File Ref.No.93543/GA - IV - J1/2021/Admn

UNIVERSITY OF CALICUT

Abstract

General & Academic IV- CBCSS PG Regulations 2019 - Scheme and Syllabus of M.Sc Biology Programme w.e.f 2020 Admission (I to IV) semester - Implemented -Subject to ratification by the Academic Council - Orders Issued.

G & A - IV - J

U.O.No. 14305/2022/Admn Dated, Calicut University.P.O, 25.07.2022

Read:-1) U.O.No. 5513/2021/Admn, dated 24.05.2021.
2) U.O.No. 8003/2021/Admn dated, 13.08.2021
3) U.O.No. 5734/2022/Admn dated, 28.02.2022
4) Email from Chairman, Board of Studies for M.Sc Biology/ Integrated M.Sc Biology & similar Bio science courses dated 29.06.2022
5) Remarks of the Dean, Faculty of Science, dated 20.07.2022
6) Orders of the Vice Chancellor in the file of even no, dated 23.07.2022

ORDER

1. Scheme and syllabus of Ist, IInd & IIIrd semester M.Sc Biology Programme in tune with the new CBCSS PG Regulations 2019, with effect from 2020 Admission has been implemented, vide paper read (1) ,(2) & (3) above.
2. Vide paper read (4) above, Chairman, Board of Studies in M.Sc Biology/ Integrated M.Sc Biology & similar Bio science courses has forwarded, IVth Semester syllabus of M.Sc Biology Programme and circulated among the board members as per Chapter 3(34) of Calicut University First Statute, 1976.
3. The Dean, Faculty of Science, vide paper read (5) above, and the Vice Chancellor subject to ratification by the Academic Council have approved the IVth semester syllabus of M.Sc Biology Programme in tune with the new CBCSS PG Regulations 2019, with effect from 2020 Admission.
4. The Scheme and syllabus of M.Sc Biology Programme in tune with the new CBCSS PG Regulations 2019, is therefore implemented with effect from 2020 admission, subject to ratification by the Academic Council.
5. Orders are issued accordingly. (Syllabus of M.Sc Biology Programme appended herewith)

Ajayakumar T.K

Assistant Registrar

To

The Principals of all affiliated colleges
Copy to: PS to VC/PA to PVC/ PA to Registrar/PA to CE/JCE I/DOA/CDC/GA-I-F Sn/JCE V/EX and EG Sections/SF/DF/FC

Forwarded / By Order

Section Officer

CURRICULUM AND SYLLABUS FOR CHOICE BASED CREDIT SEMESTER SYSTEM (CBCSS- 2020) M.Sc BIOLOGY COURSE w.e.f 2020 ADMISSSION

FIRST SEMESTER THEORY COURSES

Code No. & Title of the Course	Credits	External Weightage	Internal Weightage
BIO1C01 BIOCHEMISTRY	4	30	5
BIO1C02 MOLECULAR BIOLOGY	4	30	5
BIO1C03 IMMUNOLOGY	4	30	5

SECOND SEMESTER THEORY COURSES

Code No. & Title of the Course	Credits	External Weightage	Internal Weightage
BIO2C04 MICROBIOLOGY	4	30	5
BIO2C05 BIOPHYSICS	4	30	5
BIO2C06 ECOLOGY AND EVOLUTION	4	30	5

FIRST & SECOND SEMESTER PRACTICAL COURSES

Code No. & Title of the Course	Credits	External Weightage	Internal Weightage
BIO2L01 BIOCHEMISTRY & MOLECULAR BIOLOGY	4	24	5
BIO2L02 IMMUNOLOGY AND MICROBIOLOGY	4	24	5
BIO2L03 BIOPHYSICS AND ECOLOGY & EVOLUTION	4	24	5

THIRD SEMESTER THEORY COURSES

Code No. & Title of the Course	Credits	External Weightage	Internal Weightage
BIO3C07 CELL BIOLOGY AND GENETICS	4	30	5
BIO3C08- BIOSTATISTICS, BIOINFORMATICS & RESEARCH METHODOLOGY	4	30	5
BIO3E0901- MOLECULAR MEDICINE AND VIROLOGY I:GENOMICS	4	30	5
BIO3E0902- OMICS AND MOLECULAR MEDICINE I: PROTEOMICS AND METABOLOMICS	4	30	5

FOURTH SEMESTER THEORY COURSES

Code No. & Title of the Course	Credits	External Weightage	Internal Weightage
BIO4C10 PHYSIOLOGY & DEVELOPMENTAL BIOLOGY	4	30	5
BIO4E1101 - MOLECULAR MEDICINE AND VIROLOGY II: VIROLOGY	4	30	5
BIO4E1102- OMICS AND MOLECULAR	4	30	5

MEDICINE II: GENOMICS AND TRANSCRIPTOMICS			
BIO4E1201 - MOLECULAR MEDICINE AND VIROLOGY III: MOLECULAR DIAGNOSTICS	4	30	5
BIO4E1202- OMICS AND MOLECULAR MEDICINE III: MOLECULAR MEDICINE AND DRUG DISCOVERY	4	30	5

THIRD AND FOURTH SEMESTER PRACTICAL COURSES

Code No. & Title of the Course	Credits	External Weightage	Internal Weightage
BIO4L04 -CELL BIOLOGY AND GENETICS, BIOSTATISTICS, BIOINFORMATICS & RESEARCH METHODOLOGY & PHYSIOLOGY AND DEVELOPMENTAL BIOLOGY	4	24	5
BIO4L0501- MOLECULAR MEDICINE AND VIROLOGY I AND II	4	24	5
BIO4 L0502- OMICS AND MOLECULAR MEDICINE I AND II	4	24	5
BIO4 L0601- MOLECULAR MEDICINE AND VIROLOGY III	4	24	5
BIO4 L0602 - OMICS AND MOLECULAR MEDICINE III	4	24	5
BIO4P07- Project Work	4	24	5
BIO4V08- Viva Voce (Project-2 + General-2)	4	24	5

BIO- Biology C- Course Theory L – Practical, V – Viva voce, P – Project, 4- IV semester

Total number of theory courses – 12 Total number of practical courses - 6

Credit for each theory course - 4 Credit for each practical course - 4

Total credits for theory course - 48 Total credits for practical courses - 24

Credit for Project work - 4 Total credit for the course - 80

Credit for Viva- voce - 4

1. Practical examination shall be conducted at the end of second and fourth semesters.
2. The teacher who gives guidance to project work can select any topic from the syllabi
including the elective course and the topic shall be assigned to each student. The research
work on this topic shall be carried out by each student under the supervision of the teacher.

The report of the research work shall be submitted by each student in the form of a
Dissertation which shall be attested by the Head of the Department and shall be submitted for
the evaluation. A declaration by the student to the effect that the dissertation submitted by
him/ her has not previously been formed the basis for the award of any degree or diploma and
a certificate by the supervising teacher to the effect that the dissertation is an authentic record
of work carried out by the student under his/her supervision are to be furnished in the
dissertation.

3. Weightage for each core and elective theory course shall be 30 for the external examination
and 5 for the internal theory examination.

4. Weightage for each core and elective practical course shall be 24 for the external examination
and 5 for the internal core and elective practical examination.

5. Theory examination question paper shall contain14 short answer questions with
weightage1each , 7 short essay questions with weightage 2 each and 2 essay questions with
weightage 4 each.

6. Weightage for the external practical examination can be distributed as follows:

With submission Weightage	**Without submission Weightage**
Major question (1 number)	8 Major question (1 number) 8
Minor question (2 numbers) 2x5=10	Minor question (2numbers) 2x5=10
Spotters (2 numbers) 2x1=2	Spotters (4 numbers) 4x1= 4
Submission (slides) 2	Record 2
	Total 24

7. No submission is required for the practical in elective course, unless mentioned in syllabus.

8. A candidate has to submit the following at the time of practical examination - BIO4L04
Slides: Histology: 4 numbers
Slides: Histochemistry: 2 numbers (To test the presence of carbohydrate and protein. (Control not required)

9. If a candidate fails to submit the field study / tour report, no marks for the record be awarded.

10. Project report shall be presented using power point option. Credit given for project is limited
to maximum 4 and project and general viva-voce is limited to 4.

11. A minimum of two test papers for each course have to be conducted and the average shall be
counted for internal evaluation in each semester.
12. One seminar for each course is compulsory.

Criteria for the evaluation of dissertations Weightage
1. Introduction, review of literature etc. 2
2. Objectives and relevance of the study 3
3. Methodology 4
4. Results 3
5. Discussion and interpretation 4
6. Conclusions 3
7. Involvement of the students 1
8. Style and neatness of the dissertation 1
9. References 3
Total 24
Criteria for the Viva-voce
A. Presentation of project work- (POWER POINT Presentation) Weightage
1. Quality and correctness of slides 2
2. Clarity of presentation 3
3. Communication skill 3
4. Answers to questions 4
Subtotal 12

B. General Viva-voce Weightage
5. Knowledge of the student 4
6. Communication skill 3
7. Answers to questions 5
Subtotal 12

MODEL QUESTION PAPER

I/II/III/**SEMESTER M.Sc. DEGREE EXAMINATION (CUCSS),** Month & Year

Branch : Biology

Course Code **:**

Course Name :

Time : 3hrs **Maximum Weightage:30**

I. Answer any 4 of the following (Short Answer type questions) (Weightage-2)
1.
2.
3.
4.
5.
6.
7

4 x 2 = 8

II. Answer any 4 of the following (Short essay type questions) (Weightage-3)

8.
9.
10.
11.
12.
13.
14.

4 x 3 = 12

III. Answer any 2 of the following (Long essay type questions) (Weightage-5)

15.
16.
17.
18.

2 x 5 = 10

FIRST SEMESTER THEORY

BIO1C01- BIOCHEMISTRY (90 hrs)

COURSE OUTCOMES [COs]

CO1. The student will appreciate the importance of various chemical interactions in the biological system
CO2. The Student will develop the abilty to analyze the structure, classification, and biochemical properties of carbohydrates from other organic molecules
CO3. The student will develop the ability to describe classification,structural organization, and purification techniques of proteins.
CO4. The student will develop understanding of the classification and functions of lipids and fatty acids
CO5. The Student will develop Appreciation on the mechanism of enzyme action, inhibition, and classification of enzymes that facilitate the functioning of enzymes
CO6. The student will develop appreciation on Watson and Crick model of DNA
CO7.The student will explain the anabolicandcatabolicpathways of biomolecules such as glucose, nucleic acids, amino acids and lipids.
CO8. The student will describe the principles of energetics in biological systems.
CO9. The student will describe the structure and functions of Cellular components, plasma membrane and its models, membrane transport mechanisms and properties , cytoskeletal elements and Intracellular trafficking.
CO10. The student will explain the Chromatin structure and chromosomal alterations, Interrupted genes, gene families and extra chromosomal inheritance.

CO11. The student will explain the cellular adhesion molecules, cell-cell and cell -matrixinteractions,intercellularcommunicationsalongwithnotedsignal transduction pathways and intracellular signaling mechanisms and their significance.
CO12. The student will describe the process and significance of necrosis and apoptosis and, its regulation in the cellular level

A. CHEMISTRY AND FUNCTIONS OF BIOMOLECULES (30)

1. Introduction (2 hr)

1.1. Macromolecules, biopolymers and their subunits

1.2. Chemical bonds of biomolecules (Covalent and Non-covalent bonds)

2. Carbohydrates (10 hr)

2.1. Monosaccharides

2.1.1. Classification with examples, Biological roles of monosaccharides

2.1.2. Structure of glucose, fructose, galactose, mannose and ribose

2.1.3. Methods of representation of sugars (Ball and stick, projection formula and perspective formula)

2.1.4. Isomerism – Structural isomerism (functional group isomerism) and stereo isomerism (optical isomerism); Mention - epimer, anomer and enantiomer with examples, Mutarotation.

2.1.5. Reactions – Oxidation (by acids, metal hydroxides & H2O2); Dehydration (by acid); Reduction (by alkali); Reactions with alanine as well as phenyl hydrazine

2.1.6. Derivatives – ascorbic acid, acetal and hemiacetal, ketal and hemiketal, glycocosides –glycosidic bond and deoxyribose

2.2. Disaccharides

2.2.1. Structure and biological roles of Maltose, Sucrose, Lactose, Cellobiose and Trehalose

2.2.2. Biosynthesis of trehalose and lactose

2.3. Polysaccharides

2.3.1. Hompolysaccharides – Structure and biological roles of cellulose, starch, glycogen, inulin and chitin

2.3.2. Mode of action of amylase on homopolysaccharides (starch and glycogen)

2.3.3. Heteropolysaccharide - Structure and biological roles of hyaluronic acid, chondroitin, chondroitin sulphate, keratansulphate, heparin and agar-agar

3. Proteins (7 hr)

3.1.Amino acids

3.1.1. Classification: (a) On the basis of number of amino and carboxyl group (b) On the basis of the chemical composition of side chain (c) On the basis on the polarity of side chain-R

3.1.2. Amphoteric properties of amino acids

3.1.3. pK value and isoelectric point (pI) of amino acids

3.1.4. Peptide bond and peptides (di, tri, tetra, oligo and polypeptide)

3.2. Structure of protein

3.2.1. Primary structure, Secondary structure (α-helix –parallel & antiparallel and β pleated sheet), random coil conformation, Tertiary structure, quaternary structure.

3.2.2. Brief note on protein domains, motifs, folds and Ramachandran plot.

3.2.3. Biological roles of proteins

4. Lipids (6 hr)

4.1. Classification of lipids -Simple lipids (fats, oils and waxes), compound lipids (phospholipids, glycolipids, lipoproteins and sulpholipids) and derived lipids.
4.2. Brief account of the chemistry of sterols, terpenes and carotenoids.
4.3. Acid number, saponification number, Iodine number, Polenske number and Reichert-Meissl number of lipids
4.4. Biological roles of lipids – as food reserves (storage lipids), structural lipids in membrane, as signals, as co-factors, as pigments, as insulators, as vitamin carriers
4.5. Prostaglandins – Chemical nature and functions.
4.6. Fatty acids – definition; essential fatty acids
4.7. Classification with examples– Saturated, unsaturated, hydroxyl and cyclic fatty acids
4.8. Nomenclature of fatty acids – Genevan system

5. Nucleic acids (5 hr)

5.1. Structure of nitrogen bases and nucleotides
5.2. Structural organization of DNA (Watson –Crick model)
5.3. Characteristic features of A-, B- and Z-DNA
5.4. Structural organization of t-RNA; brief note on micro-RNA
5.5. Biological roles of nucleotides and nucleic acids

B. ENZYMOLOGY AND ENERGETICS (12 HR)

6. Enzymes (8 hrs)

6,1. Specificity of enzyme action
6.2. Mechanism of enzyme action: Formation of enzyme substrate complex - Gibbs free energy of activation; Michaelis-Menten theory, Fischer's template theory and
6.3. Koshland's induced fit theory. Electrostatic, hydrogen & Van der Waal's bonds in Enzyme - substrate complex
6.4. Enzyme kinetics - Michaelis-Menten equation – derivation; significance of Km and Vmax Values
6.5. Lineweaver-Burk equation and double reciprocal plot of enzyme reaction
6.6. Enzyme inhibition – Competitive, non-competitive and uncompetitive inhibition (distinguish kinetically), suicide inhibition and feedback inhibition
6.7. Allosteric enzymes, Iso-enzyme and ribozyme
6.8. Factors influencing enzyme action- Coenzymes, Vitamins as coenzymes Classification, Structure and functions of Vitamins

7. Bioenergetics (4 hr)

7.1. Laws of thermodynamics and biological system
7.2. Enthalpy, Entropy, Free energy concept
7.3. Energy of activation, Standard free energy change
7.4. Role of ATP as a free energy carrier in the biological system

C. METABOLISM OF BIOMOLECULES (40 HR)

8. Carbohydrate metabolism (15 hr)

8.1. Glycolysis – (PFK as pacemaker – Hexokinase conformation and change by glucose), Fate of pyruvic acid
8.2. Citric acid cycle; Pyruvate dehydrogenase complex and ketoglutarate dehydrogenase complex
8.3. Electron transport system and oxidative phosphorylation; Redox porential, Chemiosmotic hypothesis; inhibitors of electron transport chain

8.4. Gluconeogenesis. Glycogenesis and its regulation. Glycogenolysis and its regulation.

8.5. Pentosephosphate pathway (HMP pathway).

8.6. Uronic acid pathway

8.7. Inborn errors of carbohydrate metabolism, Galactosemia and Glycogen storage diseases.

9. Amino acid metabolism (9 hr)

9.1. Biosynthesis and degradation of amino acids – glutamic acid, phenyl alanine, methionine, tryptophan, isoleucine, histidine. Valine.

9.2. Fate of amino acids in the body. Transamination, Decarboxylation and deamination reactions in the biological system.

10. Lipid metabolism (8 hr)

10.1. Oxidation of fatty acids

10.2. Biosynthesis of fatty acids

10.3. Biosynthesis of cholesterol

11. Nucleic acid metabolism (8 hr).

11.1. Biosynthesis and degradation of purines and pyrimidines, regulation of purines and pyrimidines biosynthesis.

11.1.2. Biosynthesis of ribonucleotides and deoxyribonucleotides.

11.1.3. Uric acid overproduction and underexcretion; pathology and differential diagnosis of gout, treatment of gout,

11.1.1.4. Enzyme disorders of purine metabolism (Lesh-Nyhan syndrome and Orotic acid urea.

12. Clinical biochemistry. (8 hr)

12.1. Principle, assay, and clinical significance of transaminases, creatine kinase, lactate dehydrogenase, phosphatases, isocitrate dehydrogenase, amylase, lipase, trypsin, chymotrypsin, choline esterase, glutamate dehydrogenase, glucose-6-phosphate dehydrogenase and ceruloplasmin.

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FIRST SEMESTER THEORY

BIO1C02- MOLECULAR BIOLOGY (90 hrs)

COURSE OUTCOMES [COs]

CO1. The student will acquire knowledge regarding the mechanism of DNA replication-both chromosomal and extra chromosomal, enzymes involved, models of replication, inhibitors and the significance of DNA replication.
CO2. The student learn to know the safeguard systems of DNA, restriction enzymes and their significance, mechanisms involved in damage and repair of eukaryotic DNA and its importance.
CO3. The student will explain the general features of genetic code, special features of the genetic code in mitochondria, and variations in genetic code.
CO4. The student will explain the structural organization of mRNA in prokaryotes and eukaryotes, the mechanism of transcription, translation, post transcriptional and translational modifications, structure , biogenesis and role of ribosomes in protein synthesis ; and RNA editing.
CO5. The student will explain the regulation of gene expression in Phages, Bacteria, and in Eukaryotes; recent research findings like antisense RNA strategies and role of si RNA and mi RNA in the regulation of eukaryotic gene expression and their applications.
CO6. The student will describe the components, organization and special features of eukaryotic genome, interrupted genes and their evolution; concept of gene families, and molecular evolutionary clock.
CO7. The student will explain the transposition mechanisms in prokaryotes and eukaryotes , and their significance.
CO8. The student will describe the Molecular mechanisms of genetic recombination, models, and significance.
CO9. The student will compare the Special features of microbial genetics, and organelle genome, their replication and mapping.
CO10. The student will explain the regulation of cell cycle, its alteration and causes of cancer. Genes involved in the regulation of cancer and modern therapeutic interventions like immunotherapy and gene therapy.

1. DNA replication (12 Hrs.)

1.1. Semiconservative mode of replication (Experiments of Messelson and Stahl; Cairns), rolling circle mode and D-loop mode of replication
1.2. Semidiscontinuous synthesis-Okazakifragments
1.3. Enzymes and accessory proteins involved in DNA replication.
1.4. Replication of the ends of eukaryotic chromosome – role of telomerase
1.5. Fidelity ofreplication
1.6. Extrachromosomal replicons
1.7. Inhibitors of DNA replication

2. DNA repair(4 Hrs.)

2.1. DNA damage- major kinds of damage and causes
2.2. Repair mechanisms-photoreactivation, excision repair, post replication repair, mismatch repair and SOS repair.

3. Restriction & modification(4 Hrs.)

3.1. Types of restriction enzymes
3.2. Restriction fragment length polymorphism (RFLP)
3.3. DNA modifications

4. Gene editing (3 Hrs.)

4.1. Methods of gene editing
4.2. CRISPR technique , Applications

5. Transcription and processing of RNA:(12Hrs.)

5.1. Types of RNAs- structure and function
5.2. Transcription factors and machinery in prokaryotes & Eukaryotes
5.3. Transcription in prokaryotes andeukaryotes- mechanism & regulation
5.4. Characteristic features of RNA polymerases of phages, prokaryotes and eukaryotes
5.5. Post transcriptional modifications of RNA
5.6. RNA editing: site specific deamination and role ofgRNAs
5.7. mRNAtransport
5.8. Inhibitors of transcription

6. Translation: (12 Hrs.)

4.1 Genetic code- Characteristics, Wobble hypothesis, variations in genetic code.
4.2 Molecular machinery and mechanism of translation
4.3 Differences between prokaryotic and eukaryotic protein synthesis.

4.4 Translational inhibitors
4.5 Post- translational modification of proteins: protein folding (role of chaperones) and biochemicalmodifications, protein targeting

7. Control of gene expression at transcription and translation level: (10Hrs.)

7.1. Regulation of gene expression in Phages
7.2. Regulation of gene expression in bacteria – basic features of tryptophan, arabinose and galactoseoperons
7.3. Regulation of gene expression in eukaryotes
  7.3.1. Role of chromatin in regulating geneexpression
  7.3.2. Activation and repression of transcription
  7.3.3. Regulation of translation by genearrangement
  7.3.4. Regulation of translation by alternate pathways of transcriptsplicing
  7.3.5. Antisense RNA strategies for regulating geneexpression
  7.3.6. si RNA and mi RNA inregulation

8. Characteristic features of eukaryotic genome (16 Hrs.)

8.1. Unique, moderately repetitive and highly repetitive DNA sequences
8.2. Reassociation kinetics
8.3. Cot value and complexity of the genome
8.4. Satellite DNA and selfish DNA.
8.5. Human genome - HGP
8.6. Interrupted genes- discovery, examples, origin
8.7. Gene families - Definition and concept, Organization of globin genes, Pseudo genes

9. Transposons (8Hrs.)

9.1. Definition, features andtypes andmechanism of transposition

9.2. Transposons in bacteria - ISelements, Tn family

9.3. Transposons i eukaryotes

9.3.1. SINE, Alu family; LINE

9.3.2. P elements in*Drosophila*

9.3.3. Transposons inMaize

9.4. Retroviruses and transposition

8. Molecular biology of Cancer (9 Hrs.)

8.1. Gene Mutations in cancer and Genetic rearrangements in progenitor cells

8.2. Oncogenes and tumor suppressor genes

8.3. Virus-induced cancer 13.5

8.4. Alteration of cell cycle regulation in cancer

8.5. Metastasis and angiogenesis in cancer.

8.6. Therapeutic interventions of uncontrolled cell growth – Immunotherapy and Gene therapy

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FIRST SEMESTER THEORY

BIO1C03- IMMUNOLOGY (90 hrs)

COURSE OUTCOMES [COs]

CO 1. The student will appreciate the major findings and milestones in the history of Immunology. An in depth knowledge will be developed in the process of immune cell synthesis and maturation, antigen receptor structure and the mechanisms of antigen recognition by B-cell and T-cells.

CO 2. The student will explore the Structure and diversity of immunoglobulins, antigens and its classification, production and clinical uses of monoclonal antibodies and antigen antibody interactions.

CO 3. The student will explain the key principles, procedure and applications of different Immunetechniques used in the biomedical field and to develop new methods and techniques on the basis of the earned knowledge.

CO 4. The student will describe theMechanisms of humoral and cellular immunity, immune cell receptor and intracellular signal cascades related to immune system activation and response.

CO 5. The student will explore the fundamentals of Immune effector mechanisms, chemical signalling through cytokines, its therapeutic uses and cytokine related diseases.

CO 6. The student will compare the complement system and its components, hypersensitivity and allergic responses, diseases related to hypersensitivity, and complement deregulation.

CO 7. The student will appreciate the scientific principles behind vaccination, types of vaccines ,Vaccine technology, their role in fighting diseases and recent advances.

CO 8. The student develop skills to analyze various molecular diagnostic tools using monoclonal antibodies and other therapeutic applications.

CO 9. The student will describe the clinical aspects of immune mechanisms involved in various disease conditions like autoimmunity, infectious diseases, tumor immunology, malnutrition and immune deficiency diseases.

A. INTRODUCTION TO IMMUNOLOGY

1. Introduction (2 Hrs.)

1.1 Introduction to immunology- Major milestones in the history of immunology
1.2 Types of immunity- innate, acquired, passive and active.
1.3 Brief account on Immune system, Physiology of immune response- Humoral and Cell Mediated Immunity(HI &CMI) Immune specificity and Immune memory.

2. Cells and Organs Of Immune System (4 Hrs.)

2.1. Hematopoiesis – Lymphoid and myeloidlineages
2.2. Hematopoietic growthfactors
2.3. Cellular components of immune system (Lymphocytes and Phagocytes)
2.4. Mechanisms of Humoral and Cellular immunity.
2.5. Primary and Secondary lymphoid organs (Bone marrow, Thymus, Spleen, Lymph nodes, Payer's patches, MALT & GALT)

3. Antigens and Antibodies (8 Hrs.)

3.1. Immunogenicity and Antigenicity.
3.2. Factors that influenceimmunogenicity
3.3. Superantigens ,Haptens and Adjuvants.
3.4. Structure and functions of different classes of Immunoglobulins
3.5. Antigenic determinants of immunoglobulins - (a) Isotype (b) Allotype (c)Idiotype.
3.6. Epitopes and Properties of B-cell and T- cellepitopes.
3.7. Strength of antigen – antibody interactions. (a) Antibody affinity (b) Antibodyavidity.
3.8. Cross-reactivity and Precipitation reactions.

4. Theories of antibody formation. (5 Hrs.)

4.1. Clonal selection theory.
4.2. Multi-gene organization of immunoglobulin
4.3. Mechanism of VD (J) recombination and Generation of Antibodydiversity
4.4. Expression and secretion of Immunoglobulins.

5. Generation of B-cell and T-cell responses (5 Hrs.)

4.5. B Cell receptor- structure and BCR signaling
4.6. T Cell receptor, TCR-CD3 complex.
4.7. Activation, maturation and differentiation ofB and T Cells.

B. IMMUNE EFFECTOR MECHANISMS

6. Cytokines (6 Hrs)

4.8. Cytokines and their Properties.
4.9. Cytokine secretion by TH1 andTH2-cells.
4.10.Cytokineantagonists.
4.11.Cytokine related diseases. (a) Bacterial septic- shock (b) chaga's disease) (c) lymphoid and myeloidcancers.
4.12.Therapeutic uses ofcytokines.
4.13.Toll- likereceptors.

7. The Complement system. (7 Hrs)

4.14. The complementcomponents.
4.15. The functions of complementcomponents.
4.16. Complement activation (a) Classical pathway (b) Alternate pathway

(c) Lectinpathway.

4.17. Regulation of complementsystem.
4.18. Biological consequences of complementactivation.
4.19. Complementdeficiencies.

8. Major Histocompatibility Complex (MHC) (7 hours).

4.20. MHC molecules andgenes.
4.21. Cellular distribution ofMHC.
4.22. General organization and inheritance ofMHC.
4.23. Antigen- processing and presentation- Exogenous and Endogenouspathways.
4.24. Presentation of non- peptideantigens.

C. IMMUNOLOGICAL TECHNIQUES AND APPLICATIONS

9. Techniques using Antigen antibody interactions (6 Hrs)

4.25. Agglutination, Agglutination inhibition, precipitation reaction, immune-fluorescence, immune electrophoresis, and Immune-blotting,
4.26. Enzyme Linked Immunosorbent Assay (ELISA)and Radio Immuno Assay (RIA)
4.27. Fluorescence Activated Cell Sorting (FACS) and its applications in disease diagnosis.
4.28.Production and purification of antibodies, determination of antibody titer by Radial Immuno - Diffusion *(RID)* assay

5. Monoclonal antibodies &Immunodiagnosis (6 Hrs)

5.1. Monoclonal antibodies and their Production (Hybridomatechnology)
5.2. Alternatives to hybridoma technology-
5.3. Antibody engineering – Human and humanized antibodies
Catalytic antibodies, application of PCR technology to produce humanized antibodies (Single chain fragment variable)
5.4. Clinical uses of Monoclonal Antibodies.

D. CLINICAL IMMUNOLOGY

6. Transplantation immunology (6 Hrs)

6.1. Auto graft, Allograft, Isograft andXenograft
6.2. Transplantation antigens.
6.3. Clinical manifestations and Immunological basis of graftrejection.
6.4. Role of cell- mediatedresponses in graft rejection.
6.5. General immune suppressivetherapy.

7. Hypersensitivity Reactions (4 Hrs)

7.1. Allergens.
7.2. IgE- mediated (type- I)hypersensitivity.
7.3. Antibody- mediated cytotoxic (type- II)hypersensitivity.
7.4. Immune complex- mediated (type- III)hypersensitivity.
7.5. TDTH- mediated (type- IV)hypersensitivity

8. Autoimmunity (3Hrs)

8.1. Tolerance – Establishment and maintenance
8.2. Organ specific and systemic autoimmune diseases with examples
8.3. Mechanism of induction of autoimmunity

8.4. Treatment of autoimmune diseases

9. Immune response to infectious diseases (3Hrs)

9.1. Antigen presentation via Class I and Class II pathways.

9.2. Th1/ Th2 polarities, NK Effector Mechanism.

9.3. Inflammation and apoptosis (brief)

10. Tumor Immunology (3Hrs)

10.1. Tumor antigens and malignant transformation

10.2. Immune response to tumor-Effector mechanisms in antitumor immunity-
a) Antibodies b) T.lymphocytes c) NK cells d) Macrophages etc.

11. Immunity and malnutrition and immune deficiency diseases. (5 Hrs)

11.1. Immunity andmalnutrition. Primary immune deficiency diseases.
(a)Burton's disease (b) Di-George syndromeand SCID.

11.2. Secondary immune deficiency -AIDS.

11.3. AIDS pathogenesis and immune response to retroviruses

11.4. Role of chemokines in management of AIDS

11.5. Vaccines to preventAIDS (Brief)

12. Classification of Vaccines and its Preparations. (8 Hrs)

12.1. Active and passive immunization.

12.2. Whole organism vaccines. Viral/bacterial/parasite vaccines and combination vaccines

12.3. Cell based Vaccines and therapeutic vaccines

12.4. Methods of vaccine preparation – Live, killed, attenuated, sub unit vaccines (Brief)

12.5. Vaccine technology - Role and properties of adjuvants, Recombinant Vector vaccines, DNA vaccines, Synthetic peptide vaccines, and Multivalent vaccines.

12.6. Recent advances in Malaria, Tuberculosis, HIV and COVID-19 Vaccinations

12.7. Reverse vaccinology (Brief)

13.Immunotherapy-Brief account (2 Hrs)

13.1. Materials-based immunotherapies

13.2. Genetic engineering approaches

13.4. HIV specific immunotherapies

13.5. Immunotherapy with genetically engineered antibodies

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3. Essential Immunology by Roitt I. Blackwell Scientific Publications, Oxford.
4. Essentials of clinical Immunology. 6th ed. Blackwell Scientific Publications.HelenChappel and Moused Harney (2014).
5. Immunology a short course by Benjamini E. and Leskowitz S. Wiley Liss.
6. Immunology.8th ed. Janis Kuby (2018) .W.H. Freeman& Co. NewYork.
7. Immunology and Immunotechnology.Oxford UniversityPress.Chakraborty ,A.K. (2006).
8. Molecular Immunology ByBenjamini E.
9. The Immune System by Peter Parham, Garland Science.
10. Understanding Immunology by Peter Wood, Pearson Education.

FIRST SEMESTER PRACTICAL

BIO1L01-BIOCHEMISTRY, MOLECULAR BIOLOGY, IMMUNOLOGY AND IMMUNOTECHNOLOGY

As Core curriculum courses, students completing thesecourses along with the practical sessions will demonstrate competence in gathering, analyzing, synthesizing, evaluating and applying information.

BIOCHEMISTRY

Course Outcomes:

CO1.	Students will gain skills in methods and techniques of biochemicalassays	
CO2	Students will appreciate the importance of biochemical assays	

Perform any 10 experiments out of 12 experiments given

1. Actual acidity and titrable acidity of a strong and a weakacid.
2. Qualitative tests for carbohydrates
   a) Qualitative tests for monosaccharides (Glucose andfructose)
   b) Qualitative tests for disaccharides (Lactose, Maltose &Sucrose)
   c) Qualitative tests for polysaccharides (Dextrin &Starch)
   d) Identification of unknown carbohydrates (Glucose, Fructose, Lactose, Maltose, Sucrose, Dextrin & Starch) by suitabletests.
3. Quantitative estimation ofcarbohydrates
   Estimation of blood glucose by colorimetric method (Somogy-Nelson method/ O- Toludine method)
   Estimation of total carbohydrate by phenol-sulphuric acidmethod
4. Qualitative tests for proteins
   a) Colour reactions with proteins (Albumin, Casein, Peptones &gelatin)
   b) Precipitation reactions with proteins (Albumin, Casein, Peptones &gelatin)
   c) Identification of unknown protein (Albumin, Casein, Peptones &gelatin)
5. Qualitative tests for non-protein nitrogenous substances (urea, uric acid andcreatinine)
6. Identification of unknown carbohydrates, protein and non-protein nitrogenous substances from a givensolution.
7. Quantitative estimation ofproteins
   a) Estimation of proteins by Biuretmethod
   b) Isolation of casein from cow's milk
8. Quantitative estimation of non-protein nitrogenoussubstances
   a) Quantitation of blood urea by diacetylmonoxinemethod
   b) Determination of urine creatineby alkaline picratemethod
9. Quantitative estimation of lipids
   a) Estimation of total serum cholesterol by Zak'smethod
   b) Saponification number of oils - coconut oil & ground nutoil.
   c) Iodine number offats

10. Determination of salivary amylase activity and effect of substrate concentration on the enzyme activity
11. Determination of salivary amylase activity and effect of Temperature and pH on enzyme activity
12. Protease assay and protease inhibition assay.

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1. An Introduction toPracticalBiochemistryPlummer, David T, (2008) III Ed. Tata McGraw-Hill, NewDelhi.
2. Keith Wilson, John Walker (2000) Principles and Techniques of Practical Biochemistry Cambridge UniversityPress.
3. PrinciplesandTechniquesofBiochemistryandMolecularBiology.(2006)VIEd. Wilson Keith and WalkerJohn.
4. Oser, B.L. (1965). Hawk's Physiological Chemistry. McGraw Hill BookCo.
5. Standard Methods of Biochemical Analysis, S. K. Thimmaiah (ed), Kalyani Publishers, Ludhiana ISBN81-7663-067-5.
6. Practical Clinical Chemistry, Harold Varley, CBS Publishers and Distributors, NewDelhi.
7. Introductory Practical biochemistry, S. K. Sawhney&Randhir Singh (eds) Narosa Publishing House, New Delhi, ISBN81-7319-302-9.

MOLECULAR BIOLOGY

Course Outcomes:

CO1	The student develops practical knowledge to isolate nuclei and genomic DNA from animal tissues.
CO2	The student acquire hands own training in the Quantification of DNA, RNA and Proteins by colourimetric methods and will be able demonstrate electrophoretic methods
CO3	The student will demonstrate competence in gathering, analyzing, synthesizing, evaluating and applying information gathered.

Perform any 8 experiments out of 12 experiments given

1. Isolation of nuclei from liver/Spleen/Thymus
2. Isolation of genomic DNA from bacteria (E.coli)
3. Isolation of genomic DNA from Blood
4. Quantification of DNA using spectrophotometric method (UV absorption)
5. Estimation of DNA by diphenyl amine method (colorimetric method)
6. Estimation of RNA by orcinol method / U V absorption
7. Estimation of protein by Lowry'smethod
8. Isolation of DNA from bacteria
9. Agarose gel electrophoresis of DNA
10. Separation of proteins by SDS-Polyacrylamide GelElectrophoresis.
11. Digestion of DNA using restriction endonucleases, and molecular weight estimation of fragmented DNA using agarose gel electrophoresis
12. Amplification of known DNA sequences by Polymerase Chain Reaction. (Demonstration only)

REFERENCES

1. Brown, T.A. (1998): Molecular biology Lab Fax. Vol. 1 and 2, Academicpress
2. Brown, T.A. (2007): Essential Molecular Biology – A practical approach Vol. 2,

Oxford University Press
3. Wilson & Walker (2006): Principles and techniques of Biochemistry and Molecular biology, Cambridge UniversityPress.

IMMUNOLOGY

Course Outcomes:

CO 1 Students will gain skill in the immune component analysis and production of antiserum in animals
CO 2 The student will gain skill in immunotechniques

Perform any 4 wet lab experiments and 3 demonstrations out of 9 experiments given

1. Preparation of serum and Separation of lymphocytes from mammalian blood.
2. Differential counting of White blood cells
3. Blood typing and demonstration of agglutination reaction
4. Ouchterlony(passive) double immune diffusion
5. Single radial immunodiffusion
6. Western Blotting (wet lab/Picture/Video demonstration).
7. Enzyme linked immunosorbant assay (ELISA)(Picture/Video demonstration)
8. Production of antibodies (Picture/Video demonstration)
9. Preparation and Titration of antiserum. (Picture/Video demonstration)

REFERENCES

1. Talwar, G.P. and Gupta, S.K.(2002). A hand book of practical and clinical immunobiology. 2nd ed. CBS Publishers, India.
2. Wilson.K. and Walker,J. (1995). Practical Biochemistry- Principles and Techniques. Cambridge University Press.
3. **SenthilkumarBalakrishnan , KarthikKaliaperumal , SenbagamDuraisamy - Practical Immunology A Laboratory Manual**

SECOND SEMESTER THEORY
BIO2C04- MICROBIOLOGY (90 hrs)
COURSE OUTCOMES [COs]

CO1. The student will be able to explain microbial classification and identification of microbes using laboratory methods
CO2. The Student will analyze the structure of microbial genome and explain the mechanism of viral replication and transpositions
CO3. The student will develop the ability to describe various microbial fermentation methods and their importance
CO4. The student will develop an appreciation about bioremediation and other beneficial microbial utilities
CO5. The Student will describe the human interactions with microbes in terms of gut biota as well as diseases
CO6. The student will develop appreciation on the significance of microbes in food industry, biogas production and for the industrial production of other chemicals of high utility

1. Introduction (2 Hrs.)

History and scope of Microbiology. Mention contributions of Louis Pasteur, Robert

Koch, Alexander Flemming and Edward Jenner.

2. Microbial Taxonomy and Phylogeny (10 Hrs)

2.1 Principles of bacterial taxonomy.
2.2 Numerical taxonomy
2.3 Taxonomical ranks, Bergy's manual; Bacteria and Archaeae.
2.4 Artificial (phenetic) system: Numerical taxonomy.
2.5 Phylogenetic (Natural) classification
2.6 Ribotyping, Nucleic hybridization analysis.

3. Bacterial cell structure and function (8 Hrs.)

3.1 The Ultra structure of bacteria: size, shape and arrangement of prokaryotic cells
3.2 Plasma membrane and internal system - Cytometrix, inclusions, ribosomes, nucleoid
3.3 Bacterial cell wall - Peptidoglycan – structure.
3.4 Gram positive and gram negative cell wall- Mechanism of gram staining
3.5 Components external to cell wall; pili and fimbriae, capsule and slime layers, Flagella and motility
3.6 The Ultra structure of virus, bacteriophage;Types: DNA viruses, RNA viruses, and enveloped viruses
3.7 Viral replication. Bacteriophage replication.
3.8 Classes of fungi and its economic importance.

4. Microbial nutrition and growth (10 Hrs.)

4.1. Factors influencing microbial growth: Environmental and nutritional factors.
4.2. Nutritional types of bacteria (Auto, Hetero, Chemo, Phototrophs & Obligate parasites).
4.3. Microbial locomotion: flagellar motility, gliding motility and amoeboid motion. Chemotaxis, Phototaxis and other taxes.
4.4. Cultivation of bacteria: culture media, types and methods. Measurement of bacterial growth. Bacterial growth curve. Binary fission, Continuous culture. Maintenance and transport of bacterial cultures. Mixed microbial population and pure cultures.

5. Microbial methods (12 Hrs.)

5.1. Current methods of identification, characterization, classification of Microorganisms. Microscopic examination of Microorganisms, Microscopes and Microscopy – Principle and applications for the study of Microorganisms.
Identification of bacteria:
5.2. Staining reactions, Cultural, physiological and biochemical characteristics.
5.3 .Disinfectants; A - physical- Heat, filtration and radiation. B- Chemical agents - Phenol and Phenolic compounds, alcohols, halogens and aldehydes.
Sterilisation: Principle& physical and chemical methods. Disinfectants & modes of action. Testing of disinfectants.
5.4. Antibiotics: Penicillin, Cephalosporins, Chloramphenicol, Tetracyclines ; Mechanism of action. Microbial drug resistance . Antibiotic sensitivity test.

6. Microbial genetics (6 Hrs.)

6.1. Bacterial chromosome and DNA structure.
6.2. Extrachromosomal genetic elements: Plasmid, Transposons and Transposition
6.3. Mechanism of gene transfer & transformation, transduction and conjugation.

7. Microbial metabolism (8 Hrs.)

7.1. Central pathways, Glycolysis, Pentose phosphate pathway, Entner Doudoroff pathway, TCA cycles, Electron transport chain.

7.2 Aerobic and anaerobic respiration. Fermentation. Peptidoglycan synthesis.
7.3. Bacterial photosynthesis.

8. Microbial interactions and diseases (10 hrs)

8.1. Human microbe interaction, normal biota of the human body, & plant microbe interaction
82. Human diseases caused by bacteria- Typhoid, Cholera, Tetanus, Leprosy, Tuberculosis and Pneumonia.
8.3. Human diseases caused by viruses- AIDS, Rabies, Measles, Swine Flu, Bird flu, SARS
8.4. Fungal diseases- Candidiasis

9. Food and Industrial microbiology (12 Hrs)

91. Microbial spoilage of food and methods of food preservation
9.2. Types of fermentation- submerged, solid and surface type
9.3. Lactic acid fermentation - homolactic and heterolactic fermenters, mention dairy products -cheese and yogurt
9.4. Industrial alcohol and Organic acids – citric, lactic and vinegar
9.5. Industrial enzymes and vitamin b12
9.6. Single cell protein

10. Environmental microbiology (12 hrs)

10.1. Microbial ecology and biogeochemical cycles
10.2. Microbiology of soil, air and water
10.3. Microbiological analysis of drinking water.
10.4. Waste water treatment and disposal
10.5. Microbial bioremediation
10.6. Biogas plant.

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10. S. Rajan. Medical Microbiology by MJP Publishers.**ISBN-13:9788180940293s**
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15. Introductory Microbiology by J. Heritage, E.G.V. Erans, R.A. Killington, Cambridge University Press. **ISBN 0521449774**
16. Microbiology – Concepts and Application. John Wiley and Sons, New York, 1988. **ISBN-10;0471021784. ISBN-13;9780471021780**

SECOND SEMESTER THEORY
BIO2C05- BIOPHYSICS (90 hrs)

COURSE OUTCOMES [COs]

CO 1 The student understands the basic principles of physics involved in biological processes.
CO 2 The student develops an understanding about the biological aspects and implications of sound energy
CO 3 The student will be able to differentiate various ionizing radiations and to understand a comparative account of their biological effects.
CO 4 The student may familiarize with various biophysical and electrophysiological methods.
CO 5 The student understands the principles of microscopy.
CO 6 The student understands the principles and applications of separation techniques.
CO 7 The student develops an understanding of biophysical principles of hearing
CO 8 Introduction and familiarization of Nano technology as a highly promising arena in biomedical applications.

1. Fundamentals of Biophysics: (4 hrs)
1.1 Surface tension, Adsorption, Osmosis, Osmotic pressure, Dialysis.
1.2 Colloids, Colloidal systems of life.

2. Properties of water: (10 hrs)
2.1 Physical and chemical properties of water, ionization and ionic product of water, structure of liquid water and ice.
2.2 Unusual properties of water. Hydrophilic, hydrophobic and amphipathic molecules in aqueous solution.
2.3 Henderson Hasselbalch equation. Electrometric determination of pH, pH meter, PH value calculation. Buffer –Importance of buffers in biology

3. Diffusion and Osmosis (4 hrs)
3.1. Fick's laws and diffusion coefficient.
3.2 Gibb's Donnan equilibrium.
3.3 Application of diffusion processes in biology: haemolysis. Osmosis, Osmotic concentration, Osmotic pressure and osmotic gradient.
3.4 Vant Hoff's laws Electrolytic and ionic balance in biological fluid

4. Bioacoustics (10 hrs)
4.1 Characteristics of sound. Physical basis of hearing.
4.2 Physical organization of ear. Physical aspects of sound transmission in the ear. Audible sound frequency.
4.3 Pitch perception and theories.
4.4 Infrasonic and ultrasonic sounds. Echolocation; receiving and analyzing echoes.

5. Centrifugation: (10 hrs)

5.1 Principle of centrifugation, the Swedberg equation.

5.2 Types of centrifuges and rotors.

5.3 Density gradient centrifugation- Caesium chloride and sucrose density gradients; examples of separations.

5.4 Sub-cellular fractionation. Design and working of analytical ultracentrifuges, sedimentation velocity and sedimentation equilibrium analyses.

5.5 Ultra-filtration; Principle, instrumentation and application.

5.6 Dialysis, principle and uses of equilibrium dialysis,. Precipitation; methods and applications.

5.7 Flow Cytometry; Principle and design of flow cytometer, cell sorting. Detection strategies in flow cytometry and parameters measured by flow cytometry.

6. Separation Techniques (8hrs)

6.1 Chromatography - Different types - Adsorption, Partition and Ion exchangechromatography.

6.2 Column chromatography, Paperchromatography, Thin- layerchromatography, Gel-filtration. Gas chromatography, Affinitychromatography, HPLC.

6.3 Electrophoresis: Paperelectrophoresis, Discelectrophoresis, PAGE, Two dimensional PAGE, High-voltage Electrophoresis.

6.4 Isoelectric-focusing.

7. Radio-isotopic methods of analysis: (15 hrs).

7.1 Atomic stability and radiation, types of decay, rate of radioactive decay, half life, units of radioactivity.

7.2 Detection and measurement of radioactivity, Design and applications of Geiger-Muller Counter, and types of scintillation counters. Disadvantages of scintillation counters, quenching.

7.3 Chemiluminescence and phospholuminescence counting efficiency, channel ratio, sample preparation, scintillation cocktails, Cerenkov counting.

7.4 Autoradiography; types of emulsions and films for exposure to isotopes, suitable isotopes, times of exposure and processing films, direct autoradiography, fluorography, intensifying screens, quantification.

7.5 Radio tracer techniques; Supply storage and purity of radio- labeledcompounds, specific activity, radio-labeled nucleotides, metabolites. Pulse chase experiments.

8. Analytical Techniques: (15 hrs).

8.1 Properties of electromagnetic-radiations.

8.2 Principle, procedure and applications of the following techniques/instruments; UVvisible spectroscopy, Mass spectroscopy, (mention MALDI-MS), NMR and Electron Spin Resonance (ESR) spectroscopy, X-ray diffraction crystallography, Circulardichroism (CD) and Surface Plasma Resonance (SPR).

9. Microscopic techniques: (12 hrs)

9.1 Light microscope: resolution of microscopes, Optical contrast, phase contrast, and dark field microscopy.

9.2 Preparation of specimen for biochemical investigations.

9.3 Electron microscopy; Working principle and applications, specimens for electron microscopy, fixatives, immune-gold microscopy and its advantages. Metal shadowing, design and applications of scanning electron microscopy (SEM), Transmission electron microscopy (TEM), and cryo-electron microscopy. 3-D images, negative staining, single particle reconstruction.

9.4 Fluorescence microscopy: principle and applications of, design and uses of fluorescence microscopyEpi-fluorescencemicroscoy, and immuno-fluorescence

microscopy. fluorescence recovery after photo bleaching (FRAP), Fluorescence resonance energy transfer (FRET).

10. Nanotechnology (2hrs)

10.1 Definition of nanoparticles, Nanotechnology and its applications in the field of healthcare.

10.2 Role of nanotechnology in environmental management.

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SECOND SEMESTER THEORY
BIO2C06- ECOLOGY AND EVOLUTION
(90 hrs)

COURSE OUTCOMES [COs]

CO1. The course will introduce students to the basics of what life is, scales of biological organization and how interactions between an organism and its environment shape all aspects of the organism's biology.
CO2. A student of the course will understand the fundamentals of biological evolution, how evolution has shaped phenotypic diversity &behaviour, and why evolution is a unifying theme in biology.
CO3. The students will get an idea on molecular evolution and gene expression
CO4.The students will develop ideas on how the ecosystem functions and contribution to the biotic and abiotic factors affect it
CO5. The students will develop an understanding on population ecology and the relations of functional ecology
CO6. The students will develop an understanding on Community ecology
CO7. The students will have an advance understanding on Behavioural ecology
CO8. The students will develop an understanding on biodiversity and conservation ecology and their intrinsic relationship with the anthropogenic pressures.

1. Principles of Evolutionary Biology:(10 hrs)

1.1 History of evolutionary thinking - ideas that formed the basis of modern understanding of evolution.
1.2 Genes and alleles; Fundamental concepts (variation, selection, units of selection, fitness, adaptation);

2. Evolution by natural selection (12 hrs)

2.1 Prerequisites for evolution by natural selection; Evidence for natural selection and evolution.
2.2 Types of selection (directional, stabilizing, disruptive);
2.3 Evolution without selection (genetic drift, gene flow);
2.4 Species concepts and speciation;
2.5 Phylogenetics (basic terminology, tree of life, phylogenetic reconstruction, molecular dating);
2.6 Macroevolutionary patterns (mass extinction, adaptive radiation, convergent evolution, divergent evolution).

3. Molecular evolution(8 hrs)

3.1 Molecular clocks; systems of classification: cladistics and phenetics;
3.2 Molecular systematics; gene expression and evolution.

4. Principles of Ecology:(9 hrs)

4.1 Biomes; Ecosystems (trophic levels, trophic structure, energy transformation, gross and net production, primary productivity, secondary productivity);
4.2 Ecosystem types (tropical, temperate, subtropical).

5. Population ecology(9 hrs)

5.1 Metapopulation dynamics; growth rates; density independent growth; density dependent growth; niche concept.

5.2 Functional ecology; ecophysiology; behavioural ecology.

6. Community ecology(8 hrs):

6.1 Community assembly, organization and evolution.

6.2 Biodiversity: species richness, evenness and diversity indices; endemism; speciesarea relationships.

7. Behavioural ecology:(12 hrs)

7.1 Classical ethology; neuro-ethology; evolutionary ethology.

7.2 Chemical, acoustic and visual signaling.

7.3 Mating systems; sexual dimorphism; mate choice; parenting behaviour Competition; aggression; foraging behaviour; predator–prey interactions.

7.4 Sociobiology: kin selection, altruism, costs and benefits of group-living.

8. Biodiversity: (10 hrs)

8.1 Taxonomy and phylogenetic systematics.

8.2 Diversification of life - a phylogenetic perspective; Diversification of life - a timeline.

8.3 Measuring extant diversity; Threats to extant biodiversity (habitat loss and degradation, Invasive species.

8.4 Pollution, Over- exploitation, Global climate change).

9. Conservation Ecology(12 hrs)

9.1 National Parks, Wild life Sanctuaries and Biosphere Reserves.

9.2 Endangered and Endemic species of India: Common plant and animal species. Keystone species, measurement of biodiversity. In-situ and ex-situ conservation.

9.3 Biodiversity of India; Island biogeography.

9.4 Environmental Priorities, strategies and Environmental Legislation (Acts) in India, Environmental Impact Assessment.

9.5 Bioremediation: Concept need and scope, environmental applications.

REFERENCES

1. Manuel C Molles, Ecology: Concepts and Applications McGraw Hill 7th Edition 2014
2. Douglas J Futuyma, Evolution Oxford University Press 3rd Edition 2013
3. Barton et al., Evolution Cold Spring Harbor Laboratory Press 1st Edition 2007
4. Stephen C. Stearns and Rolf F. Hoekstra, Evolution: An Introduction Oxford University Press 1st Edition 2000
5. Nicholas J. Gotelli, A primer of Ecology Oxford University Press, 4th Edition 2008
6. Begon et al., Ecology: From Individuals to Ecosystem Wiley-Blackwell, 4th Edition 2005
7. Jason Matthiopoulos 2020 How to be a quantitative ecologist: The 'A to R' of green mathematics and statistics

SECOND SEMESTER PRACTICAL
BIO2L02-BIOPHYSICS, MICRO BIOLOGY, AND ECOLOGY
MICROBIOLOGY

Course outcomes

CO1. The student gather hands own experience in isolation, staining and counting of bacteria
CO2. The student gain better knowledge regarding various sterilization techniques bacterial culture and antibiotic sensitivity tests

1. Selective isolation and enumeration of bacteria.

2. Microscopic examination of bacteria in living conditions

3. Testing of motility

4. Bacterial staining technique
a. Simple staining of bacteria.
b. Negative staining
c. Hanging drop technique.
d. Differential staining- Gram staining, Acid fast staining.
e. Special Staining- CapsularStaining, Volutin Granules, Endospore Staining
5. Turbidity test for contamination of milk.
6. Preparation of media and sterilization methods.eg: Nutrient agar, mac conkey agar,
7. Cultivation of yeast and molds
8. Bacteriological analysis of water e.g., fecal pollutants.
9. Antibiotic sensitivity test.
10. Maintenance of *E. coli* culture (shake and surface cultures) and quantitative evaluation (number of cells/ml) of a given sample of culture by dilution and plating.

REFERENCES

1. Kannan, N.(2003). Lab Manual in General Microbiology. Panima Publishing Company,India.
2. Cappuccino,J.G. and Sherman,N. (2007). Microbiology-A laboratory Manual Benjamin-Cummings Publishing Company.USA.

BIOPHYSICS

Course outcomes (COs)

CO1 The student familiarize with the instruments/ techniques in biophysics; PH meter,
CO 2 The student will be able to perform Paper chromatography, TLC, Gel electrophoresis, C02 Application of colorimetry in quantitative analysis.
CO 3The student will explain Tm value and reassociation kinetics of DNA

1. pH meter and measurement of pH
2. Paper chromatography of amino acids
3. Separation and identification of amino acids in mixtures
4. Thin layer chromatography.
5. Gel electrophoresis of protein/DNA.
6. Determination of unknown concentration of coloured solutions by calibration curve using colorimeter.
7. Absorption spectrum and max of a coloured solution (KMnO4).
8. Determine the titration curve of amino acids & calculate the pKa values.
9. Determine the titration curve of Proteins & calculate the pKa values.
10. Determine the Tm of DNA.
11. Denaturation & Renaturation of DNA.
12. Drawings using Camera lucida.

REFERENCES

1. Daniel, M. (1998). Basic Biophysics for Biologists.. Agri. Botanica, Bikaner.
2. Das, D.(1987). Biophysics and Biophysical Chemistry. Academic Publishers, Calcutta.
3. Gassey, E.J.(1962). Biophysical concepts and mechanics. Van Norstrant Reinhold co.
4. Hoppe, W (1988). Biophysics, Springer Veilag.21
5. White, D.C.S.(1974).Biological Physics, Chapman and Hall. London.

ECOLOGY AND EVOLUTION

Course outcomes (COs)

CO 1 The students will be able to perform various methods to assess the habitat and ecosystems
CO 2 The students will be exposed with the various laboratory mechanisms to understand the species and its interaction with various responses

Habitat studies:

1. Physical and chemical characteristics of soil.
2. Assessing influence of light, temperature and moisture on plant germination and growth/animal behavior and growth.
3. Assessing influence of soil nutrient status on plant germination and growth.

Community/ecosystem studies:

1. Assessment of density, frequency and abundance of plants/animal in a community using various techniques i.e. transect, quadrate etc.
2. Comparison of stands/communities and ordination.
3. Profile diagrams.
4. Biomass and reproductive allocation under various environments.
5. Nutrient uptake and budget for various communities/Food chain assessment.
6. Decomposition of various organic matters and nutrient release mechanisms/role of arthropods and other micro-, and macrofauna in decomposition.
7. Understanding ecosystem succession by studying various stages of vegetation/community assemblages development.
8. Molecular techniques in laboratory (DNA barcoding).
9. Insect diversity in soil (Three different soil samples with 5 orders).

Landscape studies:

1. Principles of GIS, GPS and RS technology.
2. Interpretation (visual and automated) of remote sensing information for landscape differentiation

Ethology

1. To study the median threshold concentration of sucrose solution in eliciting feeding responses of housefly.

REFERENCES:

1. NC Aerry, N.C. (2010) - A manual of environmental analysis . Ane books private limited.
2. Goodenough, J; McGuire B. and Robert, W. (1993) Perspectives on Animal Behaviour. John
Wiley and Sons, Lond.
3. Manning, A. (1967). An Introduction to Animal Behaviour. Edward Arnold Pub., London.
4. Manning, A. and Dawkins,M.S.(1995).An introduction to Animal Behaviour, Cambridge Press.
5. Bonnie,J, Plager and Ken Yamkawa (2003). Exploring Animal Behaviour in Laboratory and
Field. Academic press.
6. Michael, P.(1984). Ecological methods for field and laboratory investigations. Tata McGraw Hill
publishing co.
7. Webber, W.J (1972).Physicochemical Processes for water quality control. Wiley interscience.

8. George,T, Franklin, L. Burton and David, S.H.(2002). Waste water Engineering-Metcalf and
Eddy.4th ed. Inc. Tata McGraw Hill publishing co.

THIRD SEMESTER THEORY

BIO3C07- CELL BIOLOGY & GENETICS (90 hrs)

COURSE OUTCOMES [COs]

CO1. The student will acquire knowledge on cell theory, cell-ECM interactions, structure and function of plasma membrane and membrane transport
CO2. The student learn to know the structure and functions of cell organelles
CO3. The student will explain the general features of genetic code, special features of the genetic code in mitochondria, and variations in genetic code.
CO4. The student will be able to explain the regulation of cell cycle and how the alterations of cell cycle can cause cancer. The students also will understand the fundamentals of cancer biology.
CO5. The student will explain the cell-cell interactions, cell-ECM interactions and signaling pathways.
CO6. The student will describe the principles of Mendelian Genetics
CO7. The student will explain the non Mendelian inheritance
CO8. The student will describe the sex determination in plants and animals and its methods
CO9. The student will get a clear picture of chromosomes and its aberrations in human body.
CO10. The student will explain the significance of Population and Evolutionary Genetics

Unit 1 (10 hrs)

Cell and its membranes - Discovery of cell, cell Theory. Ultra-structure of Prokaryotic and Eukaryotic cell. Cell wall and ECM; Plasma membrane: Models of membrane structure Membrane components; Solute transport mechanisms.

Unit 2 (10 hrs)

Cell organelles - structure & function – Mitochondria; Plastids; Endoplasmic reticulum; Golgi complex; Lysosome, Endosome and microbodies; Nucleus, nucleolus and Ribosome, vacuoles; cytoskeleton, cell motility: cilia and flagella.

Unit 3 (10 hrs)

Cell cycle & Cancer - An overview of cell cycle; cell cycle checkpoints, Intracellular and Extra-cellular regulation of cell division, Mitosis and Meiosis. Apoptosis **–** Intrinsic & Extrinsic pathways, cancer, oncogenes, tumor suppressor genes.

Unit 4 (10 hrs)

Protein secretion & targeting – Chaperones & Protein folding, protein targeting into mitochondrion, nucleus, chloroplast, peroxisome. Transport across ER & Golgi vesicular trafficking.

Unit 5 (8 hrs)

Cell signaling – cell signaling pathways, cell to cell interactions, cell to ECM interactions, tight junctions, gap junctions, plasmodesmata, adherence

Unit 6 (10 hrs)

Genetics: Mendel's work, Laws of heredity, Test cross, Incomplete dominance. Linkage and crossing over - Coupling and repulsion hypothesis, Linkage in maize and Drosophila.

Unit 7 (6 hrs)

Gene Interactions: Multiple alleles: Blood groups in human beings. Non-Mendelian Inheritance - Extra nuclear Inheritance, Maternal Effect, Epigenetic Inheritance.

Unit 8 (6 hrs)

Sex Determination in Plants and animals, Concept of allosomes and autosomes. XX-XY-XX-XO-ZW-ZZ ZO-ZZ types. Sex-Linked Characteristics.

Unit 9 (10 hrs)

Chromosomes- Discovery, Morphology and structural organization, Euchromatin and Heterochromatin. Special type of chromosomes: Polytene chromosome and Lamp brush chromosomes, Karyotyping**.** Chromosomal Variations: structural and numerical aberrations.

Unit 10 (10 hrs)

Quantitative Genetics- Quantitative Traits, Polygenic Inheritance, Types of Heritability. Population Genetics- Genotypic and Allelic Frequencies, Hardy–Weinberg Equilibrium, Genetic Drift. Evolutionary Genetics- Modes of Speciation, Phylogenetic Trees, Molecular Clock.

References

1. Cooper, G.M. (1997). The Cell: A molecular approach, ASM Press, USA.
2. Darnell, J., Lodish, H., Baltimore, D. (1990). Molecular Cell Biology. Scientific American Books Inc. NY.
3. Edwards and Hassall (1980). Biochemistry and Physiology of cell, 2nd Edn. McGraw Hill Company.
4. Karp, G. (1996). Cell and Molecular Biology concepts and experiments, John Wiley and Sons Inc. NY.

5. Lodish, H., Baltimore, D., Berk, A., Zipursky, B.L., Mastsydaira, P., Darnell, J. (2004). Molecular Cell Biology, Scientific American Books Inc. NY.
6. Wolfe, S.L. (1991). Molecular and Cellular Biology, Wordsworth Pub.Co.
7. Brooker, R.J., (2012). Concepts of Genetics, McGraw-Hill
8. Pierce, B.A., (2012). Genetics: A Conceptual Approach, W. H. Freeman and Company.
9. Gardener, E.J., Snustad, D.P., Simmons, M.J., Jenkins, J.B., (1997). Principles of genetics, John Wiley & Sons.
10. Tamarin, R.H., (2002). Principles of Genetics, 7th Edition, The McGraw−Hill Companies

THIRD SEMESTER THEORY

BIO3C08- BIOSTATISTICS, BIOINFORMATICS AND RESEARCH METHODOLOGY (90 hrs)

COURSE OUTCOMES [COs]

CO 1. The student will understand the basic steps involved in biostatistics and how to apply them in various problems
CO 2. The student will be able to organize and interpret data through various statistical methods
CO 3. The student will describe probability distributions, testing of hypothesis and learn to use SPSS software, which can be utilized during research publications
CO 4. The students will understand how to correlate data and interpret the data using different statistical methods
CO. 5 The student will be able to understand about biological databases for collecting biological data in research.
CO 6. The student will compare the protein structures, protein interactions using modeling techniques like docking
CO 7. The student develop skills to prepare work plan, proposal and thesis writing methods.
CO 8. The student will understand how to publish a research paper, and the different ways to analyze the quality of a research journal.

1. **Unit 1 (8 hrs):**

   Introduction to Biostatistics- Basic concepts, data types. Tabulation of data, construction of graph and graphical representations of data. Different models of data presentations. Frequency distribution, Arithmetic mean, mode, median and

percentiles. Measures of variability: Range, mean deviation. Standard deviation and co-efficient of variation.

2. **Unit 2 (10 hrs):**

   Properties of the data- Organization of data, Central tendency, dispersion, linear regression and correlation-test of significance, skewness and kurtosis. Simple linear correlation and regression analysis. Analysis of variance. Population and sample: parameter and statistics.

3. **Unit 3 (14 hrs):**

   Probability distributions- Binomial, Poisson and Normal distribution. Testing of hypothesis: basic concepts and definitions, Tests based on Normal, student's t, chi-square and F distributions. Introduction to statistical software (SPSS).

4. **Unit 4 (8 hrs):**

   Correlation and Regression: Types of correlation. Methods to measure correlation-Scatter diagram. Karlpearson's coefficient of correlation, Spearman's correlation Types of regression analysis Regression equations Difference between regression and correlation analysis.

5. **Unit 5 (14 hrs):**

   Biological Databases: Data mining and applications, accessing bibliographic databases. Pubmed, Nucleic acid sequence data bank – NCBI and EMBL. Protein sequence databank NBRF- PIR, SWISSPROT. Structural databases - protein data Bank (PDB). Metabolic pathway data bank (Pub gene), Microbial genomic database (MBGD), Cell line database (ATCC), Virus data bank (UICTVdb). Sequence alignment - Global and Local alignment. Similarity searching (FASTA and BLAST).

6. **Unit 6 (12 hrs):**

   Protein Structure and Molecular Interaction: Introduction to protein structure - secondary structure prediction, tertiary structure prediction, protein modelling-principles of homology and comparative modelling. Applications - Molecular docking – Autodock.

7. **Unit 7 (12 hrs):**

   Planning of Research – defining objectives , Preparation of work plans, Identification of suitable methodology, Preparation of project proposal, Thesis structure, Components - Writing Introduction, review of literature, Materials & Methods, Presentation of results, Discussion of Results based on literature , Arriving

at conclusions, Preparation of Summary/abstract, Arrangement of Bibliography and how to quote reference in thesis, Appendix.

8. **Unit 8 (12 hrs):**

   Publishing of Research- Publishing of Articles in newspapers /newsletters, Selection of journals, ISSN Number, Peer-reviewed Journals, Science citation index, impact factor and importance. Manuscripts preparation for Journals, components, Plagiarism, Submission and Publication, reprints and PDF formats. Paper presentation in Conferences.

Reference Books

1. Agarwal, B.L. (1996) Basic statistics, New Age International(P) Ltd. Publishers, New Delhi.
2. Bailey, N.T.J. (1981) Statistical methods in Biology. Hodder and Stongtton, London.
3. Campell, R.C. (1978), Statistics for biologists. Blacker and Sons Publishers, Bombay.
4. Gupta, C.B. and Gupta, V. (2002) Statistical methods. Ikas Publishing House, New Delhi.
5. Rostogi, V. B. (2009) Fundamentals of Biostatistics. Ane's Students Edition, New Delhi.
6. Magurran AE. 2004. Measuring Biological Diversity. Blackwell Publishing
7. Stephen W,Looney(2008) Methods in Molecular Biology-Biostatistical Methods Springer International Edition
8. Zar, J.H. (2003) Biostatistical Analysis - Fourth edition. Pearson Education. New Delhi
9. Anderson, Durston & Polle 1970: Thesis and assignment, writing. Wiley Eastern Limited.
10. Booth W. C. et al. 2016. The Craft of Research. University of Chicago Press.
11. Katz, M. J. 2009. From Research to Manuscript: A Guide to Scientific Writing. Springer.
12. Michael Alley. The Craft of Scientific Writing (3rd Edition) Publisher: Springer.
13. Applied Bioinformatics – an introduction – (springer) Selzer P.M and others
14. Bioinformatics Basics – (CRC) – Rashidi, Hooman H , Lukas K Buchler
15. Structural Bioinformatics – (CRC) – Burkowski
16. Bioinformation a practical guide to the analysis of genes and proteins Bexevanis Andress D - ed
17. Practical Bioinformatics (springer) - Bujnicki, Janusz M.- ed

BIO3E0901- MOLECULAR MEDICINE AND VIROLOGY I-GENOMICS (90 hrs)

COURSE OUTCOMES [COs]

CO1. The student will acquire knowledge on nucleic acids and the genome organization of eukaryotes and prokaryotes
CO2. The student will learn to interpret genetic mapping and analyze crossing data
CO3. The student will develop skills to use computer tools for biological data analysis
CO4. The student will acquire knowledge on prediction of inheritance pattern of heredity based on classical genetics
CO5. The Student will get a clear cut picture on genome sequencing and annotation

CO6. The student will develop understanding of the pattern of genome evolution and origin of gene families
CO7.The student will explain nucleic acid sequencing and different gene prediction methods
CO8. The student will explain the basics of microarray techniques and transcription sequencing and their applications

UNIT 1 (13 hrs)
Biochemical Basis of Applied Molecular Genetics: Central Dogma; DNA structure and DNA metabolizing enzymes. Biochemical methods to study DNA and RNA. Characterization of Genomic DNA: Overview of Genome organization in bacteria, yeasts, & humans, Genomic Mapping, Cosmid Vectors, BAC vectors. Contemporary Applied Molecular Genetics: Accessing Molecular Genetic Information through the Internet

UNIT 2 (10 hrs)
Core Aims of Genomic Science: Polymorphism and Gene Mapping, Nature of SNP's and polymorphisms. Mapping Genomes: Genetic Maps, Physical Maps, Cytological Maps, Comparative Maps. Managing and Distributing Genomic Data.

UNIT 3 (13 hrs)
Organization of genomes: Introduction: Genome, Genomics, Omics and importance, General features, C-value paradox. Gene identification; gene prediction rules and software's; Genome databases; Annotation of genome. Genome diversity: taxonomy and significance of genomes – bacteria, yeast, Caenorhabditis, Homo sapiens, Arabidopsis, etc.

UNIT 4 (10 hrs)
Mapping genomes: Genetic mapping – i) Cross breeding and pedigree analysis, ii)DNA markers - RFLPs, SSLPs, SNPs Physical mapping - Restriction mapping, Fluorescent in situ hybridization, Radiation hybrid mapping and Sequence tagged site mapping.

UNIT 5 (13 hrs)
Genomics: Genome projects: The Human genome project, HapMap Project, The 1000 genome project, and The ENCODE Project. Structural genomics: Assembly of a contiguous DNA sequence- shotgun method, clone contig method, and whole –genome shotgun sequencing Understanding a genome sequence: locating the genes in a genome sequence, determining the functions of individual genes and by studying the activity of a protein coded of an unknown gene

UNIT 6 (13 hrs)
Pattern of genome evolution: The origin of genomes- Origin of macromolecules, RNA world and DNA world Acquisition of new genes (By gene duplication) and Gene families – (Types, Pseudogenes, Origin of gene families (lateral gene transfer, allopolyploidy). Synthetic genomes and their applications

UNIT 7 (10 hrs)
Automated DNA sequencing. Genomic Sequencing: Hierarchical. Genomic Sequencing: Shotgun. Sequence Verification. Genomic Annotation: EST sequencing, Ab initio gene discovery, non-protein coding genes. Structural features of Genome Sequences. Functional Annotation and Gene Family Clusters, note COG's with Orthologs and Paralogs

UNIT 8 (8 hrs)
Introduction to CDNA Microarray technology, Pligonucleotide Microarray Technology, Microarray data mining, SAGE, Differential display, Properties of Transcriptomes: Cancer

Reference Books

1. 1. Brown T. A. 2007, Genomes 3. Garland Science Publishing, New York.
2. 2. Dunham, I., 2003. Genome Mapping and sequencing. Horizon Scientific
3. 3. Graur, D and W H Li, 2000. Fundamentals of molecular evolution. Sinauer Associates.
4. 4. Hartwell, L. H., L. Hood, M. L. Goldberg, A. E. Reynolds, L. M. Silver and R. G. Veres. 2004. Genetics from Genes to Genomes. McGraw Hill.
5. 5. Lewin B. 2003. Genes VIII. Oxford University Press. Oxford.
6. 6. The Human Genome 2001, Nature Vol. 409.
7. 7. The Drosophila Genome. 2000, Science Vol. 267.
8. 8. The Caenorhabditis elegans genome 1998. Science Vol. 282.
9. 9. The Arabidopsis Genome 2000 Nature vol. 408.
10. 10. Primrose, S. B., and R. M. Twyman . 2006. Principles of gene manipulation and Genomics, Blackwell Publishing MA. USA

THIRD SEMESTER THEORY

BIO3E0902- OMICS AND MOLECULAR MEDICINE I-PROTEOMICS AND METABOLOMICS (90 hrs)

COURSE OUTCOMES [COs]

CO1 :Students will be enabled with advanced knowledge in protein studies
CO2:The student will develop the ability to analyse the structure, classification, separation of proteins
CO3:The student will develop Appreciation on the mechanism of protein modifications
CO4:Student will understand about various protein - protein interactions
CO5:Students will gain knowledge in Quantitative proteomics and protein modelling.
CO6:Students will appreciate the applications of proteomics and metabolomics
CO7:Students will learn targeted and untargeted metabolomics.
CO8:Students will gain knowledge about Fluxomics

UNIT 1 (12 hrs)

Introduction to Proteomics: Proteins, Classification, and structural hierarchy. Separation of Proteins by Multidimensional Approach; Chromatography, Electrophoresis, Determination of the Primary Structure of Proteins- Non Spectrometric methods;from DNA sequence, Edman Degradation,Mass Spectrometry; Determination of the 3D Structure of a Protein-X-Ray Crystallography/X-Ray Diffraction, Neutron Scattering, Nuclear Magnetic Resonance Spectroscopy, Comparative Modelling, Threading Method, Ab Initio Method.

UNIT 2 (12 hrs)

Proteomics of Protein Modifications: Phosphorylation and Phosphoproteomics, Glycosylation and Glycoproteomics, Ubiquitination and Ubiquitinomics. Miscellaneous Modifications of Protein- Proteolysis, Methylation, Sulfation, Hydroxylation and

Carboxylation, Lipidation, Amidation, Sumoylation. Genetic code, Wobble hypothesis. Methods to determine protein modifications.

UNIT 3 (10 hrs)

Protein–Protein Interactions: Protein—Protein Interactions (PPI) in Vivo - Yeast Two-Hybrid Assay, Phage Display. Protein arrays and peptide arrays. Analysis of Protein Interactions in Vitro- TAP and Mass Spectrometry. Experimental designs for protein-protein interaction study. Analysis of Protein Interactions in Silico; Interactomes, Evolution and Conservation of Interactomes. Methods to study protein –DNA interactions.

UNIT 4 (8 hrs)

Quantitative proteomics: Isotope label based proteomics and label free proteomics, High resolution MS based proteomics, Relative and absolute quantification.

UNIT 5 (10 hrs)

Protein Modelling: Protein structure Analysis and predictions. Structure Comparison. Phylogenetic Analysis.: Different approaches for tree construction. Homology modelling. Docking: Types, interaction algorithms, Stages of docking, application. Protein databases, Use of NIST database.

UNIT 6 (6 hrs).

Applications of Proteomics: Diseasome, Medical Proteomics, Clinical Proteomics, Metaproteomics and Human Health, Proteomics in Biology and Industry of Drug Production, Bioterrorism and Biodefense.

UNIT 7 (6 hrs)

Metabolomics: Introduction to metabolomics, significance of the study of metabolome, techniques to study metabolome, challenges, limitations in the existing techniques.

UNIT 8 (8 hrs)

Untargeted Metabolomics: Metabolite extraction, sample preparation techniques, experimental design and reproducibility, existing platforms for untargeted metabolomics, data analysis and metabolite identification, advantages and shortcomings **.**

UNIT 9 (8 hrs)

Targeted metabolomics: Platforms for targeted metabolomics, Choosing the standards, tandem mass spectroscopy, High resolution MS, metabolite identification and quantification, Peak integration, signal noise and signal drift, statistical tools for data analysis, data bases for reference metabolites.

UNIT 10 (10 hrs)

Fluxomics and Applications of metabolomics: Introduction to fluxomics, approaches to study metabolic flux, fluxes between organs and tissues, nutrient flux in the system. Discuss original research articles one each on human metabolite profiling, plant metabolite and animal metabolite profiling, fluxomics in developing seeds.

Reference Books

1. Fan, TW-M., Lane, A. N., Higashi, R. M., (2012). The handbook of metabolomics.Humana Press, usa.
2. Gross, J.H., (2011). Mass spectrometry – A textbook. Springer publications.

3. Leung, H-CE., (2012). Integrative proteomics. InTech publications.
4. Lindon, J.C., (2007). The handbook of metabonomics and metabolomics. Elsevierpublications.
5. Proteins and proteomics: A laboratory manual. Cold Spring Harbor. 1. Kulkarni, S., Pfeifer, J., (2014).
6. Clinical genomics, Academic Press.
7. Primrose, S.B., Twyman, R.M., (2006). Principles of gene manipulation and genomics,Blackwell Publishing.
8. Reece, R.J., (2004). Analysis of genes and genomes, John Wiley & Sons Ltd.
9. Barh, D., Azevedo, V., (2018). Omics Technologies and Bio-engineering: TowardsImproving Quality of Life, Academic Press
10. Wittmann, C., Lee, S.Y., (2004). Systems metabolic engineering, Springer Science &Business Media
11. Pevsner, J., (2014). Bioinformatics and Functional Genomics, Wiley-Blackwellpublications.
12. Kihara, D., (2011). Protein function prediction for omics era, Springer Science &Business Media

THIRD SEMESTER PRACTICALS

(Examinations will be conducted in the fourth semester)

BIO4L04- CELL BIOLOGY & GENETICS PRACTICALS

Course Outcomes:

CO1	The student develops practical knowledge on various cytological events like mitosis, meiosis etc
CO2	The student acquire hands own training in various techniques in genetics viz linkages, cross-over and karyotyping

Perform any 10 experiments out of 14 experiments given

1. Study of cell structure by a temporary mount of an onion peel
2. Cell division: Mitotic studies in onion root tips
3. Study of meiosis
4. Chromosomes: Mounting of polytene chromosomes
5. Buccal smear - Barr bodies
6. Isolation and vital staining of Mitochondria
7. RBC cell count by Haemocytometer
8. Karyotyping
9. Experiments on epistatic interactions including test cross and back cross
10. Determination of linkage and cross-over analysis
11. Bacterial transformation (Calcium mediated)
12. Bacterial conjugation (using AR genes)
13. ABO blood grouping
14. Differential blood count

REFERENCES

1. Sambrook, J., Fritsch, E.F., and T. Maniatis. Molecular Cloning. A Laboratory Manual. 2nd Ed. Cold Spring Harbor Laboratory Press, New York,1989.
2. Genetics: A Laboratory Manual -by G. Koliantz and D.B. Szymanski

BIO4L04- BIOSTATISTICS, BIOINFORMATICS AND RESEARCH METHODOLOGY PRACTICALS

Course Outcomes

CO 1 Students will gain skill in the statistical analysis of biological data
CO 2 The student will gain skill in-silico studies like structure prediction and designing
CO 3 The students will attain experience in writing scientific publications

Perform any 10 experiments out of 14 experiments given

1. Preparation of frequency table with given data
2. Diagrammatic presentation of census data in Kerala in the form of bar diagrams and pie diagrams. (Prepare same graph in Excel and keep print out)
3. Designing of an experiment for the comparison of efficacy of a few diets on different types of animals by the method of ANOVA. (Prepare same in Excel and keep prints out and add steps for excel).
4. Regression analysis and correlation analysis of a data of height and weight of a group of students. (Prepare same in Excel and keep print outs and add steps for excel)
5. LST determination of given data using SPSS
6. Analysis of protein sequence from protein database.
7. Analysis of gene sequence from nucleotide database.
8. Getting and analysis of primary protein structure.
9. Secondary structure analysis of protein.
10. Tertiary protein structure analysis using Rasmol.
11. Primer designing
12. Research proposal writing
13. Scientific article preparation
14. BLAST analysis of microbial genome

REFERENCES

1. Biostatistics using R: A Laboratory Manual- Raisa Hernández-Pacheco and Alexis A Diaz

2. BIOINFORMATICS. A Practical Guide to the. Analysis of Genes and Proteins. SECOND EDITION. Andreas D. Baxevanis.

3. Research Methodology: Methods and Techniques- C R Kothari

BIO4L05- MOLECULAR MEDICINE AND VIROLOGY I- GENOMICS PRACTICALS

Course Outcomes:

CO1.	Students will gain skills in methods and techniques in genomics
CO2	Students will appreciate the importance of genomics

Perform any 8 experiments out of the 10 experiments given.

1. Isolation of DNA from Human Blood by phenol-chloroform extraction method and/ or spin column based.
2. Primer design and DNA amplification by PCR method.
3. Cloning by TA method (Ligation)
4. Competent cell preparation
5. Performing transformation using cloned DNA.
6. Isolation of recombinant DNA
7. Performing restriction digestion, and electrophoresis
8. Isolation of mRNA from blood sample.
9. Whole genome expression analysis using microarrays (video demonstartion)
10. Visit to genetics and genomics Diagnostics Company.

REFERENCES

1. Barh, D., Azevedo, V., (2018). Omics Technologies and Bio-engineering: Towards Improving Quality of Life, Academic Press
2. Wittmann, C., Lee, S.Y., (2004). Systems metabolic engineering, Springer Science &Business Media
3. Pevsner, J., (2014). Bioinformatics and Functional Genomics, Wiley-Blackwell publications.
4. Kihara, D., (2011). Protein function prediction for omics era, Springer Science & Business Media.

BIO4L05- OMICS AND MOLECULAR MEDICINE I-PROTEOMICS AND METABOLOMICS PRACTICALS

Course Outcomes:

CO1: students will gain skills in methods and techniques proteomic
CO2 :Students will be equipped with protein separation and visualization techniques
CO3:Students appreciate the use of Metabolomic data
CO4:Students will learn to analyse functional metabolomic results

Perform any 10 experiments out of 12 experiments given

1. Qualitative analysis of protein in the given sample
2. Estimation of the amount of protein in the given serum sample
3. Determination of the protein content in egg white.
4. Protein separation by Electrophoresis
5. Determination of protein concentration by UV spectrophotometry
6. Determination of molecular weight of protein by sds-page
7. Western blotting (Demonstration)
8. Visualization of given molecule using RASMOL

9. Explore the relationships of metabolite pathways in different biological network by network explorer software.
10. Investigate the influence of metabolites in different biological network and find out the Metabolite-Disease Interaction.
11. Perform pathway analysis of metabolites using MetaboAnalyst.
12. Retrieve any metabolomic pathway from KEGG database

Reference

1. Proteins and proteomics: A laboratory manual. Cold Spring Harbor
2. Barh, D., Azevedo, V., (2018). Omics Technologies and Bio-engineering: Towards Improving Quality of Life, Academic Press
3. Wittmann, C., Lee, S.Y., (2004). Systems metabolic engineering, Springer Science &Business Media
4. Pevsner, J., (2014). Bioinformatics and Functional Genomics, Wiley-Blackwellpublications.
5. Kihara, D., (2011). Protein function prediction for omics era, Springer Science & Business Media.

FOURTH SEMESTER THEORY

BIO4C10: PHYSIOLOGY AND DEVELOPMENTAL BIOLOGY (90 hrs)

COURSE OUTCOMES [COs]

CO1 Students will appreciate the knowledge of Physiology
CO2 Students will learn various mechanisms in photosynthesis
CO3 Students will gain knowledge about Plant life process
CO4 Students will appreciate the knowledge of Digestion, Respiration circulation etc
CO5 Students will gain knowledge about Developmental biology
CO6 Students learn about Embryonic and body plan and regeneration
CO7 Students gain knowledge about Fertilization
CO8 Students appreciate their knowledge about Gametogenesis and early development in animals

Unit 1 (10 hours)

Photosynthesis and Plant Hormones: Light harvesting complexes; mechanisms of electron transport; photo-protective mechanisms; plant mitochondrial electron transport and ATP synthesis; alternate oxidase; photorespiratory pathway. Nitrogen metabolism: Nitrate and ammonium assimilation; amino acid biosynthesis. Plant hormones: Biosynthesis, storage,

breakdown and transport; physiological effects and mechanisms of action (auxins, gibberellins, cytokines, ethylene, abscisic acid).

Unit 2 (10 hours)

Plant Life processes and Stress Physiology: Light control of plant development (phytomorphogenesis) and the role of Photoreceptors (red/blue/UV), plant homeostatic genes and their role in organogenesis. Solute transport and photoassimilate translocation Secondary metabolite. Stress physiology: Responses of plants to biotic (pathogen and insects) and abiotic (water, temperature and salt) stresses; mechanisms of resistance to biotic stress and tolerance to abiotic stress . Sensory photobiology: Structure, function and mechanisms of action of phytochromes, cryptochromes and phototropins; stomatal movement; photoperiodism and biological clocks

Unit 3 (15 hours).

Digestion, Circulation, Respiration and Excretion : Neural-Hormonal control of digestive glandular secretion. Symbiotic digestion in Ruminants. Circulation: Respiratory pigments: Major types and their features. Fuld and Spiro's theory of blood clotting. Respiration: Regulation of respiration. Transport of O2 and CO2. Oxygen dissociation curve: Definition and factors affecting the Oxygen dissociation curve (Oxygen, Carbon Dioxide, Temperature, pH, Body size and Organic phosphate compounds – Bohr effect and Haldane effect Excretion: Ammonotelism, Uricotelism and Ureotelism with examples. Formation of Ammonia (Deamination of amino acids), Urea (Ornithine cycle) and Uric acid (Purine degradation).

Unit 4 (10 hours)

Homeostatic functions: Chemical nature of hormones. Endocrine glands: Pituitary, Thyroid, Parathyroid and Adrenal glands; secretions and their actions, effect of hyposecretion and hypersecretion. Concept of Homeostasis and role of feedback mechanism: Positive – Oxytocin secretion. Negative – Thyroid secretion (details of regulation required)

Unit 5 (10 hours)

Gametogenesis and early development in animals: Physiological, chemical, and molecular events during a) Oogenesis & b) Spermatogenesis c) Fertilization d) Cleavage e) Competence

and induction f) Primary, secondary and abnormal inductions g) Mesoderm induction in amphibians h) Totipotency and nuclear transplantation experiments.

Unit 6 (10 hours)

Embryonic and body plan and regeneration: a) Embryonic polarity – Drosophila and Amphibia, b) Gastrulation in Amphibia and Mammal c) Epithelial morphogenesis, cytoskeletal components, microtubules, microfilaments and intermediate filaments. Teratology and its significance in histogenesis. d) Erythropoiesis, pancreogenesis and myogenesis. Physiological changes during regeneration in planarians and amphibians, Life cycles and Evolution of Developmental pattern a) The frog lifecycle, b) Developmental pattern of Metazoan, c) Multicellularity Evolution of differentiation.

Unit 7 (15 hours)

Plant development: Cell territories and their role in anther differentiation Microsporagenesis: Ultra structure, physiology, and biochemistry. Male gametophyte: Pollen wall morphogenesis during tetrad and post tetrad phases, origin, structure and differential behaviour of generative and vegetative cells, formation of spores and ultrastructure of 3-celled pollen grain, the culture of anthers and meiocytes. Ovule: A general account of ontogeny and diversity in structure. Megasporogenesis: Ultrastructure and physiology. Female Gametophyte: Diversity in organization, ultra-structure of female gametophyte (In cotton), embryosac haustoria - a general account.

Unit 8 (10 hours)

Fertilization: Structure of stigma and style, pollen germination in vivo, pollen tube entry into the stigma, pollen tube growth, entry of pollen tube into female gametophyte, double fertilization, hetero fertilization and single fertilization. Endosperm: Development, cytology and physiology, reserve materials, embryo – endosperm relationship. Embryo: Structure, composition and polarity of zygote, early embryogenesis (2 celled, proembryonal tetrad, quadrant and octant stages), octant to mature embryo in Ceratophalus falcatus (Dicot), Halophila ovata (Monocot).and Grass embryo.

REFERENCES

1. Balinsky.B.L. 1971 Introduction to Embryology (Saunders College pub.)
2. Beril N.J. and Karpotata.G. 1972 Development (Mc Graw Hill Publications)
3. Easu, K. 1977. Anatomy of Seed Plants. Wiley Eastern, New Delhi.

4. Fosket, D. E. 1989. Plant growth and developments. Academic Press, New York.
5. Johansen, D. A. 1950. Plant embryology. Chronica Botanica Co., Waitham, Mass.21
6. Johri, B. M. 1984. Embryology of Angiosperms. Spinger – verlag, Berlin
7. Medical Physiology by Grabowski and Tortora(2003)
8. Animal Physiology by Hoar(1966)
9. Review of Medical Physiology by Ganong(2012)
10. Human Physiology by A.C. Guyton(2006)
11. Human Physiology Vol I & II by Chatterjee(2016)
12. Animal Physiology by Randol(2001).
13. Plant Physiology by Lincoln Taiz, Eduardo zeiger
14. Guyton & Hall Textbook of Medical Physiology 12th Ed. Elsevier Pub. 2011.
15. Developmental Biology Ninth Ed. 2010. Scott F. Gilbert

BIO4E1101: MOLECULAR MEDICINE AND VIROLOGY II: VIROLOGY (90 hrs)

COURSE OUTCOMES [COs]

CO1. The student will acquire knowledge regarding the structure, morphology and entry mechanisms of virus
CO2. The student learn to know the cuturing methods and the taxonomy of DNA and RNA viruses
CO3. The student will explain the importance of viral tropism and the characteristic features of viral tropism.
CO4. The student will explain the different types of animal viruses, the disease associated with it, and the treatment measures
CO5. The student will explain the different types of plant viruses, the diseases associated with it and the types of phages and their structural and functional mechanisms
CO6. The student will describe the viral detection techniques, diagnosis methods associated with it and infectivity assays
CO7. The student will explain the quantification and classification of viruses also will learn about the lab prohylaxis following a viral infection
CO8. The student will describe the emerging viral infections, vaccinations and the eradication measures taken

Unit 1 (10 hrs)

Virus Structure: Protective coat, nucleic acid genome packaging, virus envelope components, virion enzymes and other viral protein. Mechanisms of virus entry into cells: uncoating at plasma membrane, endocytic pathway, entry of nonenveloped virus into cells. Genome replication strategies of DNA viruses. Intracellular transport of viral components, assembly maturation and exit of progeny virion.

Unit 2 (10 hrs)

Cultivation and Taxonomy of Viruses- Methods used for viral quantification and enumeration. Laboratory requirements for cultivation. Lawn culture, Embryonated egg inoculation, Animal inoculation, Permissive and non-permissive hosts or cells. Tissue - Types of celllines used for the study, Detection of virus growth in cell culture. Sub-viral particles – viroids and prions. Classification DNA and RNA viruses

Unit 3 (10 hrs)

Viral Tropism, Factors responsible for viral tropism. Replication of DNA viruses and RNA viruses, effects of viruses on the host cells – cyto-pathic effect. Immune aversion mechanism of viruses, Emerging viral diseases. Virus Host interaction- Acute infection, chronic/persistent infection latent infection and slowly progressive virus infection. Viral inclusion bodies - methods of staining and demonstration.

Unit 4 (12 hrs)

Animal viruses Poxviruses, Papilloma Viruses, Human Herpes Viruses, Adenoviruses, Picornaviruses, Rotaviruses, Paramyxoviruses and Rhabdoviruses, Reoviruses, Retroviruses Flaviviruses, Coronaviruses Human Swine fever virus Cancer causing RNA and DNA Viruses. Viral arthritis. Control of animal viral diseases, Antiviral agents, Combination therapy, Nucleic acid based therapies.

Unit 5 (12 hrs)

Bacteriophages Lambda phage, T phages, Filamentous phages M 13 phages. Lytic and lysogenic cycles of Lambda phage. M13 replication Types of plant viruses, Economic losses due to important viruses; DNA viruses, RNA viruses, satellite viruses, satellite RNA, satellite DNA, viroids, virusoids; Disease symptoms, local and systemic movement of viruses, plasmodesmata and virus movement. Genomic Organization of DNA viruses; Caulimovirus –

eg. Cauliflower mosaic virus, Replication of CaMV, Badnavirus – Rice trungro virus (RTBV); Nanovirus – Banana bunchy top virus. Potato virus Y (PVY), Citrus triesteza virus; Bromovurudae, Alfalfa mosaic virus, Rice dwarf virus.

Unit 6 (12 hrs)

Virus detection and diagnosis; Infectivity assays- Sap transmission, insect vetor transmission, agroinfection (using Agrobacterium); Ultracentrifugation, electron microscopy, serological methods, immunelectrophoresis in gels, direct double-antibody sandwich method, Dot ELISA, Immunosorbent electron microscopy (ISEM), Decoration technique, Polymerase chain reaction; DNA and oligonucleotide microarray; Gene silencing, PTGS & TGS, viral suppressors of gene silencing.

Unit 7 (12 hrs)

Quantification and classification of viruses. Pathogenesis, laboratory diagnosis and prophylaxis of following viral infections –Polio, Influenza, Mumps, Measles, Rabies, Japanese encephalitis, Viral haemorrhagic fever, Rubella, Hepatitis, HIV, Slow virus diseases, Emerging viral diseases- Bird Flu, Swine Flu and Nippah.

Unit 8 (10 hrs)

Polio and vaccination, small pox and eradication, chickenpox and latency, influenza and genomic diversity, rubella and childhood infection, Ebola and emerging infection, rabies and infection of the brain, HPV and cancer causing viruses, HIV and viral treatment, viral hepatitis and chronic infection, prions and diseases of life style.

REFERENCES

1. Ed. C.L. Mandahar, Molecular biology of Plant viruses, Kluwer academic publishers, Dordrect, 1999. • Roger Hull (Ed), Mathews Plant Virology, 4th Edition, Academic Press, San Diego, 2002.
2. D.G.A. Walkey (Ed), Applied Plant Virology, 2nd Edition, Chapman & Hall, London, 1991.
3. Text Book of Microbiology :Ananthanarayanan & Jayaram Panikker
4. Medical Virology : Fenner and White • Principles and Practice of Infectious diseases – Madell, Bennett, Dolin Vol- 1 & 2
5. Medical Microbiology : David Greenwood, Slack, Peutherer

6. Essentials of Diagnostic Virology: G. Storch
7. Notes on Medical Virology By Morag.C. Timbury
8. Diagnostic methods in Clinical Virology : N.R. Grist
9. Fundamentals of Molecular Virology By Nicholas H. Acheson

BIO4E1102: OMICS AND MOLECULAR MEDICINE II: GENOMICS AND TRANSCRIPTOMICS (90 hrs)

COURSE OUTCOMES [COs]

CO1 Students will appreciate the knowledge of gene and its cloning
CO2 Students will learn various gene sequencing techniques
CO3 Students will gain knowledge about Comparative Genomics
CO4 Students will appreciate the knowledge of Genomic Changes during evolution
CO5 Students will gain knowledge about Genomics and Human Biology
CO6 Students learn about Transcriptome and Transcriptomic Technology
CO7 Students gain knowledge about Transcriptome Analysis
CO8 Students appreciate their knowledge about the applications of Transcriptomics in Health and Disease.

Unit 1 (8 hrs)

Introduction to genomics : Gene- Eukaryotic and prokaryotic gene structure, cloning from mRNA: Isolation and purification of RNA, synthesis of cDNA, Isolation of plasmids, cloning cDNA in plasmid vectors, cloning cDNA in bacteriophage vectors

Unit 2 (12 hrs)

Genes and gene cloning techniques. Cloning of genomic DNA: Isolation and purification of DNA, preparation of DNA fragments and cloning. In vitro packaging of λ phage and amplification of libraries. Advanced cloning strategies-synthesis and cloning of cDNA, PCR amplified DNA, use of adaptors and linkers, homopolymer tailing in cDNA cloning, expression of cloned DNA molecules.

Unit 3 (10 hrs)

Selection, screening and analysis of recombinants: Genetic selection, insertional inactivation, chromogenic substrates, complementation of defined mutations, nucleic acid hybridization, screening methods for cloned libraries, PCR screening protocols, immunological screening, restriction mapping of cloned gene, blotting techniques, sequencing methods. Purification strategies of expressed His- tagged proteins.

Unit 4 (10 hrs)

Gene Transformation Techniques: Transformation and transfection techniques, preparation of competent cells of bacteria, chemical methods calcium phosphate precipitation method, liposome mediated method, physical methods Electroporation, gene gun method. Method of DNA transfer to yeast, mammalian and plant cells, transformation and transfection efficiency.

Unit 5 (10 hrs)

Gene Labelling and Genomics: Labeling of DNA by radioactive isotopes, non-radioactive labeling, in vivo labeling, autoradiography and autofluorography. DNA sequencing by enzymatic and chemical methods, Human Genome sequencing project; DNA microarrays; Copy number variation, sequence repeats, SNV, haplotype, and their relevance in diseases.

Unit 6 (16 hrs)

Transcription and Transcriptome: Characteristics and function of bacterial RNA polymerases, mechanism of transcription and regulation. Eukaryotic RNA polymerases-transcription factors, mechanism of transcription and regulation. Stringent response. Post transcriptional modifications of mRNA (5‟CAP formation, poly adenylation, mechanism of splicing, Group I, II and III, spliceosome assembly, splicing editing, Group IV splicing), stablility. Processing of tRNA and rRNA. Inhibitors of transcription. Ribozyme technology: mechanism of action and applications.

Unit 7 (14 hrs)

Transcriptomic Technology: Transcription: Pre-processing of RNA, mRNA, Transcriptome and Transcriptomics, The Insights of Transcriptomics (mRNA regulation). Types and function of RNA: rRNA, tRNA, mRNA, siRNA, miRNA, RNA interference (RNAi), RNA-induced silencing complex (RISC), Biogenesis of miRNA and siRNA.

Computational prediction of- miRNA genes and miRNA targets. Bioinformatics of siRNA designing Transcriptome Project in Human, Mouse

Unit 8 (10 hrs)

Transcriptome Analysis: High-Throughput Sequencing Techniques - Sanger's Sequencing Technology, Next Generation Sequencing, 454 Sequencing, Illumina Sequencing, Bioinformatics Pipelines, and software for Transcriptome analysis.

REFERENCES

13. Lindon, J.C., (2007). The handbook of metabonomics and metabolomics. Elsevier publications.
14. Proteins and proteomics: A laboratory manual. Cold Spring Harbor. 1. Kulkarni, S., Pfeifer, J., (2014).
15. Clinical genomics, Academic Press.
16. Primrose, S.B., Twyman, R.M., (2006). Principles of gene manipulation and genomics, Blackwell Publishing.
17. Reece, R.J., (2004). Analysis of genes and genomes, John Wiley & Sons Ltd.
18. Barh, D., Azevedo, V., (2018). Omics Technologies and Bio-engineering: Towards Improving Quality of Life, Academic Press
19. Wittmann, C., Lee, S.Y., (2004). Systems metabolic engineering, Springer Science & Business Media
20. Pevsner, J., (2014). Bioinformatics and Functional Genomics, Wiley-Blackwell publications.
21. Kihara, D., (2011). Protein function prediction for omics era, Springer Science & Business Media

BIO4E1201: MOLECULAR MEDICINE AND VIROLOGY III: MOLECULAR DIAGNOSTICS (90 hrs)

COURSE OUTCOMES [COs]

CO1. The student will acquire knowledge regarding the introduction and history of diagnostic techniques, specimen collection and processing

CO2. The student learn to know the traditional disease diagnostic methods for various diseases
CO3. The student will explain the importance of biochemical molecular diagnostic techniques
CO4. The student will explain the different types of nucleic acid detection, amplification and purification techniques
CO5. The student will explain the different types nucleic acid based diagnostic techniques like RFLP, RAPD etc in disease diagnosis
CO6. The student will describe the principles, methods and instruments for Automated DNA sequencing
CO7. The student will explain the importance of clinical proteomics and immuno diagnostic techniques in disease detection and also the need to maintain good lab practices
CO8. The student will describe the genetic diseases and the diagnostic techniques.

Unit 1 (10 hrs)

Introduction and History of diagnostics, Diseases- infectious, physiological and metabolic errors, genetic basis of diseases, inherited diseases. Infection – mode of transmission in infections, factors predisposing to microbial pathogenicity, types of infectious diseases- bacterial, viral, fungal, protozoans and other parasites. · Philosophy and general approach to clinical specimens, Sample collection- method of collection, transport and processing of samples, Interpretation of results, Normal microbial flora of the human body, Host - Parasite relationships.

Unit 2 (10 hrs)

Traditional disease diagnosis methods and tools - diagnosis of infection caused by Streptococcus, Coliforms, Salmonella, Shigella, Vibrio, andMycobacterium., Diagnosis of fungal infections. Major fungal diseases: Dermetophytoses, Candidiosis and Aspergillosis. · Diagnosis of DNA and RNA viruses- Pox viruses, Adenoviruses, Rhabdo Viruses, Hepatitis Viruses and · Retroviruses. · Diagnosis of Protozoan diseases: Amoebiosis, Malaria, Trypnosomiosis, Leishmaniasis. Study of helminthic diseases- Fasciola hepatica and Ascaris lumbricoides. Filariasis and Schistosomiasis.

Unit 3 (10 hrs)

Biochemical tests for detection and quantification of sugar, albumin, urea, protein, globulin, vitamin · Biochemistry and diagnostic tests of following diseases - Duchenne Muscular Dystrophy (DMD) (Creatine phosphokinase-CPK) , Phenylketonuria-PKU (phenylketone), G6PD deficiency syndrome (G6PD) , Mucopolysaccharidosis, Endocrine disorders related to thyroid and reproduction (TSH, T3, T4, Estradiol, Testosterone, LH, FSH) · Isolation and Purification of Nucleic acids- Principles and Methods. Molecular cloning, labeling of nucleic acids, hybridization.

Unit 4 (12 hrs)

Nucleic acid amplification methods and types of PCR: Reverse Transcriptase-PCR, Real-Time PCR, Inverse PCR, Multiplex PCR, Nested PCR, Alu-PCR, Hot-start, In situ PCR, Long-PCR, PCR-ELISA, Arbitrarily primed PCR, Ligase Chain Reaction. · Proteins and Amino acids, Qualitative and quantitative techniques: Protein stability, denaturation; amino acid sequence analysis, · Hybridization techniques – Southern, Northern, in-situ (including FISH), microarrays – types and applications; Protein extraction and analysis (including PAGE and its variations); Western Blot

Unit 5 (12 hrs)

Applications of PCR- PCR based microbial typing: Eubacterial identification based on 16S rRNA sequences- Amplified Ribosomal DNA Restriction analysis (ARDRA)-Culture independent analysis of bacteria- DGGE and TRFLP. Molecular diagnosis of fungal pathogens based on 18S rRNA sequences- Detection of viral pathogens through PCR. RAPD for animal and plants. PCR in forensic science- AmpFLP, STR, Multiplex PCR- Determination of Paternity- Human identification and sex determination.

Unit 6 (12 hrs)

Automated DNA sequencing- Principles, Methods and Instrumentation- Advances in DNA sequencing- New Generation sequencing Methods, Pyrosequencing · Microarrays- Personalised Medicine- Pharmacogenomics. · SSCP, CSGE, DGGE, DHPLC , MALDI-TOF , DNA Sequencing. Levels for rDNA experiments. Biosafety aspects of transgenic plants and germplasm.

Unit 7 (12 hrs)

Proteomics- Clinical Proteomics diagnosis. Immunodiagnostics - Introduction, antigen-antibody binding interactions and assays; polyclonal and monoclonal antibodies, · HLA typing. Immunoassays – types [RIA, ELISA, ChemiluminescentIA, FIA] and specific applications; Immunohistochemistry – principle and techniques. Good Laboratory Practices. · Different Levels of Biosafety, Containment.

Unit 8 (12 hrs)

Disease identification and Genetic tests for following disorders- Thalassemia, Fanconi anemia, Sickle Cell anemia, Fragile-X syndrome, Alzheimer's disease, Duchenne Muscular Dystrophy/ Becker's Muscular Dystrophy, Huntington's disease · Allelic susceptibility test for multifactorial disorders (Neural Tube Defect, Cleft Lip and Palate, Cardio Vascular Disorder, Male infertility) · Risk evaluation (Mendelian risk, empirical risk), Prenatal and pre-implantation diagnosis. Noninvasive: Triple test, Ultrsonography (USG), Invasive: Amniocentesis (AC), chorionic villi sampling (CVS), Fetal blood sampling (FBS), Population screening for genetic disorders.

REFERENCES

1. Fundamentals of Molecular Diagnostics (2007). David E. Bruns, Edward R. Ashwood, Carl A. Burtis. Saunders Group.
2. Henry's Clinical Diagnosis And Management By Laboratory Methods (2007) Mcpherson
3. Molecular Diagnostics: Fundamentals, Methods & Clinical applications (2007). Lele Buckingham and Maribeth L. Flaws
4. Molecular Diagnostics for the Clinical Laboratorian 2Ed. 2006, W.B. Coleman. Humana Press.
5. Molecular Pathology in Clinical Practice (2007). D. G. B. Leonard. 10. Microbial Functional Genomics (2004) by J.Zhou, D.K. Thomson. Y.Xu. J.M. Tiedje. J.Wiley & Sons Publishers.
6. Expert Review of Molecular Diagnostics

BIO4E1202: OMICS AND MOLECULAR MEDICINE III: MOLECULAR MEDICINE AND DRUG DISCOVERY (90 hrs)

COURSE OUTCOMES [COs]

CO1. The student will acquire basic knowledge on stem cells, its various types and their application in the field of molecular medicine.
CO2. The student will describe regenerative medicines and the underlying cellular and molecular mechanism behind tissue regeneration.
CO3. The student will learn importance of vaccination and vaccines.
CO4. The student will understand about biomaterials and the immense possibility they offer in the field of molecular medicine.
CO5. The student will explain the application of nanomaterials for bio-imaging, bio-sensing and bio-detection of pathogens.
CO6. The student will explain the historical evolution of drugs.
CO7. The student will describe the methods involved in drug discovery and clinical trials.
CO8. The student will describe their route of entry into the system and mode of action.
CO9. The student will get a clear picture on the pharmacodynamics and pharmacokinetics of drug action within the system.
CO10. The student will explain the significance of computer aided drug discovery.

Unit 1 (6 hours)

Stem cells: Introduction - basic concepts and definitions, self-renewal, clonality, potency, types of stem cells - Embryonic stem cells, Hematopoietic stem cells, Mesenchymal stem cells, Adult stem cells. Pluripotency and Induced pluripotency. Applications of stem cells.

Unit 2 (7 hours)

Vaccines & Vaccination – adjuvants, DNA vaccines, recombinant vaccines, bacterial vaccines, viral vaccines, principles of vaccination, passive & active immunization, immunization programs & role of WHO in immunization programs.

Unit 3 (6 hours)

Biomaterials: Natural biomaterials and Synthetic biomaterials, Design principles in biomaterials and scaffolds. Biomaterials for drug delivery and 3D cell culturing.

Unit 4 (12 hours)

Nanotechnology: Nanoparticles for drug/gene delivery, Active and passive delivery of nanoparticles to cells, Bio detection of pathogens, Nanobiotechnological applications in health and disease - infectious and chronic, Nanoparticles for therapy of diseases – cancer, diabetes. Nanoparticles as Biosensors. Nanoparticles for Bioimaging.

Unit 5 (5 hours)

Drugs - Definition, historical evolution, classification of drugs, nomenclature of drugs. General idea regarding the milestones in drug research. Sources of Drugs. Routes of drug administration.

Unit 6 (10 hours)

Drug discovery process–traditional approach and rational approach. Drug discovery phase–preclinical evaluation phase, clinical trial phase, phases of clinical trials and pharmacovigilance. Patent Protection and regulation.

Unit 7 (10 hours)

drug action - Concept of Agonists, antagonists (Competitive and non-competitive), Partial agonist, Inverse agonist, Functional antagonist, tachyphylaxis, idiosyncrasy. Illustration of drug action through examples - mechanism of action & uses Taxol, streptomycin, Diasulin, Mevastatin etc.

Unit 8 (15 hours)

Pharmacodynamics: Principles, site and mechanism of drug action (Nervous system, Histamines and Antihistamines, Cardiovascular Drugs), Drug Receptor, Classification of receptors, Drug-Receptor interactions. Dose response relationship, Therapeutic index, LD_{50}, ED_{50}, LC_{50}, EC_{50}, MIC and MEC. Adverse Drug Reactions. Pharmacovigilance, ADR monitoring.

Unit 9 (7 hours)

Pharmacokinetics: Pharmacokinetic properties: Membrane transport, absorption, distribution metabolism and excretion of drugs (ADME parameters), Factors affecting ADME, Lipinski’s rule of five.

Unit 10 (12 hours)

Computer Aided Drug Discovery: – Introduction to Open Source and Commercial in silico tools and softwares Datases- Drug Bank, Dr. Duke's Phytochemicals, Kegg, Pub-Chem, ChEMBL. Structure drawing softwares–ChemDraw, ACD/Chemsketch, SWISS Model. Molecular docking and drug receptor interactions: An overview.

REFERENCES

1. Advances in Nanotechnology and the Environment, Juyoung Kim, CRC Press, Taylor and Francis Group.
2. Biosensors: A Practical Approach, J. Cooper & C. Tass, Oxford University Press, 2004.
3. Nanomaterials for Biosensors, Cs. Kumar, Wiley – VCH, 2007.
4. G. Cao, Naostructures and Nanomaterials: Synthesis, properties and applications, Imperical College Press, 2004.
5. Computational and structural approaches to drug discovery, Robert M Stroud and Janet. F Moore, RCS Publishers.
6. Introduction to Quantitative Drug Design by Y.C. Martin, CRC Press, Taylor & Francis group.
7. Drug Design by Ariens Volume 1 to 10, Academic Press, 1975, Elsevier Publishers.
8. Principles of Drug Design by Smith andWilliams, CRC Press, Taylor & Francis.

FOURTH SEMESTER PRACTICALS

As Core curriculum courses, students completing these courses along with the practical sessions will demonstrate competence in gathering, analyzing, synthesizing, evaluating and applying information.

BIO4L04- PHYSIOLOGY & DEVELOPMENTAL BIOLOGY PRACTICALS

COURSE OUTCOMES [COs]

CO1	Students learn various techniques in development biology
CO2	Students appreciate the knowledge of Stress response
CO3	Students will gain knowledge about understanding physiological techniques

CO4 Students will learn the analysis of Megasporogenesis

1. Determination of primary production of a leaf area by chlorophyll method.
2. Effect of water and salinity stress on chlorophyll content of leaves.
3. Urine Analysis - Glucose, albumin and ketone bodies in urine
4. Blood - Total count, DC, ESR
5. Liver function test.
6. Observation of slides of the early development of fish, frogs, chick
7. Preparation of whole-mount of chick blastoderm.
8. Determine the age of the chick embryo by staining techniques.
9. Types of ovules and ovular parts.
10. Megasporogenesis and female gametophyte (Polygonum type).
11. Preparation of whole mount
12. Serial section and histochemical staining techniques

REFERENCES

1. Darwin Fand Hamilton Acton E. 2011. Practical Physiology of Plants (Reissue edition), Cambridge University Press, Cambridge, UK
2. MacDougal DT. 2009. Practical Text-Book of Plant Physiology, University of Michigan Library, Michigan, USA
3. Text book of Animal Physiology -Nagbhushenen
4. Text book of Animal Physiology - Guize
5. Text book of Animal Physiology - A.K. Berry

BIO4L05- MOLECULAR MEDICINE AND VIROLOGY II: VIROLOGY PRACTICALS

Course Outcomes

CO: Students will gain skill in the methods and experiments in virology

Perform any 9 experiments out of 11 experiments given

15. Preparation of glassware for tissue cultures (washing, sterilization)
16. Preparation of buffers like PBS, Hank’s
17. Preparation of clinical specimens for isolation of viruses (video demonstration)
18. Collection & transport of specimens (video demonstration)
19. Serological test -ELISA for HIV

20. Serological test- ELISA for HBs Ag
21. Chick Embryo techniques-inoculation and harvesting
22. Handling of mice, rats and guinea pigs for collection of blood (video demonstration)
23. Molecular techniques in virology-PCR-HPV infection
24. Bacteriophage isolation technique
25. Staining and microscopy for viral inclusion bodies
26. Hemagglutination and Haemadsorption
27. Visit to diagnostic laboratory/research institute

REFERENCES

1. **A Practical Guide to Clinical Virology by L. R. Haaheim, John R. Pattison, Richard J. Whitley.**
2. Virology: A Laboratory Manual: Florence G. Burleson, Thomas M. Chambers, Danny L. Wiedbrauk · 2014

BIO4L05- OMICS AND MOLECULAR MEDICINE II: GENOMICS AND TRANSCRIPTOMICS PRACTICALS

COURSE OUTCOMES [COs]

CO1 Students learn various techniques in gene cloning
CO2 Students appreciate the knowledge of gene amplification methods
CO3 Students will gain knowledge about blotting techniques**.**
CO4 Students will learn the analysis of transcriptomic data

Perform any 8 experiments

1. Restriction digestion analysis.
2. Ligation of restricted fragments.
3. Selection of cloned microorganisms by blue /while colony, X-Gal method
4. Design a primer
5. Isolation of RNA from bacteria
6. Reverse transcription PCR for cDNA Synthesis -PCR (Demonstration)
7. Real-time PCR (Demonstration)
8. Southern Blotting (Demonstration)
9. Analysing the given transcriptomic data

10. Retrieval and analyse of metagenomic data.

REFERENCES

1. Barh, D., Azevedo, V., (2018). Omics Technologies and Bio-engineering: Towards Improving Quality of Life, Academic Press
2. Wittmann, C., Lee, S.Y., (2004). Systems metabolic engineering, Springer Science &Business Media
3. Pevsner, J., (2014). Bioinformatics and Functional Genomics, Wiley-Blackwell publications.
4. Kihara, D., (2011). Protein function prediction for omics era, Springer Science & Business Media.

BIO4L06- MOLECULAR MEDICINE AND VIROLOGY III: MOLECULAR DIAGNOSTICS PRACTICALS

Course Outcomes:

CO: students will gain skills in methods and techniques related to molecular diagnosis

Perform any 8 experiments out of 10 experiments given

1. Isolation of Genomic DNA from Human (Peripheral Blood Sample)
2. Serological tests-ELISA-Toxoplasma infection
3. PCR based diagnosis- Tuberculosis
4. Karyotype using human lymphocyte culture
5. Western Blotting
6. RNA isolation from mammalian tissue
7. HLA typing and tissue transplantation matching (Video Demo)
8. Microarrays for pathogen detection and SNP studies (Video Demo)
9. Real Time PCR observation of working under a laboratory setting
10. Visit to Diagnostic Laboratory/Research institute

REFERENCES

1. Molecular Diagnostics: George P. Patrinos, Wilhelm Ansorge, Phillip B. Danielson · 2016
2. Molecular Diagnostic PCR Handbook: Gerrit J. Viljoen, Louis H. Nel, John R. Crowther · 2005

3. Diagnostic Molecular Pathology: A Guide to Applied Molecular : William B. Coleman, Gregory J. Tsongalis · 2016

BIO4L06- OMICS AND MOLECULAR MEDICINE III: MOLECULAR MEDICINE AND DRUG DISCOVERY PRACTICALS

Course Outcomes:

CO1: Students will get familiarized with the different stages of the bioactive molecule developments in the drug discovery process
CO2: They will get hands on training in different traditional pre analysis methods of candidate drug molecules

Perform any 8 experiments out of 10 experiments given

1. Prediction of drug ability of bioactive molecules by Lipinski rule of five
2. Evaluation of invitro antioxidant potential
    a. Nitric oxide scavenging assay
    b. DPPH
3. Basic extraction methods in traditional drug development process
    a. Decoction
    b. Soxhlet extraction
    c. Separating funnel
4. Extraction of essential oils by Clevenger apparatus
5. Silica gel column chromatography
6. Kirby Baur Antibiotic sensitivity test
7. Liebermann Burchard test for terpenoids
8. Qualitative analysis of Phytochemicals
    a. Test for flavonoids
    b. Test for terpenoids
    c. Test for saponins
9. Drug delivery via Hydrogel beads (Picture/Video demonstration)
10. Visualization of molecular interaction between drug and receptor (Picture/Video demonstration)

REFERENCES

1. Screening methods in pharmacology – Robert A. Turner.
2. Drug Evaluation – Vogel.
3. Evaluation of Drug Activities – Lawrence and Bachrach.
4. Methods in Pharmacology – Swarbrick.
5. Pharmacopoeias.

M.Sc BIOLOGY

FOURTH SEMESTER THEORY

BIO4C10: PHYSIOLOGY AND DEVELOPMENTAL BIOLOGY (90 hrs)

COURSE OUTCOMES [COs]

CO1 Students will appreciate the knowledge of Physiology
CO2 Students will learn various mechanisms in photosynthesis
CO3 Students will gain knowledge about Plant life process
CO4 Students will appreciate the knowledge of Digestion, Respiration circulation etc
CO5 Students will gain knowledge about Developmental biology
CO6 Students learn about Embryonic and body plan and regeneration
CO7 Students gain knowledge about Fertilization
CO8 Students appreciate their knowledge about Gametogenesis and early development in animals

Unit 1 (10 hours)

Photosynthesis and Plant Hormones: Light harvesting complexes; mechanisms of electron transport; photo-protective mechanisms; plant mitochondrial electron transport and ATP synthesis; alternate oxidase; photorespiratory pathway. Nitrogen metabolism: Nitrate and ammonium assimilation; amino acid biosynthesis. Plant hormones: Biosynthesis, storage, breakdown and transport; physiological effects and mechanisms of action (auxins, gibberellins, cytokines, ethylene, abscisic acid).

Unit 2 (10 hours)

Plant Life processes and Stress Physiology: Light control of plant development (phytomorphogenesis) and the role of Photoreceptors (red/blue/UV), plant homeostatic genes and their role in organogenesis. Solute transport and photoassimilate translocation Secondary metabolite. Stress physiology: Responses of plants to biotic (pathogen and insects) and abiotic (water, temperature and salt) stresses; mechanisms of resistance to biotic stress and tolerance to

abiotic stress . Sensory photobiology: Structure, function and mechanisms of action of phytochromes, cryptochromes and phototropins; stomatal movement; photoperiodism and biological clocks

Unit 3 (15 hours).

Digestion, Circulation, Respiration and Excretion : Neural-Hormonal control of digestive glandular secretion. Symbiotic digestion in Ruminants. Circulation: Respiratory pigments: Major types and their features. Fuld and Spiro's theory of blood clotting. Respiration: Regulation of respiration. Transport of O2 and CO2. Oxygen dissociation curve: Definition and factors affecting the Oxygen dissociation curve (Oxygen, Carbon Dioxide, Temperature, pH, Body size and Organic phosphate compounds – Bohr effect and Haldane effect Excretion: Ammonotelism, Uricotelism and Ureotelism with examples. Formation of Ammonia (Deamination of amino acids), Urea (Ornithine cycle) and Uric acid (Purine degradation).

Unit 4 (10 hours)

Homeostatic functions: Chemical nature of hormones. Endocrine glands: Pituitary, Thyroid, Parathyroid and Adrenal glands; secretions and their actions, effect of hyposecretion and hypersecretion. Concept of Homeostasis and role of feedback mechanism: Positive – Oxytocin secretion. Negative – Thyroid secretion (details of regulation required)

Unit 5 (10 hours)

Gametogenesis and early development in animals: Physiological, chemical, and molecular events during a) Oogenesis & b) Spermatogenesis c) Fertilization d) Cleavage e) Competence and induction f) Primary, secondary and abnormal inductions g) Mesoderm induction in amphibians h) Totipotency and nuclear transplantation experiments.

Unit 6 (10 hours)

Embryonic and body plan and regeneration: a) Embryonic polarity – Drosophila and Amphibia, b) Gastrulation in Amphibia and Mammal c) Epithelial morphogenesis, cytoskeletal components, microtubules, microfilaments and intermediate filaments. Teratology and its significance in histogenesis. d) Erythropoiesis, pancreogenesis and myogenesis. Physiological changes during

regeneration in planarians and amphibians, Life cycles and Evolution of Developmental pattern a) The frog lifecycle, b) Developmental pattern of Metazoan, c) Multicellularity Evolution of differentiation.

Unit 7 (15 hours)

Plant development: Cell territories and their role in anther differentiation Microsporagenesis: Ultra structure, physiology, and biochemistry. Male gametophyte: Pollen wall morphogenesis during tetrad and post tetrad phases, origin, structure and differential behaviour of generative and vegetative cells, formation of spores and ultrastructure of 3-celled pollen grain, the culture of anthers and meiocytes. Ovule: A general account of ontogeny and diversity in structure. Megasporogenesis: Ultrastructure and physiology. Female Gametophyte: Diversity in organization, ultra-structure of female gametophyte (In cotton), embryosac haustoria - a general account.

Unit 8 (10 hours)

Fertilization: Structure of stigma and style, pollen germination in vivo, pollen tube entry into the stigma, pollen tube growth, entry of pollen tube into female gametophyte, double fertilization, hetero fertilization and single fertilization. Endosperm: Development, cytology and physiology, reserve materials, embryo – endosperm relationship. Embryo: Structure, composition and polarity of zygote, early embryogenesis (2 celled, proembryonal tetrad, quadrant and octant stages), octant to mature embryo in Ceratophalus falcatus (Dicot), Halophila ovata (Monocot).and Grass embryo.

REFERENCES

1. Balinsky.B.L. 1971 Introduction to Embryology (Saunders College pub.)
2. Beril N.J. and Karpotata.G. 1972 Development (Mc Graw Hill Publications)
3. Easu, K. 1977. Anatomy of Seed Plants. Wiley Eastern, New Delhi.
4. Fosket, D. E. 1989. Plant growth and developments. Academic Press, New York.
5. Johansen, D. A. 1950. Plant embryology. Chronica Botanica Co., Waitham, Mass.21

6. Johri, B. M. 1984. Embryology of Angiosperms. Spinger – verlag, Berlin
7. Medical Physiology by Grabowski and Tortora(2003)
8. Animal Physiology by Hoar(1966)
9. Review of Medical Physiology by Ganong(2012)
10. Human Physiology by A.C. Guyton(2006)
11. Human Physiology Vol I & II by Chatterjee(2016)
12. Animal Physiology by Randol(2001).
13. Plant Physiology by Lincoln Taiz, Eduardo zeiger
14. Guyton & Hall Textbook of Medical Physiology 12th Ed. Elsevier Pub. 2011.
15. Developmental Biology Ninth Ed. 2010. Scott F. Gilbert

BIO4E1101: MOLECULAR MEDICINE AND VIROLOGY II: VIROLOGY (90 hrs)

COURSE OUTCOMES [COs]

CO1. The student will acquire knowledge regarding the structure, morphology and entry mechanisms of virus

CO2. The student learn to know the cuturing methods and the taxonomy of DNA and RNA viruses

CO3. The student will explain the importance of viral tropism and the characteristic features of viral tropism.

CO4. The student will explain the different types of animal viruses, the disease associated with it, and the treatment measures

CO5. The student will explain the different types of plant viruses, the diseases associated with it and the types of phages and their structural and functional mechanisms

CO6. The student will describe the viral detection techniques, diagnosis methods associated with it and infectivity assays

CO7. The student will explain the quantification and classification of viruses also will learn about the lab prohylaxis following a viral infection

CO8. The student will describe the emerging viral infections, vaccinations and the eradication measures taken

Unit 1 (10 hrs)

Virus Structure: Protective coat, nucleic acid genome packaging, virus envelope components, virion enzymes and other viral protein. Mechanisms of virus entry into cells: uncoating at plasma membrane, endocytic pathway, entry of nonenveloped virus into cells. Genome replication strategies of DNA viruses. Intracellular transport of viral components, assembly maturation and exit of progeny virion.

Unit 2 (10 hrs)

Cultivation and Taxonomy of Viruses- Methods used for viral quantification and enumeration. Laboratory requirements for cultivation. Lawn culture, Embryonated egg inoculation, Animal inoculation, Permissive and non-permissive hosts or cells. Tissue - Types of celllines used for the study, Detection of virus growth in cell culture. Sub-viral particles – viroids and prions. Classification DNA and RNA viruses

Unit 3 (10 hrs)

Viral Tropism, Factors responsible for viral tropism. Replication of DNA viruses and RNA viruses, effects of viruses on the host cells – cyto-pathic effect. Immune aversion mechanism of viruses, Emerging viral diseases. Virus Host interaction- Acute infection, chronic/persistent infection latent infection and slowly progressive virus infection. Viral inclusion bodies - methods of staining and demonstration.

Unit 4 (12 hrs)

Animal viruses Poxviruses, Papilloma Viruses, Human Herpes Viruses, Adenoviruses, Picornaviruses, Rotaviruses, Paramyxoviruses and Rhabdoviruses, Reoviruses, Retroviruses Flaviviruses, Coronaviruses Human Swine fever virus Cancer causing RNA and DNA Viruses. Viral arthritis. Control of animal viral diseases, Antiviral agents, Combination therapy, Nucleic acid based therapies.

Unit 5 (12 hrs)

Bacteriophages Lambda phage, T phages, Filamentous phages M 13 phages. Lytic and lysogenic cycles of Lambda phage. M13 replication Types of plant viruses, Economic losses due to important viruses; DNA viruses, RNA viruses, satellite viruses, satellite RNA, satellite DNA, viroids, virusoids; Disease symptoms, local and systemic movement of viruses, plasmodesmata and virus movement. Genomic Organization of DNA viruses; Caulimovirus – eg. Cauliflower mosaic virus, Replication of CaMV, Badnavirus – Rice trungro virus (RTBV); Nanovirus – Banana bunchy top virus. Potato virus Y (PVY), Citrus triesteza virus; Bromovurudae, Alfalfa mosaic virus, Rice dwarf virus.

Unit 6 (12 hrs)

Virus detection and diagnosis; Infectivity assays- Sap transmission, insect vetor transmission, agroinfection (using Agrobacterium); Ultracentrifugation, electron microscopy, serological methods, immunelectrophoresis in gels, direct double-antibody sandwich method, Dot ELISA, Immunosorbent electron microscopy (ISEM), Decoration technique, Polymerase chain reaction; DNA and oligonucleotide microarray; Gene silencing, PTGS & TGS, viral suppressors of gene silencing.

Unit 7 (12 hrs)

Quantification and classification of viruses. Pathogenesis, laboratory diagnosis and prophylaxis of following viral infections –Polio, Influenza, Mumps, Measles, Rabies, Japanese encephalitis, Viral haemorrhagic fever, Rubella, Hepatitis, HIV, Slow virus diseases, Emerging viral diseases- Bird Flu, Swine Flu and Nippah.

Unit 8 (10 hrs)

Polio and vaccination, small pox and eradication, chickenpox and latency, influenza and genomic diversity, rubella and childhood infection, Ebola and emerging infection, rabies and infection of the brain, HPV and cancer causing viruses, HIV and viral treatment, viral hepatitis and chronic infection, prions and diseases of life style.

REFERENCES

1. Ed. C.L. Mandahar, Molecular biology of Plant viruses, Kluwer academic publishers, Dordrect, 1999. • Roger Hull (Ed), Mathews Plant Virology, 4th Edition, Academic Press, San Diego, 2002.
2. D.G.A. Walkey (Ed), Applied Plant Virology, 2nd Edition, Chapman & Hall, London, 1991.
3. Text Book of Microbiology :Ananthanarayanan & Jayaram Panikker
4. Medical Virology : Fenner and White • Principles and Practice of Infectious diseases – Madell, Bennett, Dolin Vol- 1 & 2
5. Medical Microbiology : David Greenwood, Slack, Peutherer
6. Essentials of Diagnostic Virology: G. Storch
7. Notes on Medical Virology By Morag.C. Timbury
8. Diagnostic methods in Clinical Virology : N.R. Grist
9. Fundamentals of Molecular Virology By Nicholas H. Acheson

BIO4E1102: OMICS AND MOLECULAR MEDICINE II: GENOMICS AND TRANSCRIPTOMICS (90 hrs)

COURSE OUTCOMES [COs]

CO1 Students will appreciate the knowledge of gene and its cloning
CO2 Students will learn various gene sequencing techniques
CO3 Students will gain knowledge about Comparative Genomics
CO4 Students will appreciate the knowledge of Genomic Changes during evolution
CO5 Students will gain knowledge about Genomics and Human Biology
CO6 Students learn about Transcriptome and Transcriptomic Technology
CO7 Students gain knowledge about Transcriptome Analysis
CO8 Students appreciate their knowledge about the applications of Transcriptomics in Health and Disease.

Unit 1 (8 hrs)

Introduction to genomics : Gene- Eukaryotic and prokaryotic gene structure, cloning from mRNA: Isolation and purification of RNA, synthesis

of cDNA, Isolation of plasmids, cloning cDNA in plasmid vectors, cloning cDNA in bacteriophage vectors

Unit 2 (12 hrs)

Genes and gene cloning techniques. Cloning of genomic DNA: Isolation and purification of DNA, preparation of DNA fragments and cloning. In vitro packaging of λ phage and amplification of libraries. Advanced cloning strategies-synthesis and cloning of cDNA, PCR amplified DNA, use of adaptors and linkers, homopolymer tailing in cDNA cloning, expression of cloned DNA molecules.

Unit 3 (10 hrs)

Selection, screening and analysis of recombinants: Genetic selection, insertional inactivation, chromogenic substrates, complementation of defined mutations, nucleic acid hybridization, screening methods for cloned libraries, PCR screening protocols, immunological screening, restriction mapping of cloned gene, blotting techniques, sequencing methods. Purification strategies of expressed His- tagged proteins.

Unit 4 (10 hrs)

Gene Transformation Techniques: Transformation and transfection techniques, preparation of competent cells of bacteria, chemical methods calcium phosphate precipitation method, liposome mediated method, physical methods Electroporation, gene gun method. Method of DNA transfer to yeast, mammalian and plant cells, transformation and transfection efficiency.

Unit 5 (10 hrs)

Gene Labelling and Genomics: Labeling of DNA by radioactive isotopes, non-radioactive labeling, in vivo labeling, autoradiography and autofluorography. DNA sequencing by enzymatic and chemical methods,

Human Genome sequencing project; DNA microarrays; Copy number variation, sequence repeats, SNV, haplotype, and their relevance in diseases.

Unit 6 (16 hrs)

Transcription and Transcriptome: Characteristics and function of bacterial RNA polymerases, mechanism of transcription and regulation. Eukaryotic RNA polymerases- transcription factors, mechanism of transcription and regulation. Stringent response. Post transcriptional modifications of mRNA (5‟CAP formation, poly adenylation, mechanism of splicing, Group I, II and III, spliceosome assembly, splicing editing, Group IV splicing), stablility. Processing of tRNA and rRNA. Inhibitors of transcription. Ribozyme technology: mechanism of action and applications.

Unit 7 (14 hrs)

Transcriptomic Technology: Transcription: Pre-processing of RNA, mRNA, Transcriptome and Transcriptomics, The Insights of Transcriptomics (mRNA regulation). Types and function of RNA: rRNA, tRNA, mRNA, siRNA, miRNA, RNA interference (RNAi), RNA-induced silencing complex (RISC), Biogenesis of miRNA and siRNA. Computational prediction of- miRNA genes and miRNA targets. Bioinformatics of siRNA designing Transcriptome Project in Human, Mouse

Unit 8 (10 hrs)

Transcriptome Analysis: High-Throughput Sequencing Techniques - Sanger’s Sequencing Technology, Next Generation Sequencing, 454 Sequencing, Illumina Sequencing, Bioinformatics Pipelines, and software for Transcriptome analysis.

REFERENCES

1. Lindon, J.C., (2007). The handbook of metabonomics and metabolomics. Elsevier publications.
2. Proteins and proteomics: A laboratory manual. Cold Spring Harbor. 1. Kulkarni, S., Pfeifer, J., (2014).
3. Clinical genomics, Academic Press.
4. Primrose, S.B., Twyman, R.M., (2006). Principles of gene manipulation and genomics, Blackwell Publishing.
5. Reece, R.J., (2004). Analysis of genes and genomes, John Wiley & Sons Ltd.
6. Barh, D., Azevedo, V., (2018). Omics Technologies and Bio-engineering: Towards Improving Quality of Life, Academic Press
7. Wittmann, C., Lee, S.Y., (2004). Systems metabolic engineering, Springer Science & Business Media
8. Pevsner, J., (2014). Bioinformatics and Functional Genomics, Wiley-Blackwell publications.
9. Kihara, D., (2011). Protein function prediction for omics era, Springer Science & Business Media

BIO4E1201: MOLECULAR MEDICINE AND VIROLOGY III: MOLECULAR DIAGNOSTICS (90 hrs)

COURSE OUTCOMES [COs]

CO1. The student will acquire knowledge regarding the introduction and history of diagnostic techniques, specimen collection and processing
CO2. The student learn to know the traditional disease diagnostic methods for various diseases
CO3. The student will explain the importance of biochemical molecular diagnostic techniques
CO4. The student will explain the different types of nucleic acid detection, amplification and purification techniques

CO5. The student will explain the different types nucleic acid based diagnostic techniques like RFLP, RAPD etc in disease diagnosis

CO6. The student will describe the principles, methods and instruments for Automated DNA sequencing

CO7. The student will explain the importance of clinical proteomics and immuno diagnostic techniques in disease detection and also the need to maintain good lab practices

CO8. The student will describe the genetic diseases and the diagnostic techniques.

Unit 1 (10 hrs)

Introduction and History of diagnostics, Diseases- infectious, physiological and metabolic errors, genetic basis of diseases, inherited diseases. Infection – mode of transmission in infections, factors predisposing to microbial pathogenicity, types of infectious diseases- bacterial, viral, fungal, protozoans and other parasites. · Philosophy and general approach to clinical specimens, Sample collection- method of collection, transport and processing of samples, Interpretation of results, Normal microbial flora of the human body, Host - Parasite relationships.

Unit 2 (10 hrs)

Traditional disease diagnosis methods and tools - diagnosis of infection caused by Streptococcus, Coliforms, Salmonella, Shigella, Vibrio, andMycobacterium., Diagnosis of fungal infections. Major fungal diseases: Dermetophytoses, Candidiosis and Aspergillosis. · Diagnosis of DNA and RNA viruses- Pox viruses, Adenoviruses, Rhabdo Viruses, Hepatitis Viruses and · Retroviruses. · Diagnosis of Protozoan diseases: Amoebiosis, Malaria, Trypnosomiosis, Leishmaniasis. Study of helminthic diseases- Fasciola hepatica and Ascaris lumbricoides. Filariasis and Schistosomiasis.

Unit 3 (10 hrs)

Biochemical tests for detection and quantification of sugar, albumin, urea, protein, globulin, vitamin · Biochemistry and diagnostic tests of following diseases - Duchenne Muscular Dystrophy (DMD) (Creatine phosphokinase-CPK) , Phenylketonuria-PKU (phenylketone),

G6PD deficiency syndrome (G6PD) , Mucopolysaccharidosis, Endocrine disorders related to thyroid and reproduction (TSH, T3, T4, Estradiol, Testosterone, LH, FSH) · Isolation and Purification of Nucleic acids- Principles and Methods. Molecular cloning, labeling of nucleic acids, hybridization.

Unit 4 (12 hrs)

Nucleic acid amplification methods and types of PCR: Reverse Transcriptase-PCR, Real-Time PCR, Inverse PCR, Multiplex PCR, Nested PCR, Alu-PCR, Hot-start, In situ PCR, Long-PCR, PCR-ELISA, Arbitrarily primed PCR, Ligase Chain Reaction. · Proteins and Amino acids, Qualitative and quantitative techniques: Protein stability, denaturation; amino acid sequence analysis, · Hybridization techniques – Southern, Northern, in-situ (including FISH), microarrays – types and applications; Protein extraction and analysis (including PAGE and its variations); Western Blot

Unit 5 (12 hrs)

Applications of PCR- PCR based microbial typing: Eubacterial identification based on 16S rRNA sequences- Amplified Ribosomal DNA Restriction analysis (ARDRA)-Culture independent analysis of bacteria- DGGE and TRFLP. Molecular diagnosis of fungal pathogens based on 18S rRNA sequences- Detection of viral pathogens through PCR. RAPD for animal and plants. PCR in forensic science- AmpFLP, STR, Multiplex PCR- Determination of Paternity- Human identification and sex determination.

Unit 6 (12 hrs)

Automated DNA sequencing- Principles, Methods and Instrumentation- Advances in DNA sequencing- New Generation sequencing Methods, Pyrosequencing · Microarrays- Personalised Medicine- Pharmacogenomics. · SSCP, CSGE, DGGE, DHPLC , MALDI-TOF , DNA Sequencing. Levels for rDNA experiments. Biosafety aspects of transgenic plants and germplasm.

Unit 7 (12 hrs)

Proteomics- Clinical Proteomics diagnosis. Immunodiagnostics - Introduction, antigen-antibody binding interactions and assays; polyclonal and monoclonal antibodies, · HLA typing. Immunoassays – types [RIA, ELISA, ChemiluminescentIA, FIA] and specific applications; Immunohistochemistry – principle and techniques. Good Laboratory Practices. · Different Levels of Biosafety, Containment.

Unit 8 (12 hrs)

Disease identification and Genetic tests for following disorders- Thalassemia, Fanconi anemia, Sickle Cell anemia, Fragile-X syndrome, Alzheimer's disease, Duchenne Muscular Dystrophy/ Becker's Muscular Dystrophy, Huntington's disease · Allelic susceptibility test for multifactorial disorders (Neural Tube Defect, Cleft Lip and Palate, Cardio Vascular Disorder, Male infertility) · Risk evaluation (Mendelian risk, empirical risk), Prenatal and pre-implantation diagnosis. Noninvasive: Triple test, Ultrsonography (USG), Invasive: Amniocentesis (AC), chorionic villi sampling (CVS), Fetal blood sampling (FBS), Population screening for genetic disorders.

REFERENCES

1. Fundamentals of Molecular Diagnostics (2007). David E. Bruns, Edward R. Ashwood, Carl A. Burtis. Saunders Group.
2. Henry's Clinical Diagnosis And Management By Laboratory Methods (2007) Mcpherson
3. Molecular Diagnostics: Fundamentals, Methods & Clinical applications (2007). Lele Buckingham and Maribeth L. Flaws
4. Molecular Diagnostics for the Clinical Laboratorian 2Ed. 2006, W.B. Coleman. Humana Press.
5. Molecular Pathology in Clinical Practice (2007). D. G. B. Leonard. 10. Microbial Functional Genomics (2004) by J.Zhou, D.K. Thomson. Y.Xu. J.M. Tiedje. J.Wiley & Sons Publishers.
6. Expert Review of Molecular Diagnostics

BIO4E1202: OMICS AND MOLECULAR MEDICINE III: MOLECULAR MEDICINE AND DRUG DISCOVERY (90 hrs)

COURSE OUTCOMES [COs]

CO1. The student will acquire basic knowledge on stem cells, its various types and their application in the field of molecular medicine.
CO2. The student will describe regenerative medicines and the underlying cellular and molecular mechanism behind tissue regeneration.
CO3. The student will learn importance of vaccination and vaccines.
CO4. The student will understand about biomaterials and the immense possibility they offer in the field of molecular medicine.
CO5. The student will explain the application of nanomaterials for bio-imaging, bio-sensing and bio-detection of pathogens.
CO6. The student will explain the historical evolution of drugs.
CO7. The student will describe the methods involved in drug discovery and clinical trials.
CO8. The student will describe their route of entry into the system and mode of action.
CO9. The student will get a clear picture on the pharmacodynamics and pharmacokinetics of drug action within the system.
CO10. The student will explain the significance of computer aided drug discovery.

Unit 1 (6 hours)

Stem cells: Introduction - basic concepts and definitions, self-renewal, clonality, potency, types of stem cells - Embryonic stem cells, Hematopoietic stem cells, Mesenchymal stem cells, Adult stem cells. Pluripotency and Induced pluripotency. Applications of stem cells.

Unit 2 (7 hours)

Vaccines & Vaccination – adjuvants, DNA vaccines, recombinant vaccines, bacterial vaccines, viral vaccines, principles of vaccination, passive & active immunization, immunization programs & role of WHO in immunization programs.

Unit 3 (6 hours)

Biomaterials: Natural biomaterials and Synthetic biomaterials, Design principles in biomaterials and scaffolds. Biomaterials for drug delivery and 3D cell culturing.

Unit 4 (12 hours)

Nanotechnology: Nanoparticles for drug/gene delivery, Active and passive delivery of nanoparticles to cells, Bio detection of pathogens, Nanobiotechnological applications in health and disease - infectious and chronic, Nanoparticles for therapy of diseases – cancer, diabetes. Nanoparticles as Biosensors. Nanoparticles for Bioimaging.

Unit 5 (5 hours)

Drugs - Definition, historical evolution, classification of drugs, nomenclature of drugs. General idea regarding the milestones in drug research. Sources of Drugs. Routes of drug administration.

Unit 6 (10 hours)

Drug discovery process–traditional approach and rational approach. Drug discovery phase–preclinical evaluation phase, clinical trial phase, phases of clinical trials and pharmacovigilance. Patent Protection and regulation.

Unit 7 (10 hours)

drug action - Concept of Agonists, antagonists (Competitive and non-competitive), Partial agonist, Inverse agonist, Functional antagonist, tachyphylaxis, idiosyncrasy. Illustration of drug action through examples - mechanism of action & uses Taxol, streptomycin, Diasulin, Mevastatin etc.

Unit 8 (15 hours)

Pharmacodynamics: Principles, site and mechanism of drug action (Nervous system, Histamines and Antihistamines, Cardiovascular Drugs), Drug Receptor, Classification of receptors, Drug-Receptor interactions. Dose response relationship, Therapeutic index, LD_{50}, ED_{50}, LC_{50}, EC_{50}, MIC and MEC. Adverse Drug Reactions. Pharmacovigilance, ADR monitoring.

Unit 9 (7 hours)

Pharmacokinetics: Pharmacokinetic properties: Membrane transport, absorption, distribution metabolism and excretion of drugs (ADME parameters), Factors affecting ADME, Lipinski's rule of five.

Unit 10 (12 hours)

Computer Aided Drug Discovery: – Introduction to Open Source and Commercial in silico tools and softwares Datases- Drug Bank, Dr. Duke's Phytochemicals, Kegg, Pub-Chem, ChEMBL. Structure drawing softwares–ChemDraw, ACD/Chemsketch, SWISS Model. Molecular docking and drug receptor interactions: An overview.

REFERENCES

1. Advances in Nanotechnology and the Environment, Juyoung Kim, CRC Press, Taylor and Francis Group.
2. Biosensors: A Practical Approach, J. Cooper & C. Tass, Oxford University Press, 2004.
3. Nanomaterials for Biosensors, Cs. Kumar, Wiley – VCH, 2007.
4. G. Cao, Naostructures and Nanomaterials: Synthesis, properties and applications, Imperical College Press, 2004.
5. Computational and structural approaches to drug discovery, Robert M Stroud and Janet. F Moore, RCS Publishers.
6. Introduction to Quantitative Drug Design by Y.C. Martin, CRC Press, Taylor & Francis group.
7. Drug Design by Ariens Volume 1 to 10, Academic Press, 1975, Elsevier Publishers.
8. Principles of Drug Design by Smith andWilliams, CRC Press, Taylor & Francis.

FOURTH SEMESTER PRACTICALS

As Core curriculum courses, students completing these courses along with the practical sessions will demonstrate competence in gathering, analyzing, synthesizing, evaluating and applying information.

BIO4L04- PHYSIOLOGY & DEVELOPMENTAL BIOLOGY PRACTICALS

COURSE OUTCOMES [COs]

CO1	Students learn various techniques in development biology
CO2	Students appreciate the knowledge of Stress response
CO3	Students will gain knowledge about understanding physiological techniques
CO4	Students will learn the analysis of Megasporogenesis

1. Determination of primary production of a leaf area by chlorophyll method.
2. Effect of water and salinity stress on chlorophyll content of leaves.
3. Urine Analysis - Glucose, albumin and ketone bodies in urine
4. Blood - Total count, DC, ESR
5. Liver function test.
6. Observation of slides of the early development of fish, frogs, chick
7. Preparation of whole-mount of chick blastoderm.
8. Determine the age of the chick embryo by staining techniques.
9. Types of ovules and ovular parts.
10. Megasporogenesis and female gametophyte (Polygonum type).
11. Preparation of whole mount
12. Serial section and histochemical staining techniques

REFERENCES

1. Darwin Fand Hamilton Acton E. 2011. Practical Physiology of Plants (Reissue edition), Cambridge University Press, Cambridge, UK
2. MacDougal DT. 2009. Practical Text-Book of Plant Physiology, University of Michigan Library, Michigan, USA
3. Text book of Animal Physiology -Nagbhushenen
4. Text book of Animal Physiology - Guize
5. Text book of Animal Physiology - A.K. Berry

BIO4L05- MOLECULAR MEDICINE AND VIROLOGY II: VIROLOGY PRACTICALS

Course Outcomes

CO: Students will gain skill in the methods and experiments in virology

Perform any 9 experiments out of 11 experiments given

1. Preparation of glassware for tissue cultures (washing, sterilization)
2. Preparation of buffers like PBS, Hank's
3. Preparation of clinical specimens for isolation of viruses (video demonstration)
4. Collection & transport of specimens (video demonstration)
5. Serological test -ELISA for HIV
6. Serological test- ELISA for HBs Ag
7. Chick Embryo techniques-inoculation and harvesting
8. Handling of mice, rats and guinea pigs for collection of blood (video demonstration)
9. Molecular techniques in virology-PCR-HPV infection
10. Bacteriophage isolation technique
11. Staining and microscopy for viral inclusion bodies
12. Hemagglutination and Haemadsorption
13. Visit to diagnostic laboratory/research institute

REFERENCES

1. **A Practical Guide to Clinical Virology by L. R. Haaheim, John R. Pattison, Richard J. Whitley.**
2. Virology: A Laboratory Manual: **Florence G. Burleson**, **Thomas M. Chambers**, **Danny L. Wiedbrauk** · 2014

BIO4L05- OMICS AND MOLECULAR MEDICINE II: GENOMICS AND TRANSCRIPTOMICS PRACTICALS

COURSE OUTCOMES [COs]

CO1 Students learn various techniques in gene cloning
CO2 Students appreciate the knowledge of gene amplification methods
CO3 Students will gain knowledge about blotting techniques**.**
CO4 Students will learn the analysis of transcriptomic data

Perform any 8 experiments

1. Restriction digestion analysis.
2. Ligation of restricted fragments.
3. Selection of cloned microorganisms by blue /while colony, X-Gal method
4. Design a primer
5. Isolation of RNA from bacteria
6. Reverse transcription PCR for cDNA Synthesis -PCR (Demonstration)
7. Real-time PCR (Demonstration)
8. Southern Blotting (Demonstration)
9. Analysing the given transcriptomic data
10. Retrieval and analyse of metagenomic data.

REFERENCES

1. Barh, D., Azevedo, V., (2018). Omics Technologies and Bio-engineering: Towards Improving Quality of Life, Academic Press
2. Wittmann, C., Lee, S.Y., (2004). Systems metabolic engineering, Springer Science &Business Media
3. Pevsner, J., (2014). Bioinformatics and Functional Genomics, Wiley-Blackwell publications.
4. Kihara, D., (2011). Protein function prediction for omics era, Springer Science & Business Media.

BIO4L06- MOLECULAR MEDICINE AND VIROLOGY III: MOLECULAR DIAGNOSTICS PRACTICALS

Course Outcomes:

CO: students will gain skills in methods and techniques related to molecular diagnosis

Perform any 8 experiments out of 10 experiments given

1. Isolation of Genomic DNA from Human (Peripheral Blood Sample)
2. Serological tests-ELISA-Toxoplasma infection

3. PCR based diagnosis- Tuberculosis
4. Karyotype using human lymphocyte culture
5. Western Blotting
6. RNA isolation from mammalian tissue
7. HLA typing and tissue transplantation matching (Video Demo)
8. Microarrays for pathogen detection and SNP studies (Video Demo)
9. Real Time PCR observation of working under a laboratory setting
10. Visit to Diagnostic Laboratory/Research institute

REFERENCES

1. Molecular Diagnostics: George P. Patrinos, Wilhelm Ansorge, Phillip B. Danielson · 2016
2. Molecular Diagnostic PCR Handbook: Gerrit J. Viljoen, Louis H. Nel, John R. Crowther · 2005
3. Diagnostic Molecular Pathology: A Guide to Applied Molecular : William B. Coleman, Gregory J. Tsongalis · 2016

BIO4L06- OMICS AND MOLECULAR MEDICINE III: MOLECULAR MEDICINE AND DRUG DISCOVERY PRACTICALS

Course Outcomes:

CO1: Students will get familiarized with the different stages of the bioactive molecule developments in the drug discovery process
CO2: They will get hands on training in different traditional pre analysis methods of candidate drug molecules

Perform any 8 experiments out of 10 experiments given

1. Prediction of drug ability of bioactive molecules by Lipinski rule of five
2. Evaluation of invitro antioxidant potential
    a. Nitric oxide scavenging assay
    b. DPPH
3. Basic extraction methods in traditional drug development process

a. Decoction
b. Soxhlet extraction
c. Separating funnel

4. Extraction of essential oils by Clevenger apparatus
5. Silica gel column chromatography
6. Kirby Baur Antibiotic sensitivity test
7. Liebermann Burchard test for terpenoids
8. Qualitative analysis of Phytochemicals
    a. Test for flavonoids
    b. Test for terpenoids
    c. Test for saponins
9. Drug delivery via Hydrogel beads (Picture/Video demonstration)
10. Visualization of molecular interaction between drug and receptor (Picture/Video demonstration)

REFERENCES

1. Screening methods in pharmacology – Robert A. Turner.
2. Drug Evaluation – Vogel.
3. Evaluation of Drug Activities – Lawrence and Bachrach.
4. Methods in Pharmacology – Swarbrick.
5. Pharmacopoeias.