

Deccan Education Society's  
**FERGUSON COLLEGE, PUNE**  
**(AUTONOMOUS)**

**SYLLABUS UNDER AUTONOMY**  
**SECOND YEAR B.Sc. BIOTECHNOLOGY**

**SEMESTER –I**

**Academic Year 2017-2018**

### BTH 2301-Cell Biology I (3C)

Sr. No.	Topic	Lecture (Total 45)
1	<b>Introduction to Cell and its functions.</b> Comparative account of archeabacteria, prokaryotic and eukaryotic cells. Cell structure, cellular diversity, cell types.	5
2	<b>Structure and function of cell organelles:</b> Endoplasmic reticulum, Mitochondria, Chloroplast, Ribosomes Golgi body, nucleus, lysosomes, vacuoles, peroxysomes and Glyoxysomes, Plastids	15
3	<b>Plasma membrane, cytoskeleton and extra cellular matrix:</b> Organization and properties of plasma membrane. Cytoskeleton- Structure- assembly and disassembly of cytoskeleton elements, Extracellular matrix and cell junctions- relevance to tissue structure, Plamodesmata- structure and function Plant cell wall - primary and secondary, glycocalyx	15
3	<b>Cell Cycle and its regulation:</b> Mitosis, meiosis in plants and animals, Phases of cell cycle. Checkpoints and regulation of cell cycle	10

#### Learning Outcome:

#### The students should acquire the knowledge about:

- Ultra structure of organelles in a eukaryotic cell
- Structure of Cytoskeletal elements, plasma membrane and Cell wall
- Cell Cycle phases and its importance.

#### Reference Books:

1. Molecular Cell Biology. Lodish H., Berk A, Kaiser C., KReiger M., Bretscher A., Ploegh H., Angelika Amon A., Matthew P. Scott M.P., 7th Edition, (2012) W.H. Freeman and Co., USA
2. Molecular Biology of the Cell, Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter, 5th Edition (2007) Garland Science, USA
3. Cell Biology, Gerald Karp. 6th edition, (2010) John Wiley & Sons., USA
4. The Cell: A Molecular Approach, Geoffrey M. Cooper, Robert E. 6th edition (2013), Hausman, Sinauer Associates, Inc. USA
5. Becker's World of then Cell, Jeff Hardin, Gregory Bertoni, Lewis J.Kleinsmith, 8<sup>th</sup> Edition (2016), Pearson Education Limited, USA

### BTH2302 Molecular Biology I (3C)

Sr. No.	Topic	Lecture (Total 45)
1	<b>Nucleic acids - structure, properties and function:</b> a. DNA forms; A, B & Z b. Different classical experiments leading to evidence of DNA as genetic material c. Structure of DNA - Watson & Crick model d. RNA: tRNA, rRNA , mRNA and non-coding RNA (Mi-, SiRNA)	12
2	<b>Genome Structure and Organization</b> Organization of viral, prokaryotic and eukaryotic genomes Structure of chromatin, nucleosomes, higher order organization- chromosome, centromere, telomere	8
3	<b>DNA Replication and Regulation</b> DNA polymerases in prokaryotes and eukaryotes Mechanism of DNA replication and regulation in prokaryotes and eukaryotes	10
4	<b>DNA damage and Repair</b> Types of DNA damage: radiation, chemical, oxidative, intercalating agents DNA repair mechanisms- nucleotide excision repair, base excision repair, mismatch repair, recombination repair, double strand break repair	10
5	<b>Recombination</b> Homologous and site-specific recombination, models for homologous recombination- Holliday junction Proteins involved in recombination- RecA, RuvA, B, C	5

#### Learning Outcome:

##### The students should acquire the knowledge about:

- How different genomes are packaged and organized
- Molecular Biology processes like replication its regulation
- DNA alterations by mutations and recombination

#### Reference Books:

1. Genes XI, 11th edition (2012), Benjamin Lewin, Publisher - Jones and Barlett Inc. USA
2. Molecular Biology of the Gene, 6th Edition (2008), James D. Watson, Tania Baker, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Lodwick. Pearson Education, Inc. and Dorling Kindersley Publishing, Inc. USA
3. Molecular Biology, 5th Edition (2011), Weaver R., McGraw Hill Science. USA
4. Fundamentals of Molecular Biology, (2009), Pal J.K. and Saroj Ghaskadbi, Oxford University Press. India
5. Molecular Biology: genes to proteins, 4th edition (2011), Burton E Tropp, Jones & Bartlett Learning, USA

### BTH2303 Metabolic Pathways (3C)

Sr. No.	Topic	Lectures (Total 45)
1	<b>Introduction to metabolism:</b> Metabolic pathways: Metabolites, Catabolism, Anabolism, Principal characteristics of metabolic pathways. Organic reaction mechanisms: Electrophilic and Nucleophilic reactions; biologically important nucleophilic (hydroxyl, sulfhydryl, amino, imidazole) and electrophilic (protons, metal ions, carbonyl carbon, Schiff base) groups, Group transfer reactions (acyl, phosphoryl, Glycosyl group), Oxidation and Reduction (FAD and NAD mediated), Elimination (dehydration as an example), Isomerization (aldose-ketose), Condensation and Decarboxylation reactions	10
2	<b>Carbohydrate and energy metabolism:</b> Intracellular metabolism of glucose - Glycolysis, fates of pyruvate, Gluconeogenesis, TCA cycle, Glycogenesis, Glycogenolysis, Pentose Phosphate Pathway, Regulation of Glycolysis, TCA cycle and Glycogen metabolism. Oxidative phosphorylation and Electron Transport Chain: Sequence of electron carriers, Oxidative Phosphorylation, ATP synthesis	15
3	<b>Non-carbohydrate metabolism</b> i) Lipid metabolism: Triglycerides, Transport of fatty acid into mitochondria, $\beta$ -oxidation of fatty acids, reactions and energetic of beta oxidation, Biosynthesis of fatty acid, Overview of biosynthesis of Phospholipids and Cholesterol, Metabolism of ketone bodies ii) Protein metabolism: General reactions of amino acid metabolism (Oxidative deamination, Transamination, Decarboxylation), Glucogenic and ketogenic amino acids, Urea cycle, Amino acid biosynthesis; overview, metabolic precursor-based grouping. Disorders of amino acid metabolism.	20

#### Learning Outcome:

The students should acquire knowledge about:

- Basic aspects of metabolism and various reaction mechanisms.
- Metabolism of biomolecules, its regulation and malfunction.

#### Reference books:

1. Outlines of Biochemistry, Eric Conn and Paul Stumpf, 5<sup>th</sup>edi.,2009, Wiley and Sons, USA.
2. Biochemistry, Donald Voet and Judith Voet, 4<sup>th</sup>edi.,2012, John Wiley and Sons, Inc. USA
3. Biochemistry, Jeremy Berg, LubertStryer, 7<sup>th</sup>edi.,2006, W.H. Freeman and company, NY
4. Principles of Biochemistry, Albert Lehninger, David Nelson and Michael Cox,5<sup>th</sup> edi., 2008, W.H. Freeman and company, NY.
5. Harper's illustrated biochemistry, Victor Rodwell, David Bender, Kathleen Botham, Peter Kennelly, P Weil, 30<sup>th</sup>edi., 2015, McGraw Hills publications.

**BTH 2304: MEDICAL MICROBIOLOGY AND IMMUNOLOGY**

UNIT. No	Title and Contents	No. of Lectures
	<b>MEDICAL MICROBIOLOGY</b>	
<b>I</b>	<p><b><u>BASICS IN MEDICAL MICROBIOLOGY</u></b></p> <p><b><u>1. Types of Infectious Diseases</u></b></p> <p>a. Common Terminologies used in Medical Microbiology            b. Reservoirs of Infection            c. Sites of entry, exit and transmission, types of transmission between humans, transmission from animals.            d. Concepts of normal flora            e. Epidemiology types</p> <p><b><u>2. Pathogenesis of Bacterial Diseases</u></b></p> <p>a. Reservoirs of Bacterial pathogens            b. Mechanisms of bacterial invasion growth and            c. multiplication of pathogens            d. Bacterial virulence factors            e. Bacterial toxins</p> <p><b><u>Pathogenesis of Viral Diseases</u></b></p> <p>a. Routes of entry            b. Viral spread</p> <p>Significance of Incubation Period            Virioids and Prions – Significance in Medical Microbiology</p> <p><b>4. Pathogenesis of protozoan diseases</b>  <b>5. Pathogenesis of fungal diseases</b></p>	<p align="center">2</p> <p align="center">5</p> <p align="center">3</p>
<b>II</b>	<p><b><u>HOST PARASITE INTERACTIONS</u></b></p> <p>Detailed Study of following infections including Etiology, Transmission, Pathogenesis, Laboratory diagnosis.</p> <p><b><u>1. Respiratory tract infections:</u></b></p> <p>a. Diphtheria            b. Influenza virus infection</p> <p><b><u>2 . Central nervous system infections:</u></b></p> <p>Tetanus            Polio</p> <p><b><u>3. Gastrointestinal tract infections:</u></b></p> <p>Diarrheal diseases caused by bacteria or viral infection            Entamoeba</p>	<p align="center">10</p>

	<p>4. <b><u>Vector borne infections:</u></b>  Dengue  Filariasis</p> <p><b><u>Multi system zoonosis:</u></b>  . Anthrax  . Plague</p> <p><b><u>Infections of skin and soft tissue:</u></b>  a. Fungal infections of skin  b. Bacterial infections of the skin</p> <p>7. <b><u>Urinary tract infections :</u></b>  a. Candida</p>	
III	<p><b><u>APPLIED MICROBIOLOGY ( Tie up with hospitals and development of Questionnaire )</u></b>  Activity (survey/ case study etc) related to the following:  Noscomial infections  Pyrexia of unknown origin  Emerging and reemerging diseases</p>	2
	<b>IMMUNOLOGY</b>	
IV	<b>Introduction to Immunology</b>	1
V	<p><b>Cells, Tissues and Organs of Immune system</b>  <b>Cells:</b>  - Leukocytes  - NK cells , Macrophage , Dendritic cells  <b>Tissues:</b>  -GALT , BALT and MALT  <b>Primary and secondary lymphoid organs:</b>  -Bone marrow  - Thymus  - Spleen  - Lymph node</p>	4
VI	<p><b>Types of Immunity</b>  <b>Innate immune response :</b>  i. External barriers  - Skin and mucous membranes  - Chemical secretions  - Normal microflora  ii. Inflammation  <b>Acquired immune response :</b>  i. Humoral immune response  ii. Cell mediated immune response  <b>MHC complex and development of immunity</b>  - MHC-I and MHC-II molecules – structure and function  - Antigen processing and presentation by exogenous and endogenous pathways</p>	5

VII	<b>Structure and function of Antigen and Antibody</b> - Epitopes , Paratopes , Haptens -AntigenecityVsImmunogenecity -Factors influencing immunogenicity -Basic structure of antibody -Fine structure of antibody -Functions of immunoglobulins -Antigenic determinants on immunoglobulins ( Isotype, Allotype and Idiotype)	5
VIII	<b>Antigen- Antibody Reactions</b> Precipitation reaction ( Immunodiffusion and Immunolectrophoresis ) Agglutination reaction ( Haemmaglutination or Blood typing) ELISA, Western Blot , FACS , Complement Fixation and Immunofluorescence	5
IX	<b>Vaccines</b> Active and Passive Immunization Types of Vaccines : Attenuated live Vaccine, Killed Vaccine, Subunit vaccine , Recombinant vector vaccine , DNA vaccine , Toxoids etc.	3

### Learning Objectives:

1. To understand host–parasite interactions by in-depth study of pathogenesis of various microbial parasites
2. To study and understand infectious agents colonizing various organs and systems in human body.
3. To equip the students with a thorough knowledge of the clinical features and diagnosis of each of these
4. To understand the term “Resistance “against infection.
5. To get an idea about antigen antibody reactions.
6. To acquire the knowledge on immunization.

### References

1. Evolution of Infectious Disease. Ewald PW. Oxford University Press, New York. 1994. ISBN 0-19-511139-7.
2. Emerging Infections 1. Scheld WM, Armstrong D and Hughes JM, Editors. ASM Press, Washinton, DC. 1998. ISBN 1-55581-123-3.
3. Emerging Infections 2. Scheld WM, Craig WA and Hughes JM, Editors. ASM Press, Washington, DC. 1998. ISBN 1-55581-141-8.
4. Pathology of Emerging Infections. Horsburgh, CR Jr and Nelson AM, Editors. ASM Press, Washington, DC. 1997. ISBN 1-55581-20-5.
5. Pathology of Emerging Infections 2. Nelson AM and Horsburgh, CR Jr, Editors. ASM Press, Washington, DC. 1998. ISBN 1-55581-140-X.
6. Emerging Viruses. Morse SS, Editor. Oxford University Press, New York. 1993. ISBN 0-19-510484-6.
7. Tortora, Funk and Case: “Microbiology, an Introduction”; 6th edn. Benjamin/ Cummings Publishing company, California (1998)
8. “Schaechter’s Mechanisms of Microbial Disease” by N. Cary Engleberg, Terry Dermody, and Victor DiRita. 4th Edition.
9. Godkar, Praful B: Textbook of Medical Laboratory Technology Reprint edn Bhalani Publishing house, (1998)

10. Koneman, Elrner W. Allen, Stephen D., Janda, William M. Schreckenberge, Paul C.: Color Atlas and textbook of diagnostic microbiology 5th edn. Lippincott-Raven Publishers, Philadelphia (1997).
11. Kuby, Janice: Immunology- 6th edn. W.H. Freeman and Company, New York (1991)
12. Mackie T J., McCartney, J.E.: Practical Medical Microbiology Vol1 and 2 – 13th edn. Churchill Livingstone, New York (1989)
13. Mukherjee, Kanai L.:Medical Laboratory Technology – Reprint edn. Tata MacGraw Hill Publishing Co. Ltd., New Delhi (1988).
14. Dey, N.C and Dey, TK. 1988, Medical Bacteriology, Allied Agency, Calcutta, 17thEdition
15. Ananthnarayana, R. and C.E, Jayaram Panikar, 1996 Text book of microbiology, 5th edition, OrientLongman.
16. Park and Park, Preventive and Social medicine.2013, Publisher: Banarsidas Bhanot
17. Davis B.D., DeBacco, 1990 Microbiology 4th edition, J.B. Lippincott Co. NY
18. Wolfgang K. Joklik, 1992, Zinsser Microbiology 20<sup>th</sup> Edition, McGraw-Hill Professional
19. F.H. Khan 2009. The Elements of Immunology , Pearson Education Publishing .



## BTH 2305: Fundamentals of Genetics

Sr. No.	Topic	Lectures
01	<b>Genetic basis of Inheritance-</b> Variations, Heredity, Pre- Mendelian concept ,Importance of Genetics	02
02	<b>Mendel and his work-</b> Laws of Inheritance, Monohybrid and Dihybrid Ratio, Back cross and Test cross.	05
03	<b>Post-Mendelian Discoveries-</b> Incomplete Dominance, Codominance, , Dominant and Recessive Epistasis, Complementary Genes, Supplementary Genes, Pleiotropy, Multiple alleles, lethal Genes.	08
04	<b>Chromosomal aberrations-</b> Variation in chromosome Number-Types, generation of variation. Aneuploidy, dosage compensation and barr bodies Variation in chromosome structure- Types, generation of variation, Identification of heterozygotes due to chromosomal variations, Consequences	08
05	<b>Operon Concept-</b> Inducible and repressible operons, positive and negative regulation, Lactose, Tryptophan and Arabinose operons pertaining to their structure and regulatory mechanisms.	06
06	<b>Linkage and Linkage maps-</b> Concept, Complete and Incomplete linkage, Three point cross, Genetic mapping , chromosome interference, analysis of ordered and unordered tetrads. Sex linked Inheritance (X linked and Y linked) ,sex- influenced and Sex-limited genes, Significance of Linkage.	08
07	<b>Crossing Over-</b> Mitotic crossing over and Meiotic crossing over	04
08	Inbreeding, Outbreeding , Hybrid Vigour. Evolutionary significance	04

### Learning outcomes:

1. Concepts and importance of genetics
2. Chromosomal aberrations
3. Concept of operon and linkage and linkage maps
4. Mitotic and Meiotic crossing over

### References:

1. Genetics, (2006) Strickberger MW - (Prentice Hall, India)
2. Snyder L, Champness W (2007) – Molecular genetics of bacteria (ASM Press, Washington)
3. Hartl DL, Jones EW (2001) – Genentics: analysis of genes and genomes (Jones and Bartlett, Massachusetts)
4. Griffiths AJ, Wessler SR, Carroll SB, Doebley J (2012) – Introduction to genetic analysis (Freeman & Co, New York) tenth edition.

## BTH- 2306: Animal Development

Sr.No	Topic	Lectures
1	Gametogenesis: Oogenesis; Continuous and Discontinuous with examples Spermatogenesis: Meiosis and Spermiogenesis Structure of mature gametes	5
2	Fertilization: Sperm Hyperactivation, Egg Metabolic Activation, Early and Late Responses, Cytoplasmic Rearrangement	6
3	Cleavage patterns and importance: Correlation with amount of yolk	3
4	Blastula and fate maps; Morphogenetic Movements, Comparative account of Gastrulation in Amphioxus, Frog and Chick	8
5	Formation of body plan using Drosophila as a model system	5
6	Concept of Cell Lineage, Cell potency, determination commitment and differentiation	4
7	Induction; Different experiments to prove inductive interactions, Neurulation, Optic Induction and overview of Organogenesis	6
8	Post embryonic Development: Metamorphosis (Frog and Drosophila), Regeneration ( Hydra and Salamander model systems), Aging and Death	8

### Learning Outcome:

The student should understand the concept of early development, preprogrammed events and various molecular and cellular events responsible for success in animal development

### Reference books:

- Developmental Biology (VIII edition) S. F. Gilbert.
- Principles of Development (III edition) Lewis Wolpert
- An Introduction to Embryology (V edition). B. I. Balinsky.
- Developmental Biology: R. M. Twyman. Bios Scientific Publishers LTD. New Delhi (2001)

### BTH 2307: English grammar and communication (3C)

Sr. No	Topic	Lectures (Total 45)
1	The Noun: Kinds, Gender, Number, Case The Adjective: Kinds, comparison, adjectives used as nouns, position of the adjectives, correct use of some adjectives	3
2	Articles and Pronouns : correct use Verb : Transitive and intransitive Adverb: comparison, correct position of adverbs	4
3	Active and passive voice, voice in all tenses Tense: Types and uses	4
4	Preposition and conjunction: types, use in different sentences Clauses: Adverb, Adjective, Noun	3
5	Sentences: Types, simple, compound, complex Figures of speech: all types, correct use Activity based on using correct language	3
6	Making oral presentation : Pronunciation, accent, intonation, clarity, speed, fluency, eye contact; Planning and organization	3
7	Effective written presentation: order of sentences in a paragraph, sentence connection, cohesion and coherence; contradiction, tautology, semantic anomaly, circumlocution	3
8	Enrichment of vocabulary: word forms and derivations, prefixes and suffixes, other processes of word formation, scientific and technical vocabulary, spellings, frequently confused words.	3
9	Difficult words, typical words and sentences, formats used for effective communication	2
10	Using the dictionary and thesaurus The curriculum vitae: its importance, difference between Bio data, résumé and CV	3
11	Letter writing: formal and informal letters on different science related topics	3
12	Report writing: on different scientific and non scientific topics	3
13	News writing: on different scientific and non scientific topics	3
14	Essay writing: on different scientific and non scientific topics	3

#### Learning Outcomes:

- To improve oral and written communication.
- Correct use of language for effective communication.

## References:

1. English grammar and composition by Wren and Martin
2. Scientists Must Write. 2nd Edition, (2002), Barrass, R., Routledge, Oxon, UK
3. How to Write and Publish a Scientific Paper. 6th Edition, (2006), Day, R.A. and B. A.
4. Gastgel, Greenwood Press, Westport, CT, USA.
5. Medical Writing: A prescription for clarity. 3rd Edition, (2006), Goodman, N.W. and M.B. Edwards, Cambridge University Press, Cambridge, UK.
7. Planning, Proposing and Presenting Science Effectively, 2nd Edition, (2006), Hailman, J.P. and K. B. Strier, Cambridge University Press, Cambridge, UK.
9. 5. Biomeasurement: Understanding, Analysing and Communicating Data in Biosciences, (2005), Hawkins, D., Oxford University Press, Oxford, UK.
- 10.

### BTH- 2308: Practicals in Animal Development and Genetics

Sr. No.	Topic	Practicals (15 P )
1.	Study of different types of egg types	1P
2.	Study of frog developmental stages	1P
3.	Chick embryo culture by filter paper ring technique/ shell less culture	4P
	Chick embryo mounting, staging and staining (24h, 48h, 72h, 96h)	4P
5.	Demonstration of regeneration in hydra	2P
6.	Karyotype Analysis	1P
7.	Study of Polytene chromosomes- preparation of slides	2P

**Learning outcomes:** After completing the practicals students should be able to do the following:

1. Identify the developmental stage of chick embryo
2. Identification of third instar larvae and isolation of imaginal disc
3. Determine the nutritive value and calorific value

### BTH2309 Exercises in Molecular Biology and Metabolic Pathways (2C)

Sr. No.	Topic	Practical (15Px2H)
	<b>Molecular Biology</b>	
1	Reagent preparation: Calculation of Molarity, Normality, Ionic strength	1
2	Bacterial DNA isolation and agarose gel electrophoresis Quantification of DNA by UV-Spectroscopy	3
3	Eukaryotic DNA isolation and agarose gel electrophoresis	3
4	SDS-PAGE separation of proteins and staining and destaining of protein gels.	4
5	Cholesterol estimation from clinical sample	2
6	Liver function tests	2

#### Learning outcome:

- Students will learn basic techniques in handling DNA and proteins, their quantification.
- They will also learn tests to detect abnormalities in metabolism

### BTH2310 Practicals in Cell Biology, Medical Microbiology and Immunology

	Title of Experiment/ Practical	Practical (15P)
1	Study of Normal flora of humans (Skin and oral cavity)	1
2	Enrichment and colony characteristics of samples -pus, urine	1
3	Identification of Candida species using the germ tube test and growth on Crome Candida differential agar	1
4	Electron Micrographs of any 2 pathogenic viruses/ virioids/ prions	1
5	Ouchterlony Double Diffusion	1
6	Radial Immunodiffusion	1
7	Immunoelectrophoresis	1
8	Blood agglutination.	1
9	Study of mitosis (onion root tip ) and meiosis (grasshopper testis/ <i>Tradescantia</i> )– preparation of slides and identification of different stages Effect of colchicine on mitosis.	3
10	Study of polytene chromosomes – preparation of slides	2
11	Micrometry – measurement of cell size and nucleus from various cell types	2

#### Learning Objective

1. To get hands on training in antigen antibody reaction in gel and in blood.
2. To get acquainted with the normal flora of humans
3. To understand the growth pattern of organisms from samples.
4. To understand and observe different cell cycle phases

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**SEMESTER –II**

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### BTH 2401 Cell Biology II (3C)

Sr. No.	Topic	Lecture (Total 45)
1	<b>Types and modes of membrane transport:</b> Passive and active and secondary active transport, membrane potential. Channels and carriers. Exocytosis, endocytosis, pinocytosis and phagocytosis.	08
2	<b>Cell signaling and communication:</b> communication between cells and environment. Signaling at cell surface, signaling molecules, hormones and receptors signaling pathways, signal transduction and second messengers.	12
3	<b>Protein trafficking and targeting-</b> Biogenesis of membrane proteins in organelles, intracellular protein trafficking, vesicle transport.	12
3	<b>Neoplasia:</b> Cell transformation pathways, role of checkpoints. Oncogenes and tumor suppressors. Types and properties of tumor cells.	10
4	<b>Cell death:</b> Programmed cell death and necrosis, molecular mechanism and apoptotic pathways. Regulation and control of apoptosis.	08

#### Learning Outcome:

#### The students should acquire the knowledge about:

- Transport of molecules across plasma membrane.
- Cell signaling and its role in cancer and cell death

#### Reference Books:

1. Molecular Cell Biology. Lodish H., Berk A, Kaiser C., KReiger M., Bretscher A., Ploegh H., Angelika Amon A., Matthew P. Scott M.P., 7th Edition, (2012) W.H. Freeman and Co., USA
2. Molecular Biology of the Cell, Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter, 5th Edition (2007) Garland Science, USA
3. Cell Biology, Gerald Karp. 6th edition, (2010) John Wiley & Sons., USA
4. The Cell: A Molecular Approach, Geoffrey M. Cooper, Robert E. 6th edition (2013), Hausman, Sinauer Associates, Inc. USA
5. Becker's World of then Cell, Jeff Hardin, Gregory Bertoni, Lewis J.Kleinsmith, 8<sup>th</sup> Edition (2016), Pearson Education Limited, USA

## BTH2402 Molecular Biology II (3C)

Sr. No.	Topic	Lecture (Total 45)
1	<b>Structural features of coding and non-coding DNA:</b> Definition of gene – introns/exons, Regulatory sequences, promoters, enhancers and suppressors Gene families, clusters, Pseudogenes, super-families, Organelle genomes	12
2	<b>Transcription and its Regulation:</b> RNA polymerases Mechanisms of transcription in prokaryotes and eukaryotes and its regulation	8
3	<b>Genetic Code:</b> a. Major scientific contributions (experimental) to decipher genetic code b. Concept of codon, reading frame, frame shift c. Degeneracy of codon	8
4	<b>Translation Mechanism:</b> a. In Prokaryotes b. In Eukaryotes c. Inhibitors of translation	12
5	<b>Post-translational modifications for protein targeting:</b> a. Protein localization: glycation, glycosylation, phosphorylation b. Protein degradation: ubiquitination, SUMOylation	5

### Learning Outcome:

The students should acquire the knowledge about:

- Structural organization of DNA
- Various Molecular Biology processes like transcription, translation and its regulation
- Post-translational modifications to proteins

### Reference Books:

1. Genes XI, 11th edition (2012), Benjamin Lewin, Publisher - Jones and Barlett Inc. USA
2. Molecular Biology of the Gene, 6th Edition (2008), James D. Watson, Tania Baker, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Lodwick. Pearson Education, Inc. and Dorling Kindersley Publishing, Inc. USA
3. Molecular Biology, 5th Edition (2011), Weaver R., McGraw Hill Science. USA
4. Fundamentals of Molecular Biology, (2009), Pal J.K. and Saroj Ghaskadbi, Oxford University Press. India
5. Molecular Biology: genes to proteins, 4th edition (2011), Burton E Tropp, Jones & Bartlett Learning, USA

## BTH 2403 Protein Biochemistry and Enzymology (3C)

Sr. No	Topic	No. of lectures
1.	<u>Introduction to protein structure and function:</u> Biological diversity of proteins: functional roles of proteins within cells, Common structural features, classification by R group, Zwitter ion structures, acid-base properties; Essential amino acids, Classification and different structural levels (Primary, secondary, tertiary & quaternary) of proteins	5
2.	<u>Catalytic strategies:</u> Specificity of enzyme action, hypothesis (lock and key, induced fit), Basic catalytic principles: Covalent catalysis, Acid-base catalysis, Metal ion catalysis, catalysis through Proximity and Orientation effects. Mechanism of action of Lysozyme and Serine protease	15
3.	<u>Enzyme kinetics:</u> Enzyme nomenclature, enzyme co-factors, Kinetics of single-substrate enzyme reactions; Time course of enzymatic reactions, effect of substrate concentration on velocity, rapid equilibrium model, Steady state model, Significance of $K_{cat}$ and $K_m$ , Quantitative assay of enzyme activity: Unit of enzyme activity, specific activity, turnover number, Factors affecting enzyme catalyzed reaction: concentration, temperature, pH, time and cofactors. Other linear transformations of enzyme kinetic data, Inhibition of enzyme catalyzed reaction: reversible and irreversible inhibition, linear-mixed type inhibitions and their kinetics.	7
4.	<u>Enzyme regulation:</u> Allosterism, Feedback inhibition and feed forward stimulation. Reversible (phosphorylase) and irreversible (proteases) covalent modifications of enzymes. Isoenzymes: Properties, measurement and significance	8
5.	<u>Methods of enzyme purification and characterization :</u> salting in, salting out, dialysis, solvent fractionation, ultrafiltration, ultracentrifugation, ion exchange chromatography, molecular exclusion chromatography, affinity chromatography, electrophoresis- Native and SDS-PAGE	10

### Learning outcome:

After completion of this course student is expected to know basic principles of enzymology, how enzymes work in biological systems and how enzymes are purified and characterized.

### References:

1. Fundamentals of Enzymology, Nicholas C. Price and Lewis Stevens, 3<sup>rd</sup> ed., 1999, Oxford University Press.
2. Principles of Biochemistry, Albert Lehninger, David Nelson and Michael Cox, 5<sup>th</sup> ed., 2008 W.H. Freeman and company, NY.
3. Biochemistry, Jeremy Berg, Lubert Stryer, 7<sup>th</sup> ed., 2006, W.H. Freeman and company, NY
4. Enzymes: Biochemistry, Biotechnology and Clinical Chemistry, Trevor Palmer, Philip Bonner, 2<sup>nd</sup> ed., 2014, Woodhead Publishing Ltd.

5. Biochemistry, Donald Voet and Judith Voet, 4<sup>th</sup>ed., 2012, John Wiley and Sons, Inc. USA
6. Biochemical calculations, Irwin Segel, 2<sup>nd</sup> ed., 2010, Wiley publications, USA
7. An Introduction to practical Biochemistry, David Plummer, 3<sup>rd</sup> ed., 2004, Tata McGraw Hill Publishers Co. Ltd.,New Delhi.

## BTH 2404: FOOD AND DAIRY MICROBIOLOGY

I	<b>FOOD MICROBIOLOGY</b>	
1.	<b>Classification of food based on shelf life</b> Perishable, Semi-perishable & stable	1
2.	<b>Factors influencing microbial growth in food</b> •Intrinsic •Extrinsic	2
3.	<b>Spoilage of different groups of food:</b> i.Meat and meat products ii.Cereal and Cereal products iii.Fruits and Vegetables iv.Eggs& Poultry v.Fish& other Sea foods vi.Canned /Packed food	3
4.	<b>Food Preservation:</b> General principles of food preservation Concepts of TDT, TDP,D , Z & F value & its significance <b>Methods of Food Preservation:</b> Use of Chemicals & Antibiotics (Added and Developed Preservatives) Radiations Low and High Temperature Canning (Process in detail) New and Emerging Non Thermal techniques in Food Preservation	5
5.	<b>Microbial Foodborne diseases:</b> <b>Food poisoning by:</b> i. <i>Staphylococcus aureus</i> ii. <i>Campylobacter</i> iii. <i>Clostridium botulinum</i> iv. <i>Aspergillus flavus</i> <b>b.Food infection by :</b> i. <i>Salmonella typhimurium</i> ii. <i>Vibrioparahemolyticus</i>	5
6.	<b>Methods for detection of microbes and their products</b> •Conventional Microbiological Methods i.Sampling for microbial analysis ii.Microbial enumeration in food iii. Qualitative Methods for detection of microbes and their toxins in food iv. Tests with Fluorogenic and Chromogenic Substrates v.Rapid and new Techniques : PCR , Lux Gene Luminescence etc.	3
7.	<b>Microbiology of fermented foods</b> Definition and Types and role of starter culture and other microorganisms Oriental and Western fermented food Examples : Anarsa ,Idli , Soy Sauce ,Temphe	2
8.	<b>Food Regulation:</b> HACCP (Hazard Analysis and Critical Control Points)	1

	Food Regulatory bodies	
9.	Activity based on current trends in food industry	1

S. No	Topic	Number of Lectures
II	<b>DAIRY MICROBIOLOGY</b>	
1.	<b>Dairy Industry in India:</b> Scope and opportunities for dairy Industry.	1
2.	Composition, nutritive value and Physico-Chemical properties of dairy products.	1
3.	<b>Microbiology of milk:</b> a. Common micro-organisms found in milk b. Sources of contamination of milk c. Fermentation and spoilage of milk d. Flavour and Colour defects, Sweet curdling, and Stormy fermentation, Ropiness e. Milk borne diseases	5
4.	<b>Preservation of Milk by Pasteurization &amp; its storage:</b> a.Methods of Pasteurization – LTH, HTST, UHT b.Storage specifications after pasteurization c.Membrane Technology for Milk and Milk products.	5
5.	<b>Microbial analysis of milk:</b> a.Total bacterial count. (direct and indirect methods) b.Brucella ring test and tests for mastitis. c.Somatic cell count	4
6.	<b>Fermented Dairy Products:</b> Types (Dahi, Yogurt, Kefir,Cultured butter milk,Acidophilusmilk,different types of Cheeses) Role Starter cultures and other organisms Probiotic dairy products and their health benefits New concepts in Dairy Products.	5
7.	Milk and Milk Product Standards and Legislations in India.	1

#### Learning outcomes:

1. Gain knowledge of Food Safety & its scope in Quality Control of Foods
2. Understand the principles & methods involved in food & dairy fermentation
3. Understand preservation as an important field for a microbiologist

#### References: -

1. Food Microbiology, Frazier & Westhoff, 4th edition, Tata McGraw Hill Publications
2. Modern Food Microbiology, James Jay, 7th edition, Springer Publications
3. Food Microbiology by Adams & Moss, 3rd edition, The Royal Society of Chemistry
4. Advances in Biotechnology, S. N. Jogdand, Himalaya Publishing House
5. Milk & Milk Products, C. Eckles, 4th edition, Tata McGraw Hill Publications
6. Prescott, S.C. and Dunn, C. G., (1983) Industrial Microbiology, Reed G. AVI tech books.

## BTH2405 - Plant Development

Sr. No.	Topics	Lectures
<b>1</b>	<b>Plant Development</b> Plant as a living system Unique features of plant development Principles of plant development	2
<b>2</b>	Concept of competence, determination, commitment, differentiation, de-differentiation and re-differentiation (partial/ terminal) in vivo with one example each	2
<b>3</b>	<b>Plant development at:</b> Cellular, organ and whole-plant levels Concept of plant growth regulators Biosynthesis, Bioassay and mode of action of Auxin, Gibberellic acid, Cytokinin, Ethylene and abscisic acid	5
<b>4</b>	<b>Major phases of plant development using Arabidopsis as model system</b> Vegetative development: Zygote to seed embryo to seedling till vegetative maturity Pattern formation in plants- vegetative; axial and radial patterning; leaf development, stomata development, vascular differentiation	5
<b>5</b>	<b>Reproductive development:</b> Shift from vegetative to reproductive phase Induction- perception of inductive stimuli and subsequent changes, Pattern formation in plants- flowering; inflorescence meristem, floral whorls specification, whorl boundary specification	5
<b>6</b>	Microsporogenesis, development of male gametophyte and male gamete Megaspores, development of female gametophyte and female gamete; Double fertilization and triple fusion Development of endosperm	7
<b>7</b>	Fucus as model system to understand plant development	2
<b>8</b>	Programmed Cell Death- ageing and senescence	2
<b>9</b>	Signal transduction in plants governing growth and development	3
<b>10</b>	light mediated regulation, photoreceptors and circadian rhythm	3
<b>12</b>	Molecular basis of development Genes in radial, axial development ABC model for Flower development Embryogenesis mutants Hormonal regulation of gene expression- PGRs	5
<b>13</b>	Advanced methods/molecular methods to study plant development: imaging techniques, GWAS	4

## Learning outcome:

After completing the syllabus the students should understand-

- Different stages of plant growth and development
- Development of root, shoot and leaf
- Flower patterning, induction of flowering in response to stimulus
- Molecular basis of plant development: at genetic, hormonal and signaling mediated level
- Advanced techniques currently used to understand plant growth and development

## References:

1. Principles of Development, Wolpert L and Tickle C, 4<sup>th</sup> edition (2010), Oxford Publication. University Press, USA.
2. Embryology of Angiosperms, Bhojwani S.S. and Bhatnagar S.P.(2009) –Vikas Publishing House, New Delhi
3. An Introduction to Plant Cell Development, Burgess J. (1985), Cambridge University Press, UK
4. Plant physiology , Taiz L , and Zeiger E (2010) Sinauer Associates, USA.
5. Plant embryology: Classical and experimental , Sharma HP (2009) (alpha sci)
6. Patterns in plant development. Steeves TA & Sussex IM (2004). Cambridge University Press, Cambridge, New York)

## Reference articles (Advanced techniques)

1. Busch W, Moore BT, Martsberger B, et al. A microfluidic device and computational platform for high throughput live imaging of gene expression. *Nature methods*. 2012;9(11):1101-1106. doi:10.1038/nmeth.2185.
2. Meijón, M., Satbhai, S. B., Tsuchimatsu, T., & Busch, W. (2014). Genome-wide association study using cellular traits identifies a new regulator of root development in *Arabidopsis*. *Nature genetics*, 46(1), 77-81.
3. Fitzgibbon J, Bell K, King E, Oparka K. Super-Resolution Imaging of Plasmodesmata Using Three-Dimensional Structured Illumination Microscopy. *Plant Physiology*. 2010;153(4):1453-1463. doi:10.1104/pp.110.157941.
4. Grossmann G, Guo W-J, Ehrhardt DW, et al. The RootChip: An Integrated Microfluidic Chip for Plant Science. *The Plant Cell*. 2011;23(12):4234-4240. doi:10.1105/tpc.111.092577.
5. Fernandez, R., Das, P., Mirabet, V., Moscardi, E., Traas, J., Verdeil, J. L., ... & Godin, C. (2010). Imaging plant growth in 4D: robust tissue reconstruction and lineaging at cell resolution. *Nature methods*, 7(7), 547-553.
6. Paige JS, Wu K, Jaffrey SR. RNA mimics of green fluorescent protein. *Science (New York, N.y)*. 2011;333(6042):642-646. doi:10.1126/science.1207339.
7. Sena G, Frenz Z, Birnbaum KD, Leibler S. Quantitation of Cellular Dynamics in Growing *Arabidopsis* Roots with Light Sheet Microscopy. Grebe M, ed. *PLoS ONE*. 2011;6(6):e21303. doi:10.1371/journal.pone.0021303.



### BTH2406 Environmental Biotechnology (3C)

S.No.	Topic	Lectures
1.	<p><b>Global Environmental Problems</b></p> <p><b>a. Global Environmental Problems</b> – Green House Effect, Acid rain, El Nino, Ozone depletion, deforestation, desertification, salination, biodiversity loss; chemical and radiation hazards.</p> <p><b>b. Environmental toxicants</b> – Xenobiotic and recalcitrant compounds, Heavy metals, plastics, pesticides, herbicides, chemical fertilizers, their effects on human beings. bioaccumulation and biomagnifications.</p> <p><b>c. Introduction to Environmental Biotechnology</b>- Exploring possibilities of finding solutions to environmental toxicants .</p>	<b>8</b>
2.	<p><b>Biodegradation and Bioremediation</b></p> <p><b>a.</b> Bioremediation, advantages and disadvantages; In situ and ex-situ bioremediation; Bioremediation of contaminated ground water and oil spills</p> <p><b>b.</b> Phytoremediation of metals</p> <p><b>c.</b> Microbiology of degradation of xenobiotics(pesticide, herbicide, plastics)</p> <p><b>d.</b> Biotransformation of recalcitrant compounds.</p>	<b>10</b>
3.	<p><b>Biofertilizers and biocontrol agents</b></p> <p><b>a.</b> Plant growth promoting rhizobacteria; Biofertilizers: Nitrogen fixing microorganisms (symbiotic and non-symbiotic free living) ,Phosphate solubilizers; IAA producers. Bacteria and viruses as biocontrol agents and biopesticides; <i>B.thuringiensis</i> toxin as a natural pesticide</p> <p><b>b.</b> Development of disease resistant transgenic plants as Biopesticides,</p>	<b>8</b>
4.	<p><b>Waste-water treatment &amp; Solid waste management</b></p> <p><b>a.</b> What are bioindicators? Plankton community as indicators of water pollution; use of diversity index in evaluation of water quality. Determination of microbiological quality of recreational and potable waters, indicator organisms, coliforms , fecal streptococci, lichens as air pollution indicators.</p> <p><b>b.</b> Biotechnological interventions in waste-water treatment: Primary, secondary and tertiary treatments; BOD, COD</p> <p><b>c.</b> Effluent disposal strategies used for effluents of Textile and Dairy industries and biotechnology industry.</p> <p><b>d.</b> New methods in Solid waste management, Hospital waste management.</p>	<b>10</b>

5.	<p><b>Role of Biotechnology in Air Pollution Control and monitoring</b></p> <p><b>a.</b> Biofuels and biological control of air pollution, plant derived fuels, biogas, landfill gas, bioethanol, biohydrogen;</p> <p><b>b.</b> Use of biological techniques in controlling air pollution;</p> <p><b>c.</b> Removal of chlorinated hydrocarbons from air.</p> <p><b>d. Microbial biosensors in environmental monitoring:</b>          What is a biosensor? Components, Advantages and limitations, ammonia gas, alcohol, BOD, methane and mutagen sensors.          Applications of biosensors in environmental monitoring.          International Environmental Laws, Environmental laws in India, National policy on EIA (Environment Impact Assessment)          Case Studies : Environmental Impact Assessment</p>	10
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### Learning Outcome:

After completing the module, the students will gain knowledge about:

1. Global Environmental Problems and Environmental toxicants.
2. Role of environmental biotechnology in management of environmental problems.
3. Biodegradation, Bioremediation, Phytoremediation.
4. Ecofriendly alternatives to pesticides and fertilizers.
5. Waste management methods.
6. Air pollution management by biological techniques.
7. Environmental monitoring, EIA, Environmental Laws.

### Reference Books:

1. An Introduction To Geographic Information Technology (2009) Suchandra Choudhury I K International Pvt. Ltd., New Delhi.
2. Ecology and environment (2005) Sharma PD Rastogi Publication, New Delhi
3. Ecology and environmental biology (2011) Saha T K Books & Allied (p) Ltd, Kolkata
4. Ecology science and practice (2001) Faurieet al Oxford & IBH Publ. Co. Pvt. Ltd, New Delhi
5. Ecology: Principles and Applications (1998) J. L. Chapman, M. J. Reiss Cambridge
7. Environment Problems & Solutions (2001) Asthana&Asthana S. Chand Limited, New Delhi
8. Environmental Biology (2000) Varma & Agarwal S. Chand Limited, New Delhi
9. Environmental biology and toxicology (2011) Sharma PD Rajpaland Sons Publishing, Delhi
10. Environmental biotechnology (2010) RanaRastogi Publications, New Delhi
11. Environmental chemistry (2003) A. K. De 5 Delhi edition, New Age International Ltd, New
12. Environmental Chemistry (2007) B.K. Sharma 11<sup>th</sup> edition, Goel Publishing House, Delhi

13. Environmental pollution and health hazard in India (1987) Ram Kumar Ashish Pub. House, New Delhi
14. Environmental risks and hazards (1994) Susan Cutter Prentice Hall, Inc., New Jersey
15. Environmental Science (2010) G. TyMiller, Jr., Scott Spoolman Brooks and Coel, Cengage Brain learning, USA
16. Environmental Science (2011) Santra S.C. New Central Book Agency, Kolkata
17. Fundamentals of Ecology (2005) Eugene Pleasants Odum, Gary W. Barrett Brooks and Coel, USA
18. Fundamentals of Ecology (2009) Dash 3 edition, Tata McGraw-Hill Education, NewDelhi
19. Introduction to Environmental Biotechnology (2007) Chattergy PHI Learning Pvt. Ltd, Delhi
20. Text book of Environmental Engineering (2005) P. Venugopala Rao PHI learning Pvt Ltd, Delhi
21. Textbook of environmental studies for undergraduate courses (2005) Erach Bahrucha Universities Press, Hyderabad
22. The Microbiology of Activated Sludge (2010) R. J. Seviour IWA publication, UK
23. Principles of microbiology(1997 )Ronald M. AtlasWm. C. Brown Publishers, Science

### BTH 2407 Scientific Writing and communication (3C)

<b>Sr. No</b>	<b>Topic</b>	<b>Lectures (Total 45)</b>
1	Scientific method: Concept, hypothesis, theory, law; Design of experiment; Inductive and deductive reasoning	3
2	Types of presentation: Oral, poster, written, audio-visual. Aids for presentation	3
3	Preparing the manuscript. Guidelines for authors. The IMRAD format.	3
4	Title, byline; Abstract and Summary; Keywords.	2
5	Introduction: Defining the problem; Literature survey; Justification of study.	2
6	Materials and Methods: Contents, sources, procedures, techniques, reproducibility, Units of measurements, metric system and SI units. Basic statistical techniques, confidence limits, tests, probability, significance.	3
7	Results: Text; How to present data; Tables and illustrations. Writing captions, labels and legends.	3
8	Discussion: Components and sequence. Analysis, comparison and integration of data. Likely sources of errors in Results; Conclusions and significance. Implications for further study.	3
9	Acknowledgements. Literature citation systems. Sources of references: Journals, books, bibliographies, abstracting journals; Databases.	3
10	Preparing and submitting the manuscript. Revising, editing, proofreading.	3
11	Importance of scientific communication Types of scientific communications Logical organization of scientific data and documentation	3
12	Different modes of scientific communication Details of – Proposal writing, Research paper writing, Thesis writing	5
13	Legal forms of communication of science	3
14	Ethics in scientific communication Concept of IPR, patent submissions	3
15	Research paper reading	3

## **Learning Outcomes:**

### **Students will get the knowledge about**

- Correct way of scientific communication
- Errors in scientific writing and communication
- Research methodologies and research paper reading and presentation

## **Reference Books:**

1. Scientists Must Write. 2nd Edition, (2002), Barrass, R., Routledge, Oxon, UK
2. How to Write and Publish a Scientific Paper. 6th Edition, (2006), Day, R.A. and B. A. Gastgel, Greenwood Press, Westport, CT, USA.
3. Medical Writing: A prescription for clarity. 3rd Edition, (2006), Goodman, N.W. and M.B. Edwards, Cambridge University Press, Cambridge, UK.
4. Planning, Proposing and Presenting Science Effectively, 2nd Edition, (2006), Hailman, J.P. and K. B. Strier, Cambridge University Press, Cambridge, UK.
5. Biomeasurement: Understanding, Analysing and Communicating Data in Biosciences, (2005), Hawkins, D., Oxford University Press, Oxford, UK.
6. AMA Manual of Styles. A Guide for Authors and Editors, 10th Edition, (2007), JAMA and Archives Journals, Oxford University Press, New York.
7. Successful Scientific Writing: A step-by- step guide for the biological and medical sciences, 3rd Edition, (2008), Mathews, J.R. and R.W. Mathews, Cambridge University Press, Cambridge, UK
8. Writing Papers in the Biological Sciences. 4th Edition, (2004),McMillan, V.E., Bedford Books/St Martins.
9. A Short Guide to Writing About Biology. 6th Edition, (2006), Pechenik, J.A., Longman, New York.
10. A Manual for Writers of Research Papers, Theses and Dissertations. Edn. 7, (2007), Turabian K.L., W.C. Booth, G.G. Colomb, J.M. Williams and University of Chicago  
a. Press Staff, University of Chicago Press, Chicago, IL, USA.

**BTH- 2408: Practicals in Plant Development and Environmental Biotechnology (2C)**

Sr. No.	Topic	Practicals (15 P )
	<b>Plant Development</b>	
1	Methods of studying plant development	2
	a) Dissection	
	b) Sectioning	
	c) Maceration	
	d) Staining	
	e) Mounting	
2	Study of apices and meristem-RAM, SAM, florally induced meristem	1
	Microsporogenesis- anther squash technique	1
	Development of male and female gametophytes	1
	Developmental stages during plant embryogenesis in dicots and monocots	1
	Dissection of seed and excision of young embryo and endosperm (one dicotyledon and one monocotyledon)	1
	<b>Environmental Biotechnology</b>	
4	Assessment of potability of water a.Presumptive b.Confirmed and c.Completed test. d. Eijkman's test e. IMViC tests	3
5	BOD and COD estimation of polluted water	2
6	Preparation and Efficiency testing of Biofertilizer/ Biopesticide.	2
7	Visit to an Effluent treatment or Waste water treatment Plant	1

**Learning outcome:**

After completing the course students should be acquainted with the techniques involved in:

1. Studying plant development
2. Growth pattern in plants
3. Developmental stages during plant embryogenesis
4. Assessment of potability of water
5. BOD and COD estimation
6. Preparation of Biofertilizer

**BTH2409 Practicals in Molecular Biology, protein biochemistry and enzymology (2C)**

<b>Sr. No.</b>	<b>Topic</b>	<b>Practical (15Px2H)</b>
<b>1</b>	UV-Visible Absorption spectra and quantification of DNA, RNA and proteins. Choosing the correct wavelength for a molecule; structural basis for obtaining emission.	3
<b>2</b>	Effect of mutations on DNA: growth of auxotrophs on minimal medium/Effect of UV/EtBr on growth	3
<b>3</b>	Native-PAGE separation of proteins and activity staining of protein gels. Quantification of proteins by UV-Spectroscopy	4
<b>4</b>	Effect of various cell lysis methods on protein extraction efficiency a. Sonication b. Homogenisation c. SDS lysis buffer Comparison between different quantification methods of proteins by Biuret, Lowry, Bradford reagents.	3
<b>5</b>	Enzyme assay: Acid phosphatase/ $\beta$ -galactosidase/amylase	2

**Learning outcome:**

- Students will learn methods of protein extraction, separation and estimation.
- Efficiency of various cell lysis methods.
- Enzyme assay

**BTH 2410: Practicals in Cell Biology and Food & Dairy Microbiology (2C)**

<b>Sr. No.</b>	<b>Topic</b>	<b>Practical (Total 15)</b>
1.	Isolation and identification (Genus level) of spoilage causing microorganisms from spoiled foods	1
2.	To determine TDT, TDP and D values	3
3.	Determination of efficiency of Pasteurization by quantitative phosphatase test. Grading of raw milk (Dye reduction test)	1
4.	Isolation and identification of starter organisms from Idli batter/ Dahi	2
5.	Isolation and study of types of Plastids (chloroplast /leucoplast/chromoplast)	1
6.	Light microscopy and EM, and their resolution with respect to organelle structure , Study of cell junctions	1
7.	Isolation of nuclei from goat liver by differential centrifugation, staining and counting of nuclei by haemocytometer.	3
8.	Isolation of mitochondria from goat liver by differential Centrifugation and mitochondrial succinate dehydrogenase assay	3

**Learning outcomes:**

1. To get hands on training for Isolation and identification of organism from spoiled food and starter organism.
2. To get acquainted with different methods by which one can grade the quality of milk and also comment on its efficiency.
3. To study various organelles and their isolation