNA
RNA Structure and function

Vitamins and Coenzymes

Definition and classification of vitamins water soluble vitamins, fat soluble vitamins Occurrence and nutritional role Coenzymes and their role in metabolism Metal ion containing biomoleculeus (heme, porhurins and cyanocobalamine; their biological role

References

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.
Textbook of Biochemistry with Clinical Correlations (2011) 7th ed., Devlin, T.M., John Wiley & Sons, Inc. (New York), ISBN:978-0-470-28173-4

PRACTICALS

Biomolecules

(BSBC-207P(A)

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 accorbic acid in fruit juices

Techniques in Biochemistry
(BSBC-204B)

Course Objective

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

Course Learning Outcomes

Students will acquire knowledge about the principles and applications of spectrophotometric and chromatography techniques used in a biochemistry lab. Students will learn about the principle and application of electrophoresis, centrifugation techniques, cell culture and microscopic techniques. It will also give them an opportunity to get hands on experience to develop their experimental skills expected from any biochemist working in a research lab.

UNIT I: Spectroscopic Techniques

Electromagnetic radiation, interaction of radiation with biomolecules, principle of UV-visible absorption spectrophotometry, Lambert's Law, Beer's Law, working of a spectrophotometer. Applications of UV-visible absorption spectrophotometry in biochemistry. Fluorescence spectrophotometry: Phenomena of fluorescence, intrinsic and extrinsic fluorescence, applications of fluorescence in biochemistry.

UNIT II: Chromatography

Preparation of sample, different methods of cell lysis, salting out, dialysis. Introduction to chromatography. Different modes of chromatography: paper, thin layer and column. Preparative and analytical applications. Principles and applications of: Paper Chromatography, Thin Layer Chromatography, Ion Exchange Chromatography, Molecular Sieve Chromatography, Affinity Chromatography.

UNIT III: Electrophoresis

Basic Principle of electrophoresis, Paper electrophoresis, Gel electrophoresis, discontinuous gel electrophoresis, PAGE, SDS-PAGE, Native gels, denaturing gels, agarose gel electrophoresis, buffer systems in electrophoresis, electrophoresis of proteins and nucleic

acids, protein and nucleic acid blotting, detection and identification (staining procedures), molecular weight determination, isoelectric focusing of proteins.

UNIT IV: Centrifugation

Principle of centrifugation, basic rules of sedimentation, sedimentation coefficient. Various types of centrifuges, low speed centrifuge, high speed centrifuge and ultracentrifuge, types of rotors. Application of centrifugation, differential centrifugation, density gradient centrifugation- zonal and isopycnic.

UNIT V: Microbiological/Cell culture techniques

Types of media, selective and enrichment media, sterilization methods, bacterial culturing, CFU determination, growth curves, Generation/doubling times, cell counting, viable and non-viable. Growth and maintenance of cultures, biosafety cabinets, CO_2incubator. Staining procedures, plating and microtony.

Microscopy

Principle of light microscopy, phase contrast microscopy, fluorescence microscopy. Permanent and temporary slide preparation, histology and staining.

References

Boyer, R.F., Biochemistry Laboratory: Modern Theory and Techniques, 6th ed., Boston, Mass: Prentice Hall, 2012, ISBN-13: 9780136043027.

Plummer D. T., An Introduction to Practical Biochemistry 3rd ed., Tata McGraw Hill Education Pvt. Ltd. (New Delhi), 1998, ISBN: 13: 9780070994874 / ISBN:10: 0070994870.

Wilson K. and Walker J., Principles and Techniques of Biochemistry and Molecular Biology, 7th ed., Cambridge University Press, 2010, ISBN 9780521516358.

Wiley, J.M., Sherwood, L.M. and Woolverton, C.J.. Prescott's Microbiology 10th edition. McGraw Hill Higher Education 2017, ISBN13: 9781259657573.

Additional Resources:

Cooper T G, The Tools of Biochemistry 2nd ed., Wiley-Interscience Publication (New Delhi), 2011, ISBN: 13:9788126530168.

Freifelder, D., Physical Biochemistry: Applications to Biochemistry and Molecular Biology 2nd ed., W.H. Freeman and Company (New York), 1982, ISBN:0716713152 / ISBN:0716714442.

PRACTICALS

Techniques in Biochemistry
(BSBC-207P(B)

1. Verification of Beer's Law
2. Estimation of proteins by Biuret/Lowry method
3. Separation of amino acid acids by TLC/paper chromatography
4. To perform agarose gel electrophoresis
5. To isolate mitochondria by differential centrifugation
6. Visualization of cells by methylene blue

Membrane Biology and Bioenergetics
(BSBC-301)

Course Objective

The objective of the course is to provide students with:
Knowledge of membrane composition, structure-function relationship and properties. Understanding of mechanism of membrane transport. Knowledge of basics of Bioenergetics and mechanisms of oxidative phosphorylation and photophosphorylation.

Course Learning Outcomes

On successful completion of the course, students will:
Understand the general composition and structure of biomembranes. Understand the basic properties of membranes such as membrane fluidity. Have knowledge about the various types of membrane transport mechanisms. Understand the basic tenets of Bioenergetics. Understand the concept of chemiosmotic theory and the mechanism of Oxidative phosphorylation and ATP synthesis. Understand the basic mechanisms of photophosphorylation in plants and microbes.

UNIT I: Membrane composition and structure

Historical background and various membrane models. Overview of membrane functions. Composition of membranes: Lipids -Phospholipids, Glycolipids, sterols, Proteins - Peripheral Proteins, Integral Membrane Proteins and Lipid-Anchored proteins, and carbohydrates. Comparison of the composition of various cellular and subcellular membranes. Lateral and transverse asymmetry in membranes. Role of Flippase, Floppase and Scramblase. Model systems to study membranes - Model systems to study membranes - Lipid Monolayers, Planar Bilayer and Liposome, and their application. Polymorphic Lipid–Water Systems. The various determinants of polymorphic phases: CMC, lipid shape, critical packing parameter. Membrane Fusion: Mechanism of Entry of Enveloped Animal Viruses

UNIT II: Membrane dynamics

Membrane fluidity: lateral, transverse and rotational motion of lipids and proteins. Factors affecting membrane fluidity- composition, barriers (tight junctions), cytoskeleton interactions, microdomains – rafts, caveolae. Fence and gate model. Study of RBC membrane

architecture. Homeoviscous Adaptation. Techniques to study membrane dynamics: FRAP, TNBS, SPT.

UNIT III: Membrane transport

Thermodynamics of transport. Simple diffusion and facilitated diffusion. Passive transport- glucose transporter and anion transporter. 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 and CFTR. Group translocation and bacteriorhodopsin. Ion channels: voltage-gated ion channels (Na+ /K+ voltage-gated channel) and ligand-gated ion channels (acetyl choline receptor), and aquaporins. Ionophores: valinomycin, gramicidin. Relationship of membrane transport and diseases.

UNIT IV: Introduction to Bioenergetics

Laws of thermodynamics. Concept of state functions, free energy change, equilibrium constant, coupled reactions, energy charge, ATP cycle, phosphorylation potential, and 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 V: Oxidative phosphorylation

The electron transport chain - its organization and function. Peter Mitchell's chemiosmotic hypothesis and Proton motive force. FoF1ATP synthase, structure and mechanism of ATP synthesis. Metabolite transporters in mitochondria. Regulation of oxidative phosphorylation. ROS production and antioxidant mechanisms. Thermogenesis Alternative respiratory pathways in plants.

Photophosphorylation

General features of photophosphorylation, historical background and Hill's reaction. Role of photosynthetic pigments and light harvesting systems in plants and microbes. Bacterial photophosphorylation in purple bacteria and Green sulfur bacteria. Photophosphorylation in plants. Molecular architecture of Photosystem I and Photosystem II. The Z-scheme of photosynthetic electron flow. Cyclic photophosphorylation and its significance.

References

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.

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.

Biochemistry (2010) 4th ed., Garret, R. H. and Grisham, C.M., Cengage Learning (Boston), ISBN-13:978-0-495-11464-2.

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

Additional Resources:

Molecular cell Biology (2016) 8th ed., Lodish, H., Berk, A., Kaiser, C. A., et al. W.H. Freeman, ISBN-13: 978-1464183393 ISBN-10: 1464183392

PRACTICALS

Membrane Biology and Bioenergetics
(BSBC-306P)

1. Effect of lipid composition on the permeability of a lipid monolayer.
2. Determination of CMC of detergents.
3. Preparation of RBC ghost cell.
4. Study the photosynthetic O2 evolution in hydrilla plant.
5. Isolation of chloroplast from spinach leaves and estimation of chlorophyll content.
6. Study the Hill reaction by using artificial electron acceptor.
7. Separation of photosynthetic pigments by TLC.
8. Separation of RBC membrane proteins by SDS-PAGE.
9. Isolation of mitochondria from liver and assay of marker enzyme SDH.

Hormone : Biochemistry and Function
(BSBC-302)

Course Objective

The course is designed to provide an understanding of the process of cellular communication including signal reception, transduction, amplification and response. It imparts an understanding of the different endocrine factors that regulate metabolism, growth, ionic homeostasis, glucose homeostasis and reproductive function

Course Learning Outcomes

On successful completion of the course, a student will:

Understand and appreciate the different cognate and non-cognate modes of communication between cells in a multi-cellular organism. Understand the role of endocrine system in maintaining ionic and glucose homeostasis. Should be able to describe molecular, biochemical and physiological effects of all hormones and factors on cells and tissues.

Understand the integrative communications that regulate, growth, appetite, metabolism and reproduction

UNIT I: Introduction to Endocrinology and Cellular signaling

Functions of hormones and their regulation. Chemical signalling - endocrine, paracrine, autocrine, intracrine and neuroendocrine mechanisms. Chemical classification of hormones, transport of hormones in the circulation and their half-lives. Hormone therapy. General introduction to Endocrine methodology.

Hormone receptors - extracellular and intracellular. Receptor - hormone binding, Scatchard analysis. G protein coupled receptors, G proteins, second messengers - cAMP, cGMP, IP3, DAG, Ca2+, Effector systems - adenyl cyclase, guanyl cyclase, PDE, PLC. Protein kinases (PKA, PKB, PKC, PKG). Receptor tyrosine kinases - EGF, insulin and Ras - MAP kinase cascade. Non receptor tyrosine kinase-erythropoietin receptor JAK - STAT pathway. Steroid hormone Receptor. Receptor regulation and cross talk.

UNIT II: Hypothalamic- hypophysial system:

Hypothalamic - Pituitary axis: anatomy, histology, vasculature and secretions. Physiological and biochemical actions of hypothalamic hormones and Anterior pituitary hormones;

Hormone feed- back regulatory cascade. Posterior pituitary hormones –structure, physiology and biochemical actions of AVP and Oxytocin; Diabetes insipidus.

UNIT III: Hormones regulating Metabolism, Calcium homeostasis and Growth:

Thyroid gland- Histology; Biosynthesis of thyroid hormone and its regulation: Role of TRH and TSH in T4 synthesis and response. Physiological and biochemical action of Thyroxine. Pathophysiology of thyroxine secretion: Hyper and hypothyroidism, Goitre, Graves' disease, Cretinism, Myxoedema.

Regulation of calcium homeostasis: PTH, Vitamin D and calcitonin. Mechanism of Ca^{2+} regulation and pathways involving bone, skin, liver, gut and kidneys. Pathophysiology - rickets, osteomalacia, osteoporosis.

Regulation of Growth: growth hormone and somatomedin, Endocrine disorders - gigantism, acromegaly, dwarfism, pygmies. Physiology and biochemical actions of Growth factors- EGF, PDGF and EPO

UNIT IV: Hormones of the adrenals:

Histology of Adrenal Gland. Physiology and action of Aldosterone; the Renin Angiotensin System. Physiology and Biochemical actions of Cortisol. Regulation of cortisol synthesis: POMC and CRH. Adrenal medullary Hormones: Epinephrine and Norepinephrine. The Fight or flight response; Dual receptor hypothesis. General adaptation syndrome: acute and chronic stress response. Pathophysiology – Addison's disease, Conn's syndrome, Cushing syndrome.

UNIT V: Pancreatic and GI tract hormones:

Cells involved in release of gastrointestinal hormones; the gastrin family of hormones and CCK: the secretin family of hormones; Incretins; Ghrelin; Summary of hormone metabolite control of GI function. Hormones of the Pancreas: Structure, synthesis, physiology and biochemical actions of insulin and glucagon. Adipocyte hormones: Adiponectin and leptin; Appetite and satiety control. Pathophysiology - . Type I and type II Diabetes mellitus, Obesity and Metabolic syndrome.

Reproductive hormones:

Male and female sex hormones. Interplay of hormones during ovarian and uterine phases of menstrual cycle; Placental hormones; role of hormones during parturition and lactation. Hormone based contraception. Understand conditions like ammenorrhea, menorrhagia, PMS, PCOS, Menopause

References

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.

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.

Endocrinology (2007) 6th ed., Hadley, M.C. and Levine, J.E. Pearson Education (New Delhi), Inc. ISBN: 978-81-317-2610-5.

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

PRACTICALS

Hormone: Biochemistry and Function
(BSBC-307P)

1. Glucose tolerance test.
2. Estimation of serum Ca^{2+}.
3. Estimation of serum T4
4. HCG based pregnancy test.
5. Estimation of serum electrolytes.
6. Case studies.

BSC Biochemistry	
Paper Code. (BSBC303)	
Fundamentals of IT	
Objectives: This is a basic course for commerce students to familiarize with computer andit's applications in the relevant fields and exposes them to other related courses of IT.	
Unit No.	**Details**
1	**1.1 Introduction to Computers:** 1.1.1 The evolution of computers – Computer Generation 1.1.2 Classifications of Computers – 1.1.3 Micro 1.1.4 Mini, 1.1.5 Mainframe 1.1.6 Super Computers 1.1.7 Distributed Computer System 1.1.8 Parallel Computers 1.1.9 Computer Hardware – Major Components of a Digital Computer 1.1.10 Block Diagram of Computer 1.1.11 Input devices 1.1.12 Output devices 1.1.13 Description of Computer IPO Cycle 1.1.14 CPU **1.2 Computer Memory:** 1.2.1 Memory Types, 1.2.2 Units of memory 1.2.3 Read Only Memory, 1.2.4 Random Access Memory, 1.2.5 Serial Access Memory, 1.2.6 Physical Devices Used to construct Memories, 1.2.7 Hard disk, 1.2.8 Floppy Disk Drives, 1.2.9 CD, DVD, Flash Drives, 1.2.10 Magnetic Tape Drives.
2	**2.1 Number System:** 2.1.1 Decimal, 2.1.2 Binary, 2.1.3 Octal, 2.1.4 Hexa-decimal. 2.1.5 Conversion - Decimal to all other number systems, 2.1.6 Binary to octal and Hexa Decimal, **3.1 Computer Software:** 3.1.1 System software, 3.1.2 Operating Systemconcepts, 3.1.3 Different types of operating systems, 3.1.4 Assemblers, 3.1.5 Compilers, 3.1.6 Interpreters, 3.1.7 linkers, 3.1.8 Application Software, 3.1.9 Firmware Software,
3	**3.1 Introduction of Internet and Objectives** **3.2 Basic of Computer Networks** 3.2.1 Local Area Network (LAN) 3.2.2 Wide Area Network (WAN) **3.3 Internet**

	3.3.1 Concept of Internet 3.3.2 Applications of Internet 3.3.3 Connecting to the Internet 3.3.4 Troubleshooting **3.4 World Wide Web (WWW)** **3.5 Web Browsing Software** 3.5.1 Popular Web Browsing Software **3.6 Search Engines** 3.6.1 Popular Search Engines / Search for content 3.6.2 Accessing Web Browser 3.6.3 Using Favorites Folder 3.6.4 Downloading Web Pages 3.6.5 Printing Web Pages **3.7 Understanding URL** **3.8 Surfing the web** 3.8.1 Using e-governance website
4	**4.1 Word Processor:** 4.1.1 Word Processor and its features, 4.1.2 Editing of Text, 4.1.3 Find and Replace, 4.1.4 Bullets and Numbering, 4.1.5 Spell Checker, 4.1.6 Grammar Checker, 4.1.7 Auto Correct, 4.1.8 Auto Complete, 4.1.9 Auto Text, 4.1.10 Header and footer, 4.1.11 tables, 4.1.12 mail merge, 4.1.13 border and shading, 4.1.14 page setup, 4.1.15 Printing. **4.2 Spread sheet:** 4.2.1 Spread sheet and its features, 4.2.2 Entering Information in Worksheet, 4.2.3 Editing Cell Entry, 4.2.4 Moving and Copying Data, 4.2.5 deleting or Inserting Cells, 4.2.6 Rows and Columns, 4.2.7 Custom 4.2.8 Numeric Formats, 4.2.9 Using Formulas and functions, 4.2.10 Creating charts.
5	**5.1 Presentation Software** 5.1.1. Presentation Software and its uses, 5.1.2. steps for creating PowerPoint Presentation, 5.1.3. PowerPoint Views, 5.1.4. Assigning Slide Transitions, 5.1.5. Using Preset Animations, 5.1.6. Hiding Slides, 5.1.7. Slide Show, 5.1.8. Controlling the Slide Show with a Keyboard, 5.1.9. Setting Slide Show Timings.

Text Books:

1. Alex Leon & Mathews Leon, "Fundamentals of Information Technology", LeonTechworld, 1999.
2. Vikas Gupta, "Comdex Computer Kit", Wiley Dreamtech, Delhi, 2004
3. P. K. Sinha &PritiSinha , "Computer Fundamentals", BPB Publications, 1992.

Reference Books:

1. V. Raja Raman, "Introduction to Computers", PHI, 1998.
2. Alex Leon & Mathews Leon, "Introduction to Computers", Vikas Publishing House, 1999.
3. Norton Peter, "Introduction to computers", 4th Ed., TMH, 2001.

BSC Biochemistry	
Paper Code. (BSBC-208P)	
Fundamentals of IT-Lab	
Objectives: This is a basic course for Commerce students to familiarize with computer and it's applications in the relevant fields and exposes them to other related courses of IT.	
	Details
	MS-WORD 1. Text Manipulations 2. Usage of Numbering, Bullets, Tools and Headers 3. Usage of Spell Check and Find and Replace 4. Text Formatting 5. Picture Insertion and Alignment 6. Creation of Documents Using Templates` 7. Creation of Templates 8. Mail Merge Concept 9. Copying Text and Picture From Excel 10. Creation of Tables, Formatting Tables 11. Splitting the Screen 12. Opening Multiple Document, Inserting Symbols in Documents **MS-EXCEL** 1. Creation of Worksheet and Entering Information 2. Aligning, Editing Data in Cell 3. Excel Function (Date, Time, Statistical, Mathematical, Financial Functions) 4. Changing of Column Width and Row Height (Column and Range of Column) 5. Moving, copying, Inserting and Deleting Rows and Columns 6. Formatting Numbers and Other Numeric Formats 7. Drawing Borders Around Cells 8. Creation of Charts Raising Moving 9. Changing Chart Type 10. Controlling the Appearance of a Chart **MS -POWER POINT** Working With Slides 1. Creating, saving, closing presentation 2. Adding Headers and footers 3. Changing slide layout 4. Working fonts and bullets 5. Inserting Clip art: working with clipart, 6. Applying Transition and animation effects 7. Run and Slide Show

Biostatistics
(BSBC-304A)

Course Objective

The primary objective of this course being offered as an elective skill enhancement course is to:

Provide understanding about the principles of biological data collection, statistical analysis and presentation.
Provide a hands-on-experience by performing practicals that are well correlated with the theory topics and are designed to support skill oriented learning outcomes in the management of biological data.

Course Learning Outcomes

Learners will be able to:

Understand the principles of biological data collection, statistical analysis and presentation.
Learn and appreciate various factors that influence type of sample collected and sample size.
Collect, analyze and interpret biological data using appropriate statistical tools
Apply the principles of biological data management in real life situations
Improvise their computational, mathematical and computer skills, which would increase their eligibility to pursue research based higher education.

UNIT I: Data Collection and Presentation

Importance of statistical analysis in biological data management. Sampling schemes – Simple Random sampling, systemic sampling, Stratified sampling, Cluster sampling, Non probability sampling; Types of numerical data – Nominal data, Ordinal Data, Ranked data, discrete data, continuous data; Modes of presenting data: Frequency distributions, Relative frequency.

UNIT II: Measures of central tendency and analysis of variance

Mean, median, mode; Co-efficient of variation and standard deviation; Range and interquartile range; Grouped mean and grouped variance; Frequency distributions; One way ANOVA; Two-way ANOVA; AMOVA; student's t test

UNIT III: Probability

Operations on events, Venn diagrams, Conditional Probability; Probability distributions.

UNIT IV: Hypothesis Testing

General concepts – Null hypothesis, alternative hypothesis, Rejection of hypothesis; Type I and Type II errors; P value and sample size estimation.

UNIT V: Regression and Correlation

Chi Square Test – Observed and expected frequencies, Calculating p values, assumptions of a chi square goodness of fit; Correlation –Two-way scatter plot, Pearson's correlation coefficient; Regression – regression concepts, simple linear regression; Calculation of R^2 and ρ.

References

Analysis of biological data, M. Whitlock and D. Schluter (2009); Roberts and company publishers; ISBN- 978-0-9815194-0-1
Principles of biostatistics, M. Pagano and K. Gauvreau (2000); Duxbury Thomas learnings; ISBN- 0-574-22902-6.

Additional Resources:

Biostatisticalanlysis, J.H. Zar (2010); 5th Ed; Pearsons Int. Edition; ISBN- 978-0-13-206502-3.

PRACTICALS
Biostatistics
(BSBC-309P (A))

Exercise 1. Collection of data

Random sampling method
Stratified sampling method
Cluster sampling method

Exercise 2. Data representation

Frequency and relative frequency distribution table, Plotting different biological data in a best representative graphical format.

Exercise 3. Data analysis

Calculating Mean, median, mode, variance, standard deviation and standard error for a given data set.
Standard t-test for grouped samples.
Analysis of 2 way variance
Chi square goodness of fit test
Regression analysis and calculating regression coefficient

Exercise 4

Learning to analyze data using SPSS or R software

Exercise 5

Project assignment.

Research Methodology
(BSBC-305B)

Course Objective:

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.
An exposure to the broad range of designs used in research in laboratory, field experiments, surveys and content analysis.
An introduction to the concept of controls, statistical tools and computer applications used in research.
Knowledge of scientific writing, oral presentation and the various associated ethical issues.

Course Learning Outcomes:

By studying this paper students will be able to:

define research, learn the importance of research and its link with theoretical knowledge
describe the research process and the principle activities, skills and ethics associated with the research process
describe and compare the major quantitative and qualitative research methods
construct an effective research proposal
understand the importance of research ethics use the computer software for organization and analysis of data.
develop skills in the art of scientific writing and oral presentation

UNIT I: Objectives of research

Definition, objectives, types of research, classification, various phases of research.

UNIT II: Research proposals and literature survey

Research proposal and aspects, Review of literature using appropriate sources – reviews, patents, research papers, books.

UNIT III: Basic principles of research design

Types of research designs – exploratory, descriptive, experimental, survey and case study.

UNIT IV: Experimental, sampling design and data collection

Sample - types, criteria, characteristics and steps; Tools and techniques to execute experiments; Observation, questionnaire, interview

UNIT V: Interpretation, report writing and the art of oral presentation

Report writing, format of publications in research journals, how to present papers and research findings

Bioethics and Plagiarism in Research

Biosafety and Ethics - compliance and concerns; Plagiarism; Citation and acknowledgement

References

Research Methodology: Methods and Techniques (2004) 2nd ed., Kothari C.R., New Age International Publishers.
Research Methodology: A Step-by-Step Guide for Beginners (2005) 2nd ed., Kumar R., Pearson Education.
Research Methods The Basics -Nicholas Walliman
WHO (2001) Health Research Methodology – A Guide for Training in Research Methods.
Cresswell J : Research Design : Qualitative and quantitative Approaches Thousand Oaks CA, Sage Publications

PRACTICALS

Research Methodology

(BSBC-309P(B))

Writing of a Mini-Review paper
Design of a research survey on a specific problem
Idea presentations in small groups

Intermediary Metabolism
(BSBC-305A)

Course Objectives

The objective of this course is:

To provide the students an understanding about the major metabolic pathways of different types of metabolism such as carbohydrates, lipids, amino acids and nucleic acid with their regulation

To provide the students knowledge about the possible correlation between all metabolic pathways.

Course Learning outcomes

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

Understand the basics of metabolic pathways
Understand the pathways involved in catabolism and biosynthesis of Glucose.
Understand the mechanism of ATP synthesis.
Understand the biosynthesis and degradation of glycogen
Understand the metabolism of fatty acids, amino acids, and nucleotides
Develop the understanding of metabolic integration

UNIT I: Glycolysis and gluconeogenesis

Nature of metabolism. Role of oxidation and reduction and coupling of these. ATP as energy currency. Glycolysis a universal pathway, fructose and galactose oxidation, anaerobic glycolysis, fermentation, gluconeogenesis, reciprocal regulation of glycolysis and gluconeogenesis. Pentose phosphate pathway, importance of various pathways and their regulation

UNIT II: Citric acid cycle and Oxidative phosphorylation

Pyruvate dehydrogenase complex, oxidation of acetyl CoA, amphibolic role, regulation and glyoxylate pathway. The respiratory chain in mitochondria, proton gradient powering ATP synthesis, glycerol-3-phosphate and malate-aspartate shuttle, regulation of oxidative phosphorylation.

UNIT III: Glycogen metabolism

Glycogenolysis, phosphorylase regulation, role of epinephrine and glucagon for glycogenolysis, glycogenesis; reciprocal regulation of glycogenesis and glycogenolysis. Diseases associated with the abnormal carbohydrate metabolism.

UNIT IV: Fatty acid and amino acid degradation

TAG as energy source, β oxidation of fatty acids in mitochondria and peroxisomes, ketone bodies. Fatty acids activation, regulation of fatty acid oxidation, Protein degradation to amino acids, Role of essential and non-essential amino acids in growth and development. Protein calorie malnutrition - Kwashiorkar and Marasmus, urea cycle, feeder pathways into TCA cycle. Nitrogen fixation. Diseases associated with the abnormal metabolism.

UNIT V: Nucleotide metabolism

Biosynthesis - de novo and salvage pathways, regulation of nucleotide synthesis by feedback inhibition, degradation and excretion. Diseases associated with the abnormal metabolism

Integration of metabolism

Brief role of hormones - insulin, glucagon; metabolic shifts to provide fuel to brain during fasting and starvation, Increase in gluconeogenesis and muscle protein breakdown.

References

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

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.

PRACTICALS

Intermediary Metabolism
(BSBC-310P(A))

1. Estimation of glucose
2. Alcohol fermentation by yeast.
3. H2S production, indole production and ammonia production by bacteria.
4. Urea estimation.
5. Uric acid estimation.
6. Estimation of creatinine

Biochemical Applications in Forensics
(BSBC-305B)

Course Objectives

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 will keep abreast with all recent developments and emerging trends in forensic science thus helping interested students take up forensic science as future course of study.

Course Learning Outcomes

Students will learn the fundamental concepts and principles of forensic science and their significance. Students will understand how a forensic investigation is initiated through preservation of evidences, as well as chemical, physical and biological methods of their analysis including analysis of DNA and other bodily fluids. Students will learn how to establish identity of an individual by document evaluation, fingerprints, footprints, DNA analysis etc. Students will obtain hands-on-experience in some of the basic biochemical processes involved in forensic investigation.

UNIT I: Introduction to forensic sciences

Basic Principles and Significance; History and Development of Forensic Science; Defining the scene of investigation; Collection, Packaging, Labelling and Forwarding of biological exhibits to forensic laboratories; Preservation of biological evidence; Importance of Health and Safety Protocols in sample collection and analysis.

UNIT II: Biological science and its application in investigation

Biochemical analysis of various biological evidence like blood, semen & other biological fluids, viscera, bite marks, hair (animal and human), fibres & fabrics, pollen and soil; Establishment of identity of individuals - fingerprints, footprints, blood and DNA analysis, anthropology – skeletal remains, Odontology; Time of death- rigor mortis, liver mortis, algor mortis, forensic entomology. Biochemical basis for determination of cause of death, case studies

UNIT III: Chemical science and its application in investigation

Detection of drugs of abuse and narcotics in biological samples; Toxicological examination of viscera,detection ofpetroleum products, food adulteration; Analysis of inks and their use inquestioned document identification, blood splatter analysis, stain analysis, case studies.

UNIT IV: Recent advances in forensics.

Narco analysis: theory, forensic significance, future prospect; *Brain mapping:* introduction, EEG, P-3000 wave, forensic applications, limitation of technique; *Polygraph*: Principle and technique, polygraph as forensic investigative tool, use of psychoactive drugs in forensic analysis.

UNIT V

NHRC guidelines for polygraph test; *Facial reconstruction*: Method and technique, facial reconstruction in forensic identification; DNA Finger Printing; DNA-Introduction, source of DNA in Forensic case work, Extraction of DNA, Techniques of DNA fingerprinting-RFLP, STR, PCR. DNA fingerprinting in paternity disputes, mass disaster and other forensic case work, case studies.

References

Text Book of Medical Jurisprudence, Forensic Medicine and Toxicology by Parikh C.K.
Henry Lee's Crime Scene Handbook by Henry C Lee
Forensic Biology by Shrikant H. Lade
Crime Scene Processing and Laboratory Work Book by Patric Jones
Forensic Science: An Introduction to Scientific and Investigative Techniques 3rd ed.by Stuart H. James
Criminalistics: An Introduction to Foresnic Science, 9th ed. By Richard Saferstein
Compute Crime and Computer Forensic by Dr. R.K. Tiwari
Handbook of Forensic Psychology Dr. Veerraghavan
Text Book of Medical Jurisprudence, Forensic Medicine and Toxicology by Parikh C.K.

PRACTICALS

Biochemical Applications in Forensics
(BSBC-310P(B))

TLC method for differentiation of ink/drugs
Fingerprint development from various surfaces
Handwriting identification based on class characteristic and individual characteristics
Microscopic examination of Hair/Fibre/Pollen/diatom
Examination of blood samples: Blood grouping, DNA finger printing, Blood splatter analysis.
Examination of urine samples: Identification of drugs.
Field trip to a forensic laboratory.

Human Physiology
(BSBC-401)

Course Objectives:

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 prepare students for higher education in any field related to molecular medicine.

Course Learning Outcomes:

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

Understand the basic organization and homeostatic control of the human body from the cell itself to organ systems and the functioning of the whole body. Comprehend and appreciate the importance of the fluid components of the body in regulating and connecting the various organ systems; particularly the heart and vascular system. Appreciate and understand the biochemical, molecular and cellular events that orchestrate the coordinate working of the organ systems that regulate life processes. Get a holistic understanding of the different organ systems with respect to their basic functioning, which involves both integrative learning and the regulatory roles of the Nervous and Endocrine system. Develop in students an inquisitive learning approach to seek answers regarding the complex workings of brain. Understand the factors that cause an imbalance to the Homeostatic control in the body and how these lead to disorders and diseases. Perform and analyze various physiological tests that examine the function of various systems of the human body.

UNIT I: Introduction to Human body and Understanding Homeostasis

Physiology: overview and definition, levels of structural organization, organ system. Body fluid compartments: intracellular, extracellular and interstitial fluid. Homeostasis: definition and control mechanisms (negative and positive feedback mechanisms).

UNIT II: Blood, Heart and Circulation:

Components of blood: Plasma - Composition, SPE - electrophoretic pattern of serum proteins, major plasma proteins and their role, Erythrocytes- erythropoiesis, function and metabolism, Leukocytes, Platelets- structure and function; Hemostasis and its molecular mechanism, role of platelets in coagulation, role of vitamin K in coagulation, Anticlotting and fibrinolytic systems. Anemias: definition and types (Hemolytic, hemorrhagic, megaloblast, pernicious, iron deficiency and aplastic anemia), polycythemia, Hemophilia and Thrombosis.

Anatomy of heart. Automacity of the cardiac muscle conducting fibres; Physiology of cardiac contracting muscle fibres, Relationship between cardiac cycle, heart sound, ventricular volumes and the ECG. Control of Heart rate and stroke volume. The vascular system: Arteries, arterial blood pressure and its measurement, Capillaries and bulk flow across the capillary walls, Veins and determination of venous pressure. Regulation of systemic arterial pressure. Long term and short-term regulation of cardiac efficiency and blood pressure. Hypertension, congestive heart disease, atherosclerosis, Heart failure and myocardial infarction.

UNIT III: Life Processes:

Respiratory Physiology

Organization of the pulmonary system, site of gas exchange, Ventilation and lung mechanics. Inspiration, Expiration, Lung compliance and its determinants. Lung Volumes and Capacities. Transport of oxygen and carbon dioxide in blood. Haldane and Bohr's effect. Transport of hydrogen ions between tissues and lungs. Control of respiration. Hering-Breuer reflex. Asthma, Chronic Obstructive Pulmonary Disease (COPD), Hypoxia, Emphysema.

Renal physiology

Anatomy of the kidney and the nephron. Regulation of renal blood flow. Cell biology of the Bowmans' capsule. Physiology of glomerular filtration and GFR. Tubular processing of the glomerular filtrate. Micturition. Regulation of ion and water balance. Urine concentration: The counter current multiplier system. Blood buffer systems, renal responses to acidosis and alkalosis. Assessment of kidney function. Glomerular nephritis. Dialysis: Hemodialysis and peritoneal dialysis. Diuretics.

Gastrointestinal and hepatic physiology

Histology of the gastrointestinal tract. Propulsion and motility of food and digested material. Enteric reflexes. Secretory functions of the gastrointestinal tract, digestion and absorption of macronutrients and micronutrients. Peptic ulcer, Sprue, Celiac disease, IBD, regurgitation. Anatomy of the hepatic lobule and blood flow into the liver. Formation and secretion of bile. Enterohepatic cycle, detoxification in liver. Jaundice, liver cirrhosis and fatty liver.

UNIT IV: Muscle

Structure of Skeletal, smooth and cardiac muscle, Molecular mechanisms of skeletal muscle contraction: role of troponin, tropomyosin, and calcium in contraction, excitation-contraction

coupling. Smooth muscle contraction and its control. Excitation-contraction coupling in cardiac muscle.

UNIT V: Reproductive Physiology:

Sex determination and differentiation. Development of female and male genital tracts. Oogenesis, Spermatogenesis, capacitation and transport of sperm, blood-testis barrier. Fertilization. Early development, Implantation. Placentation and Parturition.

Neurophysiology:

Central Nervous system. Peripheral Nervous system. Blood brain barrier and CSF. Structure and maintenance of neurons. Functional classes of neurons. Membrane potentials: Resting Membrane Potential, Graded potentials, Action potential. Synapse: excitatory and inhibitory. Temporal and spatial summation. Neurotransmitters and neuromodulators (definition with examples). Somatic sensation: definition and cellular pathways of pain transmission and modulation. Physiology of EEG, sleep.

References

Vander's Human Physiology (2019) 15th ed., Widmaier, E.P., Raff, H. and Strang, K.T., McGraw Hill International Publications (New York), ISBN: 978-1259903885

Human Physiology (2018) 15th ed., Stuart Ira Fox., McGraw Hill International Publications, (New York) ISBN 978-1259864629.

Additional Resources

Textbook of Medical Physiology (2016) 13th ed., Guyton, A.C. and Hall, J.E., Reed Elseviers India Pvt. Ltd. (New Delhi). ISBN: 978-1455770052

Introduction to Human Physiology (2012) 8th edition; Lauralee Sherwood. Brooks/Cole, Cengage Learning. ISBN-13: 978-1133104544.

PRACTICALS
Human Physiology
(BSBC-406P)

Hematology:

Packed Cell Volume, Bleeding Time and Clotting time.
Preparation of blood smear and Differential leucocyte count.
Enumeration of Blood cells: RBC and WBC counting, Calculation of blood Indices.
Estimation of hemoglobin

Determination of total iron binding capacity.
Pulmonary function tests, spirometry and measurement of blood pressure.
Separation of isoenzymes of LDH by electrophoresis.
Case studies: Renal clearance, ECG, LFT, EEG (any two)

Gene Organization, Replication and Repair
(BSBC-402)

Course Objective

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.

Course Learning Outcomes

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 Students will learn about the molecular basis of processes like DNA replication, recombination and transposition and understand the significance of these processes

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

UNIT I: Structure of DNA

Building blocks of DNA structure, Watson and Crick model, features of the double helix, various forms of DNA, denaturation and renaturation of DNA, hyperchromicity, melting temperature, factors affecting T_m of DNA molecules. Supercoiling of DNA, linking number, topoisomerases and their classification. Topoisomerase inhibitors and their clinical importance.

UNIT II: Genes and genomic organization

Definition of a gene, organization of genes in viruses, bacteria and eukaryotes, concept of split genes, introns, exons, satellite DNA, highly repetitive DNA, centromere and telomere sequences. Nucleosome structure and packaging of DNA into higher order structures.

UNIT III: Replication of DNA

General features of replication, the chemistry of DNA synthesis, DNA polymerase, the replication fork, enzymes and proteins in DNA replication, E coli DNA polymerases, stages of replication-initiation, elongation and termination, origin of replication, relationship

between replication and cell division, replication in eukaryotes, end replication problem, telomerase, various modes of replication. Comparison of replication in prokaryotes and eukaryotes. Inhibitors of DNA replication and applications in medicine.

UNIT IV: Recombination and transposition of DNA

Homologous recombination, biological role and models for homologous recombination, proteins and enzymes in homologous recombination, site-specific recombination, serine and tyrosine recombinases. Transposition, the three classes of transposable elements-DNA transposons, virus-like retrotransposons and poly-A retrotransposons. DNA transposition by cut and paste and replicative mechanism.

UNIT V: Molecular basis of mutations

Importance of mutations in evolution of species. Types of mutations - transition, transversion, frame shift mutations. DNA damage by hydrolysis, alkylation, oxidation and radiation. Mutations caused by base analogs and intercalating agents. Ames test.

Various modes of DNA repair

Replication errors and their repair, mismatch repair system. Repair of DNA damage-direct reversal of DNA damage, base excision repair, nucleotide excision repair, recombination repair, trans-lesion DNA synthesis. DNA repair and diseases.

References

Watson: Molecular Biology of the Gene (2008) 7th 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.

Lehringer: 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.

PRACTICALS

Gene Organization, Replication and Repair (BSBC-407P)

1. To hydrolyze DNA and separate nucleotide bases by paper chromatography
2. To plot ultraviolet absorption spectrum of DNA
3. Determination of DNA concentration by A_{260nm}
4. Determination of the melting temperature
5. Isolation of chromosomal DNA from *E coli* cells

Metabolism of Amino Acids and Nucleotides
(BSBC-403)

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.

Course Learning Outcomes

At the end of the course the students will be able to:
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
Systematically learn the breakdown and synthesis of amino acids and nucleotides in humans and recognize its relevance with respect to nutrition and human diseases Gain knowledge of how amino acids are converted into a variety of precursors Acknowledge the role of inhibitors of nucleotide metabolism which are potentially being used as chemotherapeutic drugs Comprehend how the amino acid and nucleotide metabolism are integrated with carbohydrate and lipid metabolism

UNIT I: Overview of Nitrogen metabolism and Amino Acid Metabolism

Nitrogen cycle, incorporation of ammonia into biomolecules. Digestion and absorption of dietary proteins. Role of essential and non-essential amino acids in growth and development. Protein calorie malnutrition - Kwashiorkar and Marasmus, Nitrogen balance. Metabolic fates of amino groups. Transamination, role of pyridoxal phosphate, glucose-alanine cycle, Kreb's bicycle, urea cycle, its regulation and inherited defects of urea cycle. Gamaglutamyl cycle.

UNIT II: Catabolism and Biosynthesis of amino acids

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. Overview of amino acid synthesis. Biosynthesis of non-essential amino acids and its regulation.

UNIT III: Precursor functions of amino acids

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 IV: Biosynthesis, Degradation of purine and pyrimidine nucleotides

De novo synthesis of purine and pyrimidine nucleotides, regulation and salvage pathways. Digestion of nucleic acids, degradation of purine and pyrimidine nucleotides. Inhibitors of nucleotide metabolism. Disorders of purine and pyrimidine metabolism – Lesch-Nyhan syndrome, Gout, SCID, adenosine deaminase deficiency.

UNIT V: Deoxyribonucleotides and synthesis of nucleotide triphosphate and Co-enzymes

Biosynthesis of deoxyribonucleotides and its regulation, conversion to triphosphates, biosynthesis of coenzyme nucleotides.

Integration of metabolism

Integration of metabolic pathways (carbohydrate, lipid and amino acid metabolic pathways), tissue specific metabolism (brain, muscle, and liver). Practical

References

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.

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:978-0-470-60152-5.

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.

PRACTICALS

Metabolism of Amino Acids and Nucleotides (BSBC-408P)

1. Assay of serum transaminases – SGOT and SGPT.
2. Estimation of serum urea.
3. Estimation of serum uric acid.
4. Estimation of serum creatinine.
5. Estimation of bilirubin
6. Assay of glutamate dehydrogenase

Bioinformatics
(BSBC-404A)

Course Objectives

The objective of this course is to impart basic understanding of bioinformatics and computational biology. The course will introduce the broad scope of bioinformatics by discussions on the theory and practices of computational methods in biology. This course also aims to provide students with a practical hands-on experience with common bioinformatics tools and databases. Students will be trained in the basic theory and application of programs used for database searching, protein and DNA sequence analysis, and prediction of protein structures.

Course Learning Outcomes

After completion of the course, a student will
Understand the basics of bioinformatics and computational biology and develop awareness of the interdisciplinary nature of this field. Demonstrate the use of several softwares/tools in biology Discuss, access and use biological databases in public domain Understand protein structure using visualization softwares Be able to gain understanding of sequence alignments Analyze phylogeny using alignment tools Comprehend the fundamental aspects of *in-silico* protein structure prediction Understand how theoretical approaches can be used to analyze biological systemsObtain knowledge on applications of bioinformatics from genomes to personalized medicine.

UNIT I: Introduction to bioinformatics

Introduction to Bioinformatics, Computer fundamentals – Operating Systems, Hardware, Software, Programming languages in bioinformatics - PERL/R programming, role of supercomputers in biology, Historical background. Scope of bioinformatics - Genomics, Proteomics, Computer aided drug design (CADD) and Systems Biology.

UNIT II: Biological databases and data retrieval

Introduction to biological databases - primary, secondary and composite databases, NCBI, nucleic acid databases (GenBank, EMBL, DDBJ, NDB), protein databases (PIR, Swiss-Prot,

TrEMBL, PDB), metabolic pathway database (KEGG, EcoCyc, and MetaCyc), small molecule databases (PubChem, Drug Bank, ZINC, CSD). Organism specific databases (E. coli, yeast, Arabidopsis, mouse, Drosophila Melanogaster), Structure viewers (Ras Mol, J mol) and File formats.

UNIT III: Sequence alignment & Phylogeny

Similarity, identity and homology. Concept of Alignment – local and global alignment, pairwise and multiple sequence alignments, amino acid substitution matrices (PAM and BLOSUM), BLAST and CLUSTALW, Definition of phylogeny and its importance, Methods of Phylogenetic tree generation, Phylip

UNIT IV: Genomics

Introduction to genomics, comparative and functional genomics, gene structure in prokaryotes and eukaryotes, Genome annotation, gene prediction approaches and tools.

UNIT V: Protein sequence, structure prediction and analysis

Protein Structure - Primary, Secondary and Tertiary structure, Protein structure prediction methods: Homology modeling, Fold recognition and *ab-initio* methods, Ramachandran plot.

References

Bioinformatics – Principles and Applications (2008), 1st ed. Ghosh, Z. and Mallick, B., Oxford University Press (India), ISBN: 9780195692303.
M. Michael Gromiha, Protein Bioinformatics: From Sequence to Function, Academic Press, 2010
Bioinformatics: Sequence and Genome Analysis (2001), 1st ed., Mount, D.W. Cold Spring Harbor Laborator Press (New York), ISBN: 0-87969-608-7.
Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins (2005), 3rd ed., Baxevanis, A.D. and Ouellette, B.F., John Wiley & Sons, Inc. (New Jersey), ISBN: 0-47147878-4.

Additional Reading

D.E. Krane and M.L. Raymer, Fundamental concepts of bioinformatics, Pearson Education Inc. 2006
Bioinformatics and Functional Genomics (2003), 1st ed., Pevsner, J., John Wiley & Sons, Inc. (New Jersey), ISBN: 0-47121004-8.

Bioinformatics
(BSBC-409P (A))

Sequence retrieval (protein and gene) from NCBI and Molecular file formats - FASTA, GenBank/Genpept.
Structure download (protein and DNA) from PDB and Molecular viewer by visualization software (Pymol / Rasmol/Jmol)
BLAST suite of tools for pairwise alignment
Multiple sequence alignment (CLUSTALW/TCoffee) and construction of guide trees
Gene prediction using GENSCAN/GLIMMER
Primary sequence analyses (Protparam) and Secondary structure prediction (GOR, nnPredict).
Tertiary structure prediction (SWISSMODEL) and Protein structure evaluation - Ramachandran map (PROCHECK

Microbial Techniques
(BSBC-404B)

Course Objective

To impart basic understanding of microbial techniques by hands on experience on working with microorganisms.
To teach students about various control methods for the growth of microbes.
To make students aware about the characteristic features of different microbes

Course Learning Outcomes

After completion of this course, a student will be able:

To visualize and identify various microorganisms
To culture microorganisms in aseptic conditions
To prepare and sterilize different types of media
To maintain different types of cultures
To carry out research using microorganisms.
To learn the principles behind and importance of sterilization while working in varied areas of biology in various laboratories.

UNIT I: Introduction

Development of microbiology as a discipline, Spontaneous generation vs. biogenesis. Contributions of Anton von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister and Alexander Fleming. Development of various microbiological techniques and golden era of microbiology.

UNIT II: Microbial Nutrition and Growth

The common nutrient requirements. Nutritional types of microorganisms. Culture media and its components, Synthetic or defined media, Complex media, Enriched media, Selective media, Differential media. Isolation of Pure culture: Streaking, Serial dilution and Plating methods, cultivation, maintenance of pure cultures. Microbial Growth: phases of growth, measurement of microbial growth

UNIT III: Control of microorganisms by physical and chemical methods

Mechanism of Dry Heat, Moist Heat, Hot air oven, Filtration and Radiations, Use of Phenolics, alcoholics, halogens, heavy metals, aldehydes and gases for sterilization.

UNIT IV: Bacterial, Fungal and Algal cell organization and staining

Overview of characteristic features of bacterial, fungal and algal cell. Composition and detailed structure of gram- positive and gram- negative cell wall. Simple staining and negative staining of bacteria. Mechanism of gram staining.

UNIT V: Introduction to Viruses

General characteristic features of viruses. Nacked and envelop viruses. Examples of RNA and DNA viruses. Subviral particles: viroids, prions, virusoids and their importance. Isolation and cultivation of viruses. Virus purification and assays

References

Willey JM, Sherwood LM, and Woolverton CJ. (2017). Prescott's Microbiology. 10th edition. McGraw Hill Higher Education. ISBN13: 9781259657573
PelczarJr MJ, Chan ECS, and Krieg NR.(2004). Microbiology.5th edition Tata McGraw Hill. ISBN13: 9780074623206
Cappucino J and Sherman N. (2013). Microbiology: A Laboratory Manual. 10th edition. Pearson Education Limited. ISBN13: 9780321840226

Additional Resources:

Madigan MT, Martinko JM, Dunlap PV and Clark DP (2010).Brock Biology of Micro-organisms.13thedition. Pearson Education, Inc. ISBN 13: 9780321649638
Dubey R.C and Maheshwari D.K. (2010). Practical Microbiology. First Edition. S. Chand. ISBN: 81-219-2153-8

PRACTICALS

Microbial Techniques

(BSBC-409P (B))

Microbiology Laboratory: Basic rules and requirements.

To study the principle and applications of important instruments (biological safety cabinets, autoclave, incubator, BOD incubator, hot air oven, light microscope, pH meter) used in the microbiology laboratory.

Preparation of glassware for microbiological work, cotton plugs, medium and their sterilization.

Sterilization of heat sensitive material by filtration.

Demonstration of presence of microflora in the environment by exposing nutrient agar plates to air.

Study of different shapes of bacteria, fungi and algae using permanent slides/pictographs

To stain bacteria using crystal violet/methylene blue.

To perform Gram's staining.

To prepare temporary mount of algae.

To prepare temporary mount of fungi.

Isolation of pure cultures of bacteria by streaking method.

Enumeration of colony forming units (CFU) count by spread plate method/pour plate

Study the morphological structures of viruses (DNA and RNA) and their important characters using electron micrographs.

Isolation and enumeration of bacteriophages (PFU) from water sample.

Biochemical Techniques
(BSBC-405A)

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.

Course Learning Outcomes

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

Acquire knowledge about the principles and applications of spectrophotometric and chromatography techniques used in a biochemistry lab. Learn about the principle and applications of electrophoresis and centrifugation techniques. It will also give them an opportunity to get hands on experience to develop their laboratory skills expected of any biochemist working in a research lab.

UNIT I: Spectroscopic Techniques

Electromagnetic radiation, interaction of radiation with biomolecules, principle of UV-visible absorption spectrophotometry, Lambert's Law, Beer's Law, working of a spectrophotometer. Applications of UV-visible absorption spectrophotometry in biochemistry. Fluorescence spectrophotometry and its applications in biochemistry.

UNIT III: Electrophoresis

Principle of electrophoresis, Polyacrylamide gel electrophoresis (native and denaturing) for proteins and nucleic acids.

UNIT IV

Agarose gel electrophoresis, Isoelectric focusing of proteins, two-dimensional. Detection and identification of proteins and nucleic acids and determination of molecular weight.

UNIT V: Centrifugation

Principle of centrifugation, basic rules of sedimentation, sedimentation coefficient. Various types of centrifuges, types of rotors. Application of centrifugation, differential centrifugation, density gradient centrifugation (zonal and isopycnic).

References

Boyer, R.F., Biochemistry Laboratory: Modern Theory and Techniques, 6th ed., Boston, Mass: Prentice Hall, 2012, ISBN-13: 978-0136043027.

Plummer D. T., An Introduction to Practical Biochemistry 3rd ed., Tata McGraw Hill Education Pvt. Ltd. (New Delhi), 1998, ISBN: 13: 978-0-07-099487-4 / ISBN:10: 0-07-099487-0.

Wilson K. and Walker J., Principles and Techniques of Biochemistry and Molecular Biology, 7th ed., Cambridge University Press, 2010, ISBN 978-0-521-51635-8.

Additional Reading

Cooper T G, The Tools of Biochemistry 2nd ed., Wiley-Interscience Publication (New Delhi), 2011, ISBN: 13:9788126530168.

Freifelder, D., Physical Biochemistry: Applications to Biochemistry and Molecular Biology 2nd ed., W.H. Freeman and Company (New York), 1982, ISBN:0-7167-1315-2 / ISBN:0-7167-1444-2.

PRACTICALS
Biochemical Techniques
(BSBC-410P(A))

1. Determination of absorption maxima (λ_{max}) of small molecules and macromolecules.
2. Verification of Beer's Law.
3. Determination of molar extinction coefficient.
4. Separation of amino acid acids/sugars by thin layer chromatography (TLC)
5. Separation of proteins by gel filtration chromatography
6. Separation of protein by Ion exchange chromatography
7. Separation of nucleic acids using agarose gel electrophoresis
8. Separation of protein by SDS PAGE.

Recombinant DNA Technology
(BSBC-405B)

Course objectives:

The objective of the course is to teach:

Basics of theory and practical aspects of recombinant DNA technology.
Various techniques for DNA manipulation in prokaryotes and eukaryotes.
Applications of this knowledge for the development of Diagnostics, Therapeutics, Vaccines, etc.

Course learning outcomes:

The students after completing this course will be able to understand:

Principles and importance of gene cloning
Various methods for screening of recombinants and identification of cloned gene
Polymerase chain reaction and DNA sequencing
Recombinant gene expression system
Application of recombinant technology in the production of Biopharmaceutical processes and products such as Insulin, Vaccines and DNA finger printing.

UNIT I: Introduction to recombinant DNA technology

Overview of gene cloning. Restriction, modification systems and DNA modifying enzymes, DNA analysis by electrophoresis.

UNIT II: Cloning vectors for prokaryotes and eukaryotes

Plasmids and bacteriophages as vectors for gene cloning. Cloning vectors for *E. coli* like pBR322, pUC8, pGEM3Z. Cloning vectors based on M13 and λ bacteriophage.Ti plasmid, BAC and YAC.

UNIT III: Introduction of DNA into cells and selection of recombinants

Ligation of DNA molecules. Introduction of DNA into cells, Transformation, selection for transformed cells. Identification of recombinants, blue-white selection. Identification of recombinant phages. cDNA and Genomic libraries.

UNIT IV: Polymerase chain reaction and DNA sequencing

Fundamentals of polymerase chain reaction, designing primers for PCR. DNA sequencing by Sanger's method and automated DNA sequencing.

UNIT V: Expression of cloned genes

Vectors for expression of foreign genes in *E. coli*, cassettes and gene fusions. Production of recombinant protein by eukaryotic cells. Fusion tags and their role in purification of recombinant proteins.

Applications of genetic engineering in biotechnology

Production of recombinant proteins such as insulin and factor VIII. Gene therapy. Genetically modified herbicide glyphosate resistant crops. Ethics concerns.

References

Gene Cloning and DNA Analysis (2010) 6th ed., Brown, T.A., Wiley-Blackwell Publishing (Oxford, UK), ISBN: 978-1-4051-8173-0.

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).

PRACTICALS

Recombinant DNA Technology
(BSBC-410P(B))

DNA estimation by UV spectrophotometry.
Isolation of plasmid DNA from *E. coli.*
Restriction digestion and agarose gel electrophoresis.
Amplification of a DNA fragment by PCR.

Concepts in Genetics
(BSBC-501)

Course Objectives

The aim of the course is to provide an understanding of both classical and modern concepts in the areas of transmission, molecular and population Genetics. Practicals are well correlated with the theory topics and designed to support skill oriented learning outcomes.

Course Learning Outcomes

Understanding the principles of Mendelian genetics, extensions and applications. Learning and appreciating the various factors that confer genotypic and phenotypic variability. Using the concepts of bacterial and viral genetics to understand resistance patterns and to create linkage and genetic maps. Use statistical tools to analyse biological data.

The students will be able to apply the principles of transmission and inheritance in real life situations.

UNIT I: Principles of heredity and Transmission genetics:

Mendelian Genetics and Chromosomal basis of heredity

Mendelian laws and ratios, Laws of probability & binomial expansion, formulating and testing genetic hypothesis, chromosomal basis of Mendelism -Sutton and Boveri hypothesis with experimental evidences.

Extensions to Mendelian Genetics:

Complementation test giving examples from Drosophila eye colour mutants. Allelic variation and gene function - dominance relationships, multiple alleles, lethal alleles and null alleles. Pleiotropic gene interaction - epistatic and non- epistatic, interaction between gene(s) and environment. Penetrance and expressivity, norm of reaction and phenocopy.

Human pedigree analysis:

Pedigree conventions, characteristics of dominant and recessive inheritance; sex linked, sex influenced and sex limited traits. Applications of pedigree analysis

Organelle heredity
Extra nuclear inheritance, tests for organelle heredity and maternal effect**.**
Inheritance of complex traits
Inheritance of complex trait, analysis of quantitative traits, narrow and broad sense heritability, quantitative trait loci (QTL) and their identification. Hybrid vigor.

UNIT II: Genetics of bacteria and viruses

Concept of cistron. Bacterial and viral genomes, Mechanism of genetic exchange - conjugation, transformation and transduction. Gene mapping in bacteria.

UNIT III: Linkage, crossing over and mapping techniques:
Linkage and crossing over, genetic mapping in eukaryotes, centromere mapping with ordered tetrads, cytogenetic mapping with deletions and duplications in *Drosophila*, detection of linked loci by pedigree analysis in humans, LOD score, somatic cell hybridization for positioning genes on chromosomes and physical maps using molecular markers.

UNIT IV: Molecular genetics

Sex determination and genetic control of development
Genetic basis of sex determination in Humans, *Drosophila melanogaster and C. elegans. Drosophila* development-maternal effect genes, morphogens and zygotic genes; Genetic basis of flower development in *Arabidopsis*-ABC model
Epigenetics:

Mechanism of dosage compensation; X chromosomal inactivation in humans and *Drosophila melanogaster*. Epigenetic mechanisms of transcriptional regulation. Monoallelic expressions and Genomic imprinting.

UNIT V: Chromosomal aberrations:

Variations in chromosome number: aneuploidy and polyploidy. Variations in chromosome structure- inversions, deletions, duplications and translocations.

Population and Evolutionary Genetics:
Hardy-Weinberg law, predicting allele and genotype frequencies and exceptions to Hardy-Weinberg principle.
Molecular evolution - analysis of nucleotide and amino acid sequences, molecular phylogenies, homologous sequences, phenotypic evolution and speciation.

References

Genetics (2012) 6th ed., Snustad, D.P. and Simmons, M.J., John Wiley & Sons. (Singapore), ISBN: 978-1-118-09242-2.
Genetics - A Conceptual Approach (2012), 6h ed., Pierce, B.A., W.H. Freeman & Co. (New York), ISBN:13:978-1-4292-7606-1 / ISBN:10:1-4292-7606-1.

Additional Resources:

An Introduction to Genetic Analysis (2017), 11th ed., Griffiths, A.J.F, Wessler, S. R, Carroll, S. B. and Doebley, J., W.H. Freeman & Company (New York), ISBN: 1464109486

PRACTICALS

Concepts in Genetics
(BSBC-504P)

Squash preparation of salivary glands of Dipteran larva to observe polytene chromosomes.
Induction of polyploidy in onion roots.
Smear technique to demonstrate sex chromatin in buccal epithelial cells.
Monohybrid crosses in *Drosophila* for studying autosomal and sex linked inheritance.
PTC testing in a population and calculation of allelic and genotype frequencies.
Study of abnormal human karyotype and pedigrees (dry lab)

Gene Expression and Regulation
(BSBC-502)

Course Objective

The objective of the course is to introduce to the students the basic knowledge about how genes are transcribed and how translation takes place in prokaryotes and eukaryotes and how these processes are regulated, so that students can apply this knowledge in enhancing their analytical and problem solving skills.

Course Learning Outcomes

After completion of the course students will:
acquire basic knowledge about the processes of transcription and translation in prokaryotes and eukaryotes learn about the features of the genetic code and various experimental approaches used to crack the code develop understanding of the molecular basis of RNA processing and RNA splicing learn about the various ways in which these biological processes are regulated and the significance of regulation in maintaining life forms

UNIT I: Transcription in prokaryotes

Comparison between transcription and DNA replication, RNA polymerases, transcription cycle in bacteria, sigma factor, bacterial promoters, identification of DNA binding sites by DNA footprinting, various stages of RNA synthesis, initiation, elongation and termination, rho-dependent and rho-independent termination. Inhibitors of transcription and applications as antimicrobial drugs.

UNIT II: Transcription in eukaryotes

Comparison between prokaryotic and eukaryotic transcription. The three classes of eukaryotic RNA polymerases, transcription by RNA polymerase II, RNA polymerase II core promoters, general transcription factors, transcription by RNA polymerase I and III. Inhibitors of eukaryotic transcription and their applications

UNIT III: RNA Processing

Various types of RNA processing- polyadenylation and capping, processing of rRNA and tRNA. Chemistry of RNA splicing, the spliceosome machinery, splicing pathways, group I and group II introns, alternative splicing, exon shuffling and RNA editing.

UNIT IV: Translation of proteins

Salient features of the genetic code, triplet nature, degenerate, wobble in the anticodon. Experimental approaches used to decipher the genetic code. Suppressor tRNAs. Exceptions to the nearly universal genetic code. Messenger RNA, transfer RNA, charging of tRNA. The structure of ribosome. Three stages of translation-initiation, elongation and termination. Translation in eukaryotes. Regulation of translation. Comparison of prokaryotic and eukaryotic protein synthesis. Inhibitors of translation and their clinical importance.

UNIT V: Regulation of gene expression in prokaryotes

Principles of gene regulation, negative and positive regulation, concept of operons, regulatory proteins, activators, repressors, DNA binding domains, regulation of lac operon and trp operon. Regulatory RNAs in bacteria, small RNA and riboswitches.

Regulation of gene expression in eukaryotes

Gene regulation by chromatin remodeling, regulation of galactose metabolism in yeast, action of enhancers and insulators, working of activators and repressors, concept of combinatorial control. Regulatory RNAs in eukaryotes: synthesis and mechanism of siRNA and miRNA.

References

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.

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.

Additional Resources:

Lewin's Gene X (2018) 10th edition. Benjamin Lewin; Jocelyn E Krebs; Stephen T Kilpatrick; Elliott S Goldstein, Bartlett Learning publishers, LLC, ISBN: 978-0-7637-6632-0.

PRACTICALS

Gene Expression and Regulation
(BSBC-505P)

Estimation of RNA by Orcinol Method
Extraction of total nucleic acids from plant tissue
To study growth curve and diauxic growth curve effect in *E. coli*
Isolation of total RNA from bacteria/yeast
To study the effect of inhibitors on protein synthesis

Nutritional Biochemistry
(BSBC-503A)

Course Objective

This course provides students with knowledge and understanding of the characteristics, function, assimilation, distribution and deficiency of macro and micronutrients in the human body. It involves integrated learning between the areas of Biochemistry and Nutrition.

Course Learning Outcomes

At the end of the course, the students are expected to:
Critically analyze and evaluate concepts in nutritional biochemistry that are important for an understanding of human nutrition. Appreciate the biochemical underpinning of human nutrition in maintaining health. Demonstrate understanding of the biochemical basis of essentiality of macro and micronutrients and their nutritional deficiencies. To be aware of techniques used in the assessment of Nutritional status and nutritional disorders.
To understand drug nutrient interactions.

UNIT I: Introduction to Nutrition and Energy Metabolism

Defining Nutrition, role of nutrients. Unit of energy, Biological oxidation of foodstuff. Physiological energy value of foods, SDA. Measurement of energy expenditure, BMR and RMR- factors affecting BMR. Recommended Nutrient Intakes (RNI) and Recommended Dietary Allowances for different age groups.

UNIT II: Macronutrients

Food sources of carbohydrates, Review functions of carbohydrates. Factors affecting Digestion, absorption and utilization. Glycemic index and glycemic load. Dietary fiber and role of fibre in health. Role of Gut microbiome in maintaining health. Role of pre and probiotics in nutritive health. Essential Fatty Acids; Functions of EFA, RDA, – excess and deficiency of EFA. Dietary implications of fats and oils, Combination ratios of n6 and n3, MUFA, PUFA and SFA Factors affecting Digestion, absorption and utilization. Importance of the following: a)

Omega – fatty acids. Omega 3/ omega 6 ratio b) Phospholipids c) Cholesterol in the body d) Mono, Polyunsaturated and Saturated Fatty Acids.
Review of functions of proteins in the body, Digestion and absorption. Essential and Nonessential amino acids. Complete protein, Amino Acid Availability, Antagonism,

Toxicity, Imbalance, Amino acid complementation and Supplementation in foods. Effects of deficiency. Food source and Recommended Dietary Allowances for different age group. Amino acid pool. NPU, Biological Value, Nitrogen balance. PEM and Kwashiorkor.

UNIT III: Micronutrients: Vitamins

Vitamin A, D, E, K Dietary sources, RDA, Adsorption, Distribution, Metabolism and excretion (ADME), Deficiency. Role of Vitamin A as an antioxidant, in Visual cycle, dermatology and immunity. Role of Vitamin K in Gamma carboxylation. Role of Vitamin E as an antioxidant. Extra-skeletal role of Vitamin D and its effect on bone physiology. Hypervitaminosis.

Vitamin C- Dietary sources, RDA, Adsorption, Distribution, Metabolism and excretion (ADME); role as cofactor in amino acid modifications. The B Complex vitamins- Dietary sources, RDA, Adsorption, Distribution, Metabolism and excretion (ADME); Thiamine-TPP roe in metabolism and deficiency disease; Niacin- Metabolic interrelation between tryptophan, Niacin and NAD/ NADP; Vitamin B6-conversion to Pyridoxal Phosphate. Role in metabolism, Biochemical basis for deficiency symptoms; Vitamin B12 and folate-metabolic role, homocysteine cycle, Biochemical basis for deficiency symptoms.

UNIT IV: Micro Minerals and trace elements

Calcium, Iron and Phosphorus- Distribution in the body digestion, Absorption, Utilization , Transport, Excretion, Balance, Deficiency, Toxicity, Sources, RDA. Iodine, Fluoride, Mg, Cu, Zn, Se, Manganese, Chromium, Molybdenum Distribution in the human body, Physiology, Function, deficiency, Toxicity and Sources

UNIT V: Assessment of Nutritional status

Direct methods of assessment-Anthropometric measurements; Biochemical assessment; clinical signs; dietary records and nutrient intake. ROS assessment, GTT and glycosylated Hb, Differential diagnosis of B12 and folate.

Food-drug interactions and Nutraceuticals

Nutrient interactions affecting ADME of drugs. Drug induced nutrient deficiency: Alcohol, Antibiotics, Antimalarial drugs.

Food as medicine: turmeric, garlic, ginger, cumin, asafoetida

References

Textbook of Biochemistry with Clinical Correlations (2011) Devlin, T.M. John Wiley & Sons, Inc. (New York), ISBN: 978-0-4710-28173-4.

Krause's Food and Nutrition Care process.(2012); Mahan, L.K Strings, S.E, Raymond, J. Elsevier's Publications. ISBN- 978-1-4377-2233-8.

The vitamins, Fundamental aspects in Nutrition and Health (2008); G.F. Coombs Jr. Elsevier's Publications. ISBN-13- 978-0-12- 183493-7.

Principles of Nutritional Assessment (2005) Rosalind Gibson. Oxford University Press. ISBN: 9780195171693

Nutritional Biochemistry. Author, *Tom Brody*. Edition, 2. Publisher, Harcourt Braces, 1999. ISBN, 9814033251, 9789814033251.

PRACTICALS

Nutritional Biochemistry-Lab
(BSBC-506P(A))

Anthropometric identifications for Kwashiorkor, Marasmus and Obesity.
Blood Lipid profile
Determination of oxidative stress: TBARS, antioxidant enzymes in hemolysate.
Estimation of vitamin in drugs/food/serum.
Estimation of minerals in drugs/food/serum.
Glycosylated haemoglobin
Nutritive value of foods
Case studies.

Advanced Cell Biology
(BSBC-503B)

Course Objective

The course aims to give advance knowledge of cell biology techniques, function of organelles, the structure and function of cytoskeleton and its role in motility, the details of cellular interaction with cells and tissues around, the molecular regulation of cell growth and cell death, the molecular details cancer origin, diagnosis and treatment.

Course Learning Outcomes

The learning outcomes will be as follows:

The student will develop understanding of the principle and application of some of the classical and advanced cell biology techniques

The student 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.

The student 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.

The student will be able to understand the genetic basis of development of cancer, the molecular diagnosis and molecular drugs which are used for chemotherapy.

UNIT I: Advanced Methods in Cell Biology

Principle and application of Ultracentrifugation

UNIT II: Protein Sorting and Secretory Pathway

Transport of proteins across Nuclear Envelope; Regulation of Nuclear Protein Import and Export. Overview of The Endomembrane System; Targeting, modification and sorting of Proteins From And Into Endoplasmic Reticulum; Synthesis And Targeting Mitochondrial Protein; Chloroplast Proteins A\and Peroxisomal Proteins; Mechanism Of Vesicular Transport; Coat Proteins And Vesicle Budding; Vesicle Fusion; Targeting Of Proteins T

UNIT III: Cytoskeleton and Cell Motility

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

UNIT IV: Cell Division and its Regulation

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;

UNIT V: Cell Death and its regulation

Apoptosis and Necrosis, Application of stem cells in health and disease. Hematopoiesis, Embryonic Stem Cells and Therapeutic Cloning.

Molecular Basis of Cancer Biology

Development and causes Of Cancer; Genetic Basis of Cancer; Oncogenes, Tumor Viruses; Molecular Approach to Cancer Treatment.

References

The Cell: A Molecular Approach (2009) 7th ed., Cooper, G.M. and Hausman, R.E., ASM Press & Sunderland (Washington DC), Sinauer Associates, MA, ISBN:978-0-87893-30

The World of the cell, 7th edition (2009). Lewis J. Kleinsmith, Jeff Hardin, Gr Wayne M. Becker. ISBN-13: 978-0805393934 ISBN-10: 0805393935.

Cell and Molecular Biology: Concepts and Experiments. (2010). Karp, G., 8th edition. John Wiley & Sons. Inc. ISBN : 978-1-118-65322-7

Additional Resources:

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:13:978-14641-0981-2 / ISBN:10: 1-4641-0981-8.

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.

PRACTICALS

Advanced Cell Biology-Lab
(BSBC-506P (B))

Learn the technique of Plant/Animal Tissue Culture
Study of pinocytosis by paramecium under microscopy
Calculating viability of cells after exposure the bacterial culture to UV rays
Preparing temporary mount of nerve cell from mammalian spinal cord
Differential centrifugation of cell and validation of separated organelles by enzyme markers
Study of cell- cell agglutination by lectin and calculation of haem-agglutination titre.
Demonstration of phagocytosis/apoptosis by fluorescent label under fluorescent microscope

Microbiology
(BSBC-503C)

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.

Course Learning Outcomes

On successful completion of this paper, students should be able to:
Identify different microbes Perform routine microbiological practices including sterilization, media preparation, maintenance of microbial culture, staining etc. To carry out research using microbes. To test microbial culture for antibiotic resistance.

UNIT I: History of Microbiology

History of development of microbiology as a discipline, Spontaneous generation versus biogenesis, contributions of Anton von Leeuwenhoek, Joseph Lister, Paul Ehrlich, Richard Petri, Charles Chamberland, Edward Jenner, Louis Pasteur, Robert Koch, Martinus W. Beijerinck, Sergei Winogradsky, Alexander Fleming, Elie Metchnikoff and Emil von Behring

UNIT II: Diversity of Microbial world and Microbial Cell organization

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, occurrence and morphology. Cell-wall: Composition and detailed structure of Gram positive and Gram negative cell walls, mechanism of Gram's staining. Cell Membrane: Structure, function and chemical composition of bacterial and archaeal cell membranes.

UNIT III: Microbial Nutrition and Growth

Nutritional types of microorganisms, growth factors, culture media- synthetic and complex, types of media; isolation of pure cultures, growth curves, mean growth rate constant, generation time; influence of environmental factors on growth of microbes: effect of pH, temperature, solute, oxygen concentration, pressure and radiations. Sterilization, disinfection and antiseptics. Use of physical methods (heat, low temperature, filtration, radiation) and chemical agents (phenolics, halogens, heavy metals, sterilizing gases) in microbial control.

UNIT IV: Pathogenicity of Microorganisms and Antimicrobial Chemotherapy

Introduction to pathogenic microbes; Bacteria, Viruses, Algae, protozoa and fungi. General Characteristics of antimicrobial drugs, determining the level of microbial activity: dilution susceptibility test and disc diffusion test. Range of activity and mechanism of action of penicillin, vancomycin and tetracycline.

UNIT V: Food and Industrial Microbiology

Importance of microbiology in food and industries; Basic design of fermenter, continuous and discontinuous culture. Preparation of fermented food products such as yoghurt, curd and cheese. Preparation of alcoholic beverages like wine and beer. Single cell proteins. Treatment of waste water (Municipal treatment plant) and sewage. Bioremediation and biodegradation.

References

J. Willey, L. Sherwood & C. Woolverton, Prescott's Microbiology,. 10th Ed., McGraw Hill international, (2017). ISBN 13: 9781259657573

MJ Chan, ECS Krieg & NR Pelczar, Microbiology, 5th Ed. McGraw Hill International, (2004). ISBN 13: 9780094623206

Additional Resources:

M.T. Madigan, J.M. Martinko & D.A. Stahl, Brock Biology of Microorganisms, 13th Ed., Pearson Education International. (2010). ISBN 13: 9780321649638.

J.G. Cappuccino, and N. Sherman, Microbiology: A Laboratory manual, 10th Ed. Benajamin/ Cummings (2013), ISBN 13: 9780321840226.

PRACTICALS

Microbiology-Lab
(BSBC-506P(C))

To prepare and sterilize the culture media for the growth of microorganisms

To perform various culture transfer techniques: Solid to solid (streaking), liquid to solid (spreading), liquid to liquid, solid to liquid and determine CFU/ml

To stain bacteria using methylene blue.

To perform gram staining

To prepare temporary mount of algae (spirogyra)

To prepare temporary mount of fungi (Penicillium)

Study of different shapes of bacteria, fungi, algae, protozoa using permanent slides/pictographs

Genetic Engineering and Biotechnology
(BSBC-601)

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.

Course Learning Outcome

The students will be able to understand:

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

UNIT I: The basic principle of gene cloning

Restriction and modification systems, restriction endonucleases and other enzymes used in manipulating DNA molecules. Ligation of DNA molecules. DNA ligase, sticky ends, blunt ends, linkers and adapters, homopolymer tailing, Synthetic oligonucleotides.

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, and in vitro packaging. Vectors for yeast, Ti-plasmid, and retroviral vectors, high capacity vectors BAC and YAC.

UNIT III: Introduction of DNA in cells, selection for recombinants and clone identification

Uptake of DNA by cells. Selection and identification for transformed cells, insertional inactivation, blue-white selection. Transfection. Chemical and physical methods of DNA introduction into cells. The problem of selection, direct selection, marker rescue. Identification of recombinant phages, cDNA and Genomic libraries, identification of a clone

from gene library, colony and plaque hybridization probing, Southern and Northern hybridization, methods based on detection of the translation product of the cloned gene.

UNIT IV: Expression of cloned genes

Vectors for expression of foreign genes in *E. coli*, cassettes and gene fusions. Hybrid promoterstrc, tac, pL and T7 promoter based expression vectors. Challenges in producing recombinant protein in *E. coli.* Production of recombinant protein by eukaryotic cells. Fusion tags such as, poly-histidine, glutathione, maltose binding protein and their role in purification of recombinant proteins.

UNIT V: Polymerase chain reaction and DNA sequencing

Fundamentals of polymerase chain reaction, Types of PCR; hot start, multiplex, reverse transcriptase PCR and Nested PCR, quantitative PCR, Primer, designing for PCR. Cloning PCR products. DNA sequencing by Sanger's method including Automated Sanger's DNA sequencing. Introduction to Next Generation Sequencing.

Applications of genetic engineering in Biotechnology

Site–directed mutagenesis, Protein engineering (T4-lysozyme), yeast two hybrid systems, Production of recombinant pharmaceuticals such as insulin, human growth hormone, factor VIII. Recombinant vaccines. Gene therapy (SCID), Applications in agriculture – *Bt* cotton, glyphosate herbicide resistant crops, ethical concerns.

References

Gene Cloning and DNA Analysis (2010) 6th ed., Brown, T.A., Wiley-Blackwell publishing (Oxford, UK), ISBN: 978-1-4051-8173-0.

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.

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).

Molecular Cloning: A laboratory manual (2014),4nd ed., Michael R Green and J. SambrookCold spring Harbor laboratory press (3vol.), ISBN: 978-1-936113-42-2

PRACTICALS

Genetic Engineering and Biotechnology-Lab (BSBC-604P)

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

Immunology
(BSBC-602)

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.

Course Learning Outcomes

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

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

UNIT I: Immune System and Innate Immunity

Historical Perspective, Innate and Adaptive Immunity, Hematopoiesis, cells of the immune system, primary and secondary lymphoid organs and tissues. Anatomical barriers, cell types of innate immunity, soluble molecules and membrane associated receptors (PRR), connections between innate and adaptive immunity, localized and systemic response. Complement activation by classical, alternate and MB lectin pathway, biological consequences of complement activation, regulation and complement deficiencies

UNIT II: Antigens and Antibody

Antigens, carriers, adjuvantes and haptens, factors responsible for immunogenicity, B and T cell epitopes. Structure, classes and subclasses of immunoglobulins (Ig, Ig fold), effector functions of antibody, antigenic determinants on Ig, Ig super family. Monoclonal antibodies production and applications

UNIT III: Biology of the B lymphocyte & Humoral Immunity

Dreyer-Bennett hypothesis, multigene organization of Ig locus, mechanism of V region DNA rearrangement, mechanisms of antibody diversity. Antigen independent phase of B cell maturation and selection, humoral response – T-dependent and T-independent response, anatomical distribution of B cell populations

UNIT IV:Biology of the T lymphocyte & Cell Mediated Immunity

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 (TCR) 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; NK - T cells and antibody dependent cellular cytotoxicity (ADCC).

UNIT V: Autoimmunity and hypersensitivity

Self-tolerance and possible mechanisms of induction of autoimmunity, Organ specific and systemic autoimmune diseases, Gell and Coombs classification, IgE mediated (Type I) hypersensitivity, antibody mediated cytotoxic (Type II) hypersensitivity, immune complex mediated (type III) hypersensitivity and delayed type (Type IV) hypersensitivity

Transplantation immunology and Vaccines

Immunological basis of graft rejection, clinical manifestations, immunosuppressive therapy and privileged sites. Vaccines - active and passive immunization, types of vaccines

References

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.

Immunology: A Short Course (2009) 6th ed., Coico, R and Sunshine, G., John Wiley& sons, Inc (New Jersey), ISBN: 978-0-470-08158-7.

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

PRACTICALS

Immunology
(BSBC-605P)

Isolation of lymphocytes from blood / spleen.
Purification of immunoglobulins
Assays based on precipitation reactions - Ouchterlony double immunodiffusion (DID) and Mancini radial immunodiffusion (SRID).
Assays based on agglutination reactions - Blood typing (active) & passive agglutination.
Enzyme linked immunosorbent assay (ELISA) & DOT ELISA

Molecular Basis of Infectious Disease
(BSBC-603A)

Course Objective

The course aims to provide knowledge about various microbial infectious agents such as bacteria, virus, parasites and fungi that cause diseases in humans, the concepts of treatment and biochemical basis of mechanism of action and drug resistance for various antimicrobial agents. The course will also provide outline of the various strategies that are employed for preventing infectious diseases and the role of vaccination in eradication of diseases. It will cover the concept of emergence and re-emergence of diseases and idea of bio-terrorism and its impact worldwide. The course will also summarize the significance of hygiene, sanitation, drugs and vaccination in prevention and eradication of infectious diseases.

Course Learning Outcomes

Students will understand various classes of pathogens and their mode of action and transmission. Students will be exposed to molecular basis of treatment, diagnosis and vaccine design strategies for all the diseases listed. Students will gain insight into host immune responses that ensue following infection. Students will learn the details of diseases such as tuberculosis, AIDS and malaria which are highly prevalent in Indian subcontinent.

UNIT I: Infectious diseases: an introduction

Classification of infectious diseases, Nosocomial infections; Patterns of Disease; Measuring infectious disease frequency; Past and present emerging and re-emerging infectious diseases and pathogens. Source, reservoir and transmission of pathogens. Safety measure when working with pathogen biosafety levels, infection and evasion

UNIT II: Strategies for management of infectious diseases

Role of drugs, vaccines, hygiene and sanitation in prevention, transmission control and treatment of infectious diseases

UNIT III: Diseases caused by bacteria

Classification of bacterial pathogens based on structure and nutritional requirements; Overview of bacterial virulence factors and host pathogen interactions; Detailed study of tuberculosis: History, causative agent, molecular basis of host specificity, infection and pathogenicity, diagnostics, therapeutics and vaccines, drug resistance and implications on public health. Other bacterial diseases - virulence factors, host pathogen interaction,

symptoms, diagnosis, vaccines and drugs against - Typhoid, Diphtheria, Pertussis, Tetanus, Botulism Cholera, Anthrax and Pneumonia

UNIT IV: Diseases caused by Viruses

Structure of viruses, Baltimore system for virus classification; Overview of viral virulence factors and host pathogen interactions; Detailed study of AIDS: history, causative agent, pathogenesis, diagnostics, drugs; Other viral diseases including hepatitis, Influenza (Antigenic shift and antigenic drift), Rabies, Dengue and Polio; Chicken Pox, Herpes Virus

UNIT V: Diseases caused by Parasites

Detailed study of Malaria: history, causative agents, vectors, life cycle, Host parasite interactions, diagnostics, drugs, vaccine development. Other diseases including Leishmaniasis and Amoebiasis, Giardiasis and Trypanosoma infections

Diseases caused by Fungi

Fungal diseases such as Candidiasis, Sporotrichosis, Aspergillosis and Ring worm: general disease characteristics, medical importance, pathogenesis, diagnosis and treatment

References

Klien's Microbiology (2008) 7th ed., Prescott, Harley, Wiley, J.M., Sherwood, L.M., Woolverton, C.J. Mc Graw Hill International Edition (New York) ISBN: 978-007-126727

Sherris Medical Microbiology: An introduction to infectious diseases (2010) Kenneth J. Ryan, C.,George Ray, Publisher: McGraw-Hill. ISBN-13: 978-0071604024 ISBN-10: 0071604022

Jawetz, Melnick & Adelbergs Medical Microbiology 27th ed., McGraw Hill Education ISBN-10: 0071790314 ISBN-13: 978-0071790314

PRACTICALS

Molecular Basis of Infectious Disease-Lab (BSBC-606P(A))

Isolation and enumeration of bacteriophages (PFU) from water/sewage sample
WIDAL test
Gram staining
Acid fast staining
Permanent slides of pathogens: Mycobacterium tuberculosis, Leishmania, Plasmodium falciparum
MIC determination using Kirby Bauer / Alamar Blue assay
Fungal staining
Research and presentation on current trends in infectious diseases

Plant Biochemistry
(BSBC-603B)

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.

Course Learning Outcomes

Successful completion of this course will provide students with the following learning outcomes:
Understanding of plant cell structure and organization. Understanding of the biochemical processes and metabolic pathways specific to plants, including photosynthesis, photorespiration, cell wall biosynthesis, nitrogen fixation and assimilation and plant secondary metabolism. Gaining insight on how plants have evolved to cope up with the different stress conditions. Understanding of the basic concepts of plant tissue culture and its application in generating transgenic crops.

UNIT I: Introduction to plant cell structure and carbon fixation

Introduction to Plant cells, Plasma membrane, Vacuole and Tonoplast membrane, Cell wall, Plastids and Peroxisomes. Photosynthesis and Carbon assimilation. Structure of PSI and PSII complexes, Light reaction, Cyclic and non-cyclic photophosphorylation, Calvin cycle and regulation; C4 cycle and Crassulacean acid metabolism (CAM), Photorespiration, Photo inhibition of photosynthesis, Photosynthetic carbon reduction (PCR) cycle, Synthesis of polysaccharides in plants.

UNIT II: Respiration

Overview of glycolysis, Alternative reactions of glycolysis, Regulation of plant glycolysis, Translocation of metabolites across mitochondrial membrane, TCA cycle, electron transport chain, Alternative NAD(P)H oxidative pathways; Cyanide resistant respiration.

UNIT III: Nitrogen metabolism

Biological nitrogen fixation by free living and in symbiotic association; Structure and function of the enzyme nitrogenase. Nitrate assimilation: Nitrate and Nitrite reductase. Primary and secondary ammonia assimilation in plants; ammonia assimilation by gutaminesynthetase-glutamine oxoglutarate amino transferase (GS-GOGAT) pathway. Seed storage proteins in legumes and cereals.

UNIT IV: Regulation of plant growth and stress physiology

Introduction to plant hormones and their effect on plant growth and development, Regulation of plant morphogenetic processes by light.Plant stress, Plant responses to abiotic and biotic stresses, Water deficit and drought resistance, Flooding, Temperature stress, Salt stress, Ion toxicity, Pollution stress and potential biotic stress (insects and diseases).

UNIT V: Secondary metabolites and toxins

Representative 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.

Plant tissue culture and biotechnology

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. Germplasm storage and cryo- preservation. Brief introduction to transgenic plants.

References

Caroline Bowsher, Martin steer, Alyson Tobin (2008), Plant Biochemistry, Garland science ISBN 978-0-8153-4121-5.
Buchann(2015), Biochemistry and molecular Biology of plant, 2edition. Publisher: I KInternational. ISBN-10: 8188237116, ISBN- 978047 07 14218
P.M Dey and J.B. Harborne (Editors) (1997), Plant Biochemistry, Publisher: Academic Press ISBN-10:0122146743, ISBN-13:978-0122146749

Additional Reading

Taiz and Zeiger, Plant Physiology, 5th edition, Sinauer Associates Inc.ISBN-13: 978-0878938667, ISBN-10: 0878938664

PRACTICALS

Plant Biochemistry-Lab

(BSBC-606P(B))

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

Advanced Methodologies
(BSBC-603C)

Course Objectives

The objective of the course is to provide students with a sound background of latest techniques used in biochemistry research and to provide them with an understanding of the principles underlying these techniques. The course is designed to impart laboratory skills in the form of practical exercises so that students can apply this knowledge to augment their research acumen and improve their understanding of the subject.

Course Learning Outcomes

Students will acquire knowledge about the principles and applications of latest methods used to analyze nucleic acids and proteins. Students will learn about the principle and applications of microscopy and various cell biology techniques. Students will also be exposed to various methods of labeling DNA, proteins and whole cells and their applications in research.The course will also provide them an opportunity for hands-on-experience to develop their laboratory skills expected of any biochemist working in a research lab.

UNIT I: Methods for analysis of nucleic acids

Hybridization methods: Southern blotting, Northern blotting, *In situ* hybridization, Colony hybridization. Binding of nucleic acids with protein: DNA pull down assays, Electrophoretic Mobility Shift Assay (EMSA), DNA footprinting, Primer Extension, Chromatin immunoprecipitation (ChIP), ChIP on ChIP. Gene expression analysis: Reporter assays - example luciferase assay, DNA Microarrays, RNA seq.

UNIT II: Methods for analysis of proteins

Protein-Protein Interaction: Immunoprecipitation, Co-Immunoprecipitation (Co-IP), Pull down assays, Yeast two hybrid, Protein fragment complementation assay, Western blotting, Far western blotting, Protein microarrays, ELISA. Protein Separation: Isoelectric focusing, 2D protein gel electrophoresis, 2D-DIGE, Pulse field Electrophoresis; Structural Analysis: Mass Spectrometry, MS/MS, LC/MS.

UNIT III: Microscopy based methods

Fluorescence microscopy, Scanning electron microscopy, Transmission electron microscopy, Confocal microscopy

UNIT IV: Cell Biology techniques

Cell culture and transfection, Immunohistochemistry, Immunofluorescence, Flow cytometry, FACS, TUNEL assay, Non-invasive scanning of soft tissue

UNIT V: Labeling methods

Radioactive and Non-radioactive labeling: DNA, Proteins, Whole cells, Fluorescent labeling. DNA, Proteins, bacteria, living cells; Metabolic labeling, Pulse chase analysis

References

Protein-Protein Interactions: Methods and Applications (Methods in Molecular Biology) (2004) Vol. 261, Haian, F. (ed), Humana Press (Totowa, NJ), ISBN: 1-58829-120-0 / ISBN: 978-1588291202.

Protein-Protein Interactions: A Molecular Cloning Manual (2005) 2nd ed., Golemis, E.A. and Adams, P.D., Cold Spring Harbour Laboratory Press (New York), ISBN: 0879697237/ ISBN: 13: 9780879697235.

The Ultimate Guide to Your Microscope (2008) Levine, S. and Johnstone, L., Sterling, ISBN: 9781402743290.

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.

Principles and Techniques of Biochemistry and Molecular Biology (2010) 7th ed., Wilson, K., and Walker, J. (eds), Cambridge University Press (New Delhi), ISBN: 978-0-521-73167-6 / ISBN: 978-0-521-51635-8.

Introduction to Instrumentation in Life Sciences (2012) Bisen, P.S. and Sharma, A., CRC Press/Taylor and Francis Group (California), ISBN: 978-1-4665-1240-5.

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.

Biophysical Chemistry (2013), Schimmel, C.R.C., Macmillan Higher Education, ISBN : 0716738619, 9780716738619.

Current Protocols in Protein Science (2013) Coligan, J.E., Dunn, B.M., Speicher, D.W., Wingfield, P.T., Lippincott-Schwartz, J. and Yamada, K.M., John Wiley and Sons (Somerset, NJ), Print ISSN: 1934-3655 / Online ISSN: 1934-3663.

Current Protocols in Molecular Biology (2013) Ausubel, F.M. et al., John Wiley and Sons (Somerset, NJ), Print ISSN: 1934-3639 / Online ISSN: 1934-3663.

Current Protocols in Immunology (2013) Coligan, J.E. et al., John Wiley and Sons (Somerset, NJ), Print ISSN: 1934-3671 / Online ISSN: 1934-368X.

Current Protocols in Cell Biology (2013) Bonifacino, J.S., Dasso, M., Harford, J.B., Lippincott-Schwartz, J. and Yamada, K.M., John Wiley and Sons (Somerset, NJ), ISBN: 1934-2500.

PRACTICALS

Advanced Methodologies-Lab
(BSBC-606P(C))

Western Blotting
Southern hybridization
Labeling DNA with Biotinylated primers using PCR
EMSA
Protein Pull down assay
Virtual lab on Microarray profiling or 2D DIGE

Project /Dissertation
(BSBC-607P)