Detail Syllabus

Semester I

DSC-1

MBIN 101: Biology I **L3-T0-P1-CR4**

Course outcome

CO 1: Ability to understand different life forms.
CO2: Ability to understand the characteristics of bacteria, viruses, algae, fungi, bryophytes, pteridophytes, Gymnosperms.
CO3: Ability to identify bacteria, viruses, algae, fungi, bryophytes, pteridophytes, Gymnosperms.

Course content

Unit I: Introduction to living organisms: [6 Hrs]
Unicellular and multicellular living organisms; microbial world; plant, animal

Unit II: Viruses and bacteria: [6 Hrs]
DNA viruses, RNA viruses, lytic and lysogenic cycle, retroviruses, viral diseases. Bacteria: General characteristics and cell structure; Gram-positive and Gram-negative bacteria, Archaea: General characteristics and cell structure, extremophiles.

Unit III: Algae: [4 Hrs]
General characteristics; Ecology and distribution; Range of thallus organization and reproduction; Classification of algae; Morphology and life-cycles, Economic importance of algae.

Unit IV: Fungi: [4 Hrs]
General characteristics, ecology and significance, range of thallus organization, cell wall composition, nutrition, reproduction and classification; True Fungi- General characteristics, ecology and significance, life cycle; Symbiotic Associations-Lichens: General account, reproduction and significance; Mycorrhiza: ectomycorrhiza and endomycorrhiza and their significance

Unit V: Archegoniate: [2 Hrs]
Unifying features of archegoniates, Transition to land habit, Alternation of generations.

Unit VI: **Bryophytes**: **[5 Hrs]**
General characteristics, adaptations to land habit, Classification, Range of thallus organization. Classification (up to family), morphology, anatomy and reproduction, Ecology and economic importance of bryophytes

Unit VII: Pteridophytes: **[5 Hrs]**
General characteristics, classification, Early land plants, Classification (up to family), morphology, anatomy and reproduction, Heterospory and seed habit, stelar evolution. ecological and economical importance of Pteridophytes.

Unit VIII: Gymnosperms: **[4 Hrs]**
General characteristics, classification. Classification (up to family), morphology, anatomy and Reproduction, Ecological and economical importance.

Practical (CR 1) [2 Hrs per week]

1. Specimen study of blue green algae/cyanobacteria

2. Study of fungi: colony and hyphae under microscope
3. Specimen study of Bryophytes
4. Specimen study of Pteridophytes
5. Specimen study of Gymnosperms

Text Books

1. Campbell, N.A. and Reece, J. B. (2008) Biology 8th edition, Pearson Benjamin Cummings, San Francisco.
2. Raven, P.H et al (2006) Biology 7th edition Tata McGrawHill Publications, New Delhi
3. Griffiths, A.J.F et al (2008) Introduction to Genetic Analysis, 9th edition, W.H. Freeman & Co. NY

Practical Book

Practical Botany for B.Sc-I Edition: 2022, by Dr. Ashok Kumar. Publisher: Anvi Books & Publishers, ISBN: 9789390856039, 9390856039.

Reference book

1. Tortora, G.J., Funke, B.R., Case, C.L. (2010). Microbiology: An Introduction, Pearson Benjamin Cummings, U.S.A. 10th edition.
2. Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West. Press Pvt. Ltd. Delhi. 12. 2nd edition.
3. Vashishta, P.C., Sinha, A.K., Kumar, A., (2010). Pteridophyta, S. Chand. Delhi, India. Bhatnagar, S.P. and Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, New Delhi, India.
4. Parihar, N.S. (1991). An introduction to Embryophyta. Vol. I. Bryophyta. Central Book Depot, Allahabad.

SEC-1

MBSE 107: Bioinstrumentation-I **L1-T1-P1-CR3**

Course outcome

CO1: Acclimatization and handling of basic instruments of biological laboratories.
CO2: Understanding the principles of critical methodologies in biological laboratories.
CO3: Understanding the principles and application of microbial containment processes.
CO4: Ability to perform basic experiments required in biological laboratories.

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Course Content

Theory component:

Unit I: Qualities of measurements (7 Hrs)

The meaning of measurement, elements of measurement, static and dynamic characteristics of measurements, Dynamic response of first order and second order type instruments.

Unit II: Introduction to basic instruments in biological laboratories: (8 Hrs)

Principles and functioning of weighing balance, micro-pipettes, refrigeration units, Water purification units, pH meters.

Unit III: Principle of sterilization: (7 Hrs)

Sterilization methods: surface, dry, wet, and UV. Principle and use of autoclave.

Unit IV: Principle of electrophoresis: (7 Hrs)

Principle of common electrophoresis methods and their applications: horizontal, vertical and capillary.

Unit V: Basics of microscopy: **(6 Hrs)**
Principle of simple and compound microscopy and their applications.

Practical component: (20 Hrs)
1. Preparation of common biological buffers and adjustment of pH.
2. Autoclave of glassware and biological buffer
3. Effect of UV sterilization on microbial growth
4. Preparation of agarose gel electrophoresis
5. Observation of slides with sections of animal/plant parts using microscope

Practical book:

1. Abhishek Tiwari Practical book of instrumental methods of analysis-, Nirali Prakashan, 1st Edn., 2020, ISBN: 9789390437252
2. Practical Microbiology- D.K.Maheshwari, S. Chand Publishing, 2022 ISBN 8121921538, 9788121921534

Text books:

1. Industrial Instrumentation-Donald P. Eckman (Author), Publisher: CBS Publishers & Distributors Pvt. Ltd; Reprint 2004. ISBN: 9788123908106
2. An Introduction to Practical Biochemistry (Paperback)-David Plummer (Author). Publisher: McGraw Hill Education; 3rd edition) ISBN-10:9780070994874
3. Principle and Techniques of Biochemistry and Molecular Biology- (Paperback)- Wilson and Walker (Authors); Publisher: Cambridge University Press; 8th edition. ISBN-13:978131661476.

Semester II

DSC-2

MBIN 102: Biology II **L3-T0-P1-CR4**

CO1: Ability to identify and characterize different phyla in animal kingdom.
CO2: Ability to develop skills in describing the animal biodiversity.
CO3: Ability to identify and characteristics of an organism and classify them under different phylum/class/order.

Course content

Unit I: Animal Kingdom [2 Hrs]
General characteristics; basis of classification; classification of animals; Principles of Taxonomy: Nomenclature: Binomal, Trinomial nomenclature; New trends in taxonomy: Ecological approach, Ethological approach, Cytological approach, Biochemical approach, Numerical Taxonomy and Phylocode.

Unit II: Phylum Protista, Porifera and Cnidaria: [4 Hrs]
General characters and classification up to classes. Locomotory Organelles and locomotion in Protozoa; Canal System in Sycon**.** Life cycle leishmania donavani. Polymorphism in Hydrozoa.

Unit III: Phylum Platyhelminthes and Nemathelminthes: **[6 Hrs]**
General characters and classification up to classes. Life history of Taenia solium; Parasitic adaptations. Life history of Ascaris lumbricoides and its parasitic adaptations

Unit III: Phylum Annelida and Arthropoda: [6 Hrs]
General characters and classification up to classes; Metamerism in Annelida; Vision in Arthropoda; Metamorphosis in arthropoda.

Unit IV: Phylum Mollusca and Echinodermata: **[4 Hrs]**
General characters and classification up to classes; Torsion in gastropods. Water-vascular system in Asteroidea

Unit V: Phylum Chordata: **[6 Hrs]**
General characters and classification of chordata; General characters of acrania: Hemichordata, Urochordate and cephalochordate. General characters of craniata: vertebrata; Agnatha and gnasthostomata

Unit VI: Super class Pisces, Amphibians and Reptiles: **[4 Hrs]**
General features and Classification up to orders. Migration in fishes and parental care. Neotency and paedogenesis in Amphibia; Parental care in amphibia. Poisonous and non-poisonous snakes, Biting mechanism in snakes.

Unit VII: Superclass Aves and Mammals: **[4 Hrs]**
General features and Classification up to order. Birds are glorified reptiles; Flight or aerial adaptations in birds. Adaptive convergence in mammals; Origin and ancestry of mammals.

Practical (CR 1) [2 Hrs per week]

1. **Study of the following specimens**:
   Amoeba, Euglena, Plasmodium, Paramecium, Sycon, Hyalonema, and Euplectella, Obelia, Physalia, Aurelia, Tubipora, Metridium, Taenia solium, Male and female Ascaris lumbricoides, Aphrodite, Nereis, Pheretima, Hirudinaria, Palaemon, Cancer, Limulus, Palamnaeus, Scolopendra,

Julus, Periplaneta, Apis, Chiton, Dentalium, Pila, Unio, Loligo, Sepia, Octopus, Pentaceros, Ophiura, Echinus, Cucumaria and Antedon, Balanoglossus, Herdmania, Branchiostoma, Petromyzon, Sphyrna, Pristis, Torpedo, Labeo, Exocoetus, Anguilla, Ichthyophis/Ureotyphlus, Salamandra, Bufo, Hyla, Chelone, Hemidactylus, Chamaeleon, Draco, Vipera, Naja, Crocodylus, Gavialis, Any six common birds from different orders, Sorex, Bat, Funambulus, Loris

2. **Study of the following permanent slides:**
   T.S. and L.S. of Sycon, Study of life history stages of Taenia, T.S. of Male and female Ascaris

3. **Field survey:** Collection and study of zooplankton and phytoplankton from pond ecosystem; Survey of invertebrates and vertebrates from a selected site.

Text Book

1. Ruppert and Barnes, R.D. (2006). Invertebrate Zoology, VIII Edition. Holt Saunders International Edition.
2. Kingsley J. Text Book of Vertebrate Zoology Publisher: Nabu Press ISBN: 9781171586524, 1171586523

Practical Book

1. Dr. P S Verma A Manual of Practical Zoology: Invertebrates, ISBN: 9788121908290
2. Dr. P.S. Verma A Manual of Practical Zoology : Chordates. ISBN:9788121908306

Reference Books

1. Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2002). The Invertebrates: A New Synthesis, III Edition, Blackwell Science • Young, J. Z. (2004).
2. The Life of Vertebrates. III Edition. Oxford university press. • Pough H. Vertebrate life, VIII Edition, Pearson International.
3. Hall B.K. and Hallgrimsson B. (2008). Strickberger's Evolution. IV Edition. Jones and Bartlett Publishers Inc.

SEC-2

MBSE 108: Bioinstrumentation-II **L1-T1-P1-CR3**

Course outcome

CO1: Ability to understand the *basic principles of the Instruments used in biological laboratory.*
CO2: Ability to operate and use these instruments.
CO3: Application of these instruments in biological research.

Course content:

Theory:

Unit I. Centrifugation: **(6 Hrs)**

Basic principle & theory of centrifugation (RCF, Sedimentation coefficient etc); Types of centrifuges - microcentrifuge, High speed & Ultracentrifuges; Rotor-types; Applications.

Unit II. Spectroscopy: (6 Hrs)

Principle (Beer-Lamberts law), components, Instrumentation. Photometry, single and double beam spectroscopy, UV spectroscopy; Applications.

Unit III. Chromatography: **(7 Hrs)**

Principle, Rf value; Types of Chromatography- TLC and Paper chromatography; Applications.

Unit IV. Laminar air flow and Biosafety cabinets: (6 Hrs)
Working principle; Differences between laminar air flow and Biosafety cabinets; BSL/ABSL – Types.

Practical: (20 Hrs)

1. Operation of different types of centrifuges, understanding different types of rotors. Separation of biomolecules using centrifugation techniques.
2. Determination of λ_{max} (absorption spectra) of Biomolecules (protein, nucleic acid etc.), organic chemicals and quantification of DNA, RNA, protein and bacteria.
3. Separation of amino acids and biomolecules by TLC or paper chromatography.
4. Working in a Good laboratory practice (GLP) facility.

Practical book:

1. Practical book of instrumental methods of analysis-Abhishek Tiwari, Nirali Prakashan, 1st Edn., 2020, ISBN: 9789390437252
2. Practical Microbiology- D.K. Maheshwari, S. Chand Publishing, 2022 ISBN 8121921538, 9788121921534

Text Book

1. An Introduction to Practical Biochemistry (Paperback) –David Plummer (Author). Publisher: McGraw Hill Education; 3 edition) ISBN-10: 9780070994874.
2. Biochemical Method- (Paperback)-S. Sadasivam (Author) Publisher: New Age International Pvt Ltd ; 3 edition. ISBN-10: 8122421407.
3. Principles And Techniques Of Biochemistry And Molecular Biology-) (Paperback)-Wilson And Walker(Authors); Publisher: Cambridge University Press; 8 edition. ISBN-13: 978-1316614761

Semester III

DSC-3

MBIN 201: Genetics **L2-T1-P0-CR3**

Course outcome

CO1: *Ability to understand and appreciate the concepts of classical genetics and fundamentals of evolution.*
CO2: *Ability to know and understand the concepts of Mendelian genetics as well as population genetics.*
CO3: *Ability to know and understand the concepts of genetics encompassing complex traits and genetics of evolution.*

Course content

Unit I: Introduction to Genetics & Evolution: [6 Hrs]
Definition, History, Terminology, Scope of the course.

Unit II: Mendelian Genetics: [7 Hrs]
Fundamental concepts in genetics, Mendel's Laws, Monohybrid and Dihybrid cross, Test Cross, Back Cross, (Phenotype: Penetrance & Expressivity, Genotype, etc), Application of probability in genetics, Binomial expansion, Chi-square test.

Unit III: Deviations from Mendel's Law-I: **[7 Hrs]**
Linkage, Genetic mapping, Epistasis (Gene interactions), Co-dominance, Sex linked, Sex influenced, Sex limited inheritances, quantitative traits/loci.

Unit IV: Deviations from Mendel's Law-II: **[6 Hrs]**
Epigenetics, Imprinting, Extra nuclear inheritance (Mitochondrial and Chloroplast).

Unit V: Theories of Evolution: [7 Hrs]
Lamarck's theory, Darwin's theory, Weismann's germplasm theory; Evolution in bacteria, experimental evolution.

Unit VI: Molecular evolution: [6 Hrs]
Mutation in organisms, mechanisms, mutation rate, theories of molecular evolution (selection, neutral, nearly neutral).

Unit VII: Population genetics: [6 Hrs]
Hardy Weinberg equilibrium, factors influencing the Hardy Weinberg's equilibrium.

Textbook

1. Genetics. Author: PK Gupta, 5th Edition, Rastogi Publications (2018), ISBN-13: 978-8193775707.
2. Genetics: Analysis of Genes and Genomes. Authors: Daniel L. Hartl and Bruce Cochrane Jones, 9th Revised edition, Bartlett Publishers (2017), ISBN-13: 978-1284122930.

Suggested readings

1. Concepts of Genetics. Authors: William S. Klug, Michael R. Cummings, Charlotte A. Spencer, Michael A. Palladino, 12th Edition Darrell Killiann Publisher (2019), ISBN-13: 978-0134604718.
2. Evolution. Authors: Monroe W. Strickberger, Brian K. Hall, Benedikt Hallgrimsson, Jones & Bartlett (2007), ISBN-13: 978-0763700669.

DSC-4

MBIN 203: Cell Biology I **L2-T1-P0-CR3**

Course outcome

CO1*: Ability to understand basics of cell structure and function.*
CO2*: Ability to understand cell signalling and cellular transport of macromolecules.*
CO3: *Ability to understand the principle behind microscopy for cell imaging.*

Course content

Unit I: Introduction to Cell Biology: [6 Hrs]
The introduction of Prokaryotes and Eukaryotes cells; Evolutionary link between Prokaryotes and Eukaryotes (recent molecular evidences).

Unit II: Cell imaging: [4 Hrs]
Light microscopy (Bright-Field, Phase-Contrast and DIC); Electron microscopy.

Unit III: Cell division: [6 Hrs]
Cell division in Microbes; Plant and Animal (both mitotic and meiotic); Cell cycle and its molecular events; Cell cycle checkpoint controls; Stem cells.

Unit IV: Cell membrane and extracellular components: [7 Hrs]
Plasma membrane - Membrane lipids, Membrane proteins, Membrane fluidity; Lipids Rafts - Organization and Functions; Components of extracellular space and their functions.

Unit V: Membrane transport: [5 Hrs]
Principle of membrane transport - active and passive transport, transporters; ion channels.

Unit VI: Endomembrane systems: [7 Hrs]
Endoplasmic reticulum; Golgi body; Lysosomes; Cell nucleus - nuclear membrane, structure and organization; Sorting and trafficking of proteins in the endomembrane system; Cytoskeleton - microfilaments and intermediate filaments; cell motility.

Unit VII: Fundamentals of cell signaling: [6 Hrs]
GPCR, RTK, Insulin, Ca++, Ras-MAPK, Wnt, Hedgehog and Toll-like receptors.

Textbooks

1. Karp, G. et al, Karp's Cell Biology, 8th Edition (Wiley, 2018); ISBN: 978-1119454175
2. Alberts, B. et al., Molecular Biology of the Cell, 7th Edition (WW Norton & Co, 2022); ISBN: 978-0393884821

Reference books

1. Cooper, G. and Adams, K., The Cell: A Molecular Approach, 9th Edition (Sinauer Associates, Inc., 2022); ISBN: 978-0197583722
2. Hardin, J., and Bertoni, G., Becker's World of the Cell, 10th Edition (Pearson, 2021); ISBN: 978-0135259498
3. Lodish, H. et al, Molecular Cell Biology, 9th Edition (W. H. Freeman, 2021); ISBN: 978-1319365493

DSC5

MBIN 205: Biochemistry I **L2-T1-P0-CR3**

Course outcome

CO1: Ability to understand basic biochemical processes related to life..
CO2: Ability to understand structures of monomers and polymers of biological macromolecules.
CO3. Ability to understand principle of bioenergetics.

Course content

Unit I: Introduction to Biochemistry: [6 Hrs]

Chemical basis of life; Composition of living matter; Water –role of water in life, properties, pH, ionization and Hydrophobicity, Four families of biological macromolecules, importance of studying biochemistry

Unit II: Proteins: **[6 Hrs]**

Amino acids structure and functional group properties; Peptides and covalent structure of proteins; Classification of proteins; Protein configuration-primary, secondary, tertiary and quaternary structures.

Unit III: Protein structure: **[6 Hrs]**

Evolution of protein structure; Structure-function relationships in model proteins like ribonuclease A, myoglobin, hemoglobin, chymotrypsin etc; biological functions of proteins; protein and unfolding.

Unit IV: Carbohydrates: **[7 Hrs]**

Source and biological functions of carbohydrates; Sugars - mono, di, and polysaccharides; Mutarotation, anomers, epimers etc; classification of carbohydrates with examples of each class, glycoproteins and glycolipids.

Unit V: Lipids: **[7 Hrs]**

Lipids structure, biological functions and properties of lipids, classification of lipids; important members of storage and membrane lipids; lipoproteins. Biological membrane transport and membrane dynamics.

Unit VI: Nucleic acids: **[6 Hrs]**

Nucleosides: DNA, RNA; nucleotides, nucleic acids - structure, sugar puckering; diversity and function; sequencing; Brief overview of central dogma.

Unit VII: Bioenergetics: **[7 Hrs]**

Bioenergetics-basic principles; Equilibria and concept of free energy; Enzyme catalysis Coupled processes; Thermodynamic principles-first and second laws of thermodynamics; ATP as universal currency of energy in biological system. Biological oxidation reduction reaction and free energy.

Textbooks

1. Voet D, Pratt CW,Voet JG. Principles of Biochemistry, 4th edition, Wiley, John & Sons.2012.
2. Nelson DL, Cox MM. Lehninger Principles of Biochemistry, 6th edition, Macmilan. 2013.

Suggested Reading

1. Molecular and Cell Biology (Schaum's Outlines series special Indian edition) by W. D. Stansfield, J. S.C. Colome, R. J. Cano and R. N. Sharan (2010), McGraw Hill Education.
2. Berg JM, Tymoczko JL, StryerL.Biochemistry: International Edition, 7th edition, W.H. Freeman and Macmilan. 2011.

DSC-6

MBIN 207: Biology Lab. II (Biochemistry & Cell Biology.) L0-T0-P3-CR3

Course outcome:
CO1: Ability to identify laboratory instruments and understand the principle of measurements using those instruments with experiments in cell biology and biochemistry.
CO2: Ability to perform experimental methods in cell biology in a problem oriented manner.
CO 3: *Ability to perform biochemistry experiments in a problem oriented manner.*

Course content: [6 Hrs per week]

1. Quantification of carbohydrates in a given solutions (Starch, Sucrose, Lactose, Galactose, Glucose, Fructose)
2. Quantification of protein, DNA and RNA.
3. Quantitative analysis of reducing sugar (DNSA method) and proteins (Biuret method).
4. Separation of amino acids by TLC and determination of Rf values
5. Study of different stages of Mitosis and Meiosis by permanent slides.
6. Prepare culture media for animal tissue culture and handling of cell lines.
7. Isolation of lymphocytes from blood and check their cell viability using trypan blue exclusion method.
8. Membrane fragility/stability test using red blood cells.
9. Isolation of sub-cellular fractions
10. Staining methods to differentiate between live, apoptotic and necrotic cells and autophagy.

Practical book
1. An introduction to practical biochemistry, 3rd edition by David T Plummer
2. Culture of Animal Cells. A Manual of Basic Technique:. Third Edition. 486 R. I. Freshney. John Wiley and Sons, Inc., Publication. New York,
3. Molecular Cloning A Laboratory Manual 1 2nd Edition, J. Sambrook, E.F Fristsch and T. Maniatis
4. Molecular Cloning A Laboratory Manual 2 2nd Edition, J. Sambrook, E.F Fristsch and T. Maniatis

GE-5/ DSE-1

MBIN 209 Introduction to computing L2-T1-P0-CR3

Course outcome
CO1: Ability to operate computers and write programs.
CO2: Ability to use computers for operations on data.
CO3: Ability to use computer without compromising ethics and society.

Course content
Unit I: Introduction: **[6 Hrs]**
The von Neumann architecture, machine language, assembly language, high level programming languages, compiler, interpreter, loader, linker, text editors, operating systems, flowcharts.

Unit II: **Internet and WWW**: **[4 Hrs]**
Data communications and Networking, E-commerce.

Unit III: **Basic features of programming (Using C): [6 Hrs]**
Data types, variables, operators, expressions, statements, control structures, functions.

Unit IV: **Advanced programming features**: **[6 Hrs]**
Arrays and pointers, recursion, records (structures), memory management, files, input/output, standard library functions, programming tools, testing and debugging.

Unit V: **Fundamental operations on data**: **[5 Hrs]**
Insert, delete, search, traverse and modify.

Unit VI: **Fundamental data structures**: **[6 Hrs]**
Arrays, stacks, queues, linked lists; Searching and sorting: linear search, binary search, insertion-sort, bubble-sort, selection-sort, radix-sort, counting-sort;

Unit VII: **Object oriented Programming**: **[4 Hrs]**
Introduction to object-oriented programming and basics.

Unit VIII: **Computing ethics and Society: [6 Hrs]**
Security, ethics, and privacy. Artificial intelligence, future of computing, impact of computing on society.

Textbooks:

1. A Kelly and I Pohl, *A Book on C*, 4th Ed., Pearson Education, 1999.
2. A M Tenenbaum, Y Langsam and M J Augenstein, *Data Structures Using C*, Prentice Hall India, 1996.
3. Computing Essentials 2017 Complete Timothy O"Leary& Linda O"Leary ISBN: 9781259563652

Suggested Readings:

1. H Schildt, *C: The Complete Reference*, 4th Ed., Tata Mcgraw Hill, 2000
2. B Kernighan and D Ritchie, *The C Programming Language*, 4th Ed., Prentice Hall of India, 1988.

Semester IV

DSC-7

MBIN 202: Plant Anatomy and Embryology L2-T1-P0-CR3

Course outcome

CO 1: Ability to recognize anatomical parts of plant and different embryological stages of plant.
CO 2: Ability to recognize the anatomy of monocot and dicot plants, and plant reproduction.
CO 3: Ability to recognize the different development stages of plant

Course content

Unit I: Meristematic and permanent tissues: [5 Hrs]
Root and shoot apical meristems; Simple and complex tissues.

Unit II: Organs: **[5 Hrs]**
Structure of dicot and monocot root, stem and leaf.

Unit III: Secondary Growth: **[6 Hrs]**
Vascular cambium – structure and function, seasonal activity. Secondary growth in root and stem, Wood (heartwood and sapwood).

Unit IV: Adaptive and protective systems: **[6 Hrs]**
Epidermis, cuticle, stomata; General account of adaptations in xerophytes and hydrophytes.

Unit V: Structural organization of flower: **[6 Hrs]**
Structure of anther and pollen; Structure and types of ovules; Types of embryo sacs, organization and ultrastructure of mature embryo sac.

Unit VI: Pollination and fertilization: **[6 Hrs]**
Pollination mechanisms and adaptations; Double fertilization; Seed-structure appendages and dispersal mechanisms.

Unit VII: **Embryo and endosperm**: **[6 Hrs]**
Endosperm types, structure and functions; Dicot and monocot embryo; Embryo endosperm relationship.

Unit VIII: Apomixis and polyembryony: [5 Hrs]
Definition, types and practical applications.

Text Book

1. Bhojwani, S.S. & Bhatnagar, S.P. (2011). Embryology of Angiosperms. Vikas Publication House Pvt. Ltd. New Delhi. 5th edition.
2. Mauseth, J.D. (1988). Plant Anatomy. The Benjamin/Cummings Publisher, USA.

DSC-8

MBIN 204: Comparative anatomy of vertebrates L2-T1-P0- CR3

Course outcome

CO 1: Ability to recognize anatomical parts of vertebrates.
CO 2: Ability to recognize different parts physiological systems of vertebrates.
CO 3: Ability to recognize the different development stages of vertebrates.

Course content

Unit I: Introduction to skeletal system: **[6 Hrs]**
Structure, functions and derivatives of integument; Overview of axial and appendicular skeleton, Visceral arches of birds and mammals.

Unit II: Digestive and Respiratory Systems: [7 Hrs]
Alimentary canal and associated glands in mammals; Respiratory organs in amphibians, birds and mammals; gills and accessory respiratory organs in fishes.

Unit III: Circulatory: **[6 Hrs]**
General plan of circulation, evolution of heart and aortic arches Urinogenital system in vertebrates, its evolution and types of mammalian uteri.

Unit IV: Nervous System: **[6 Hrs]**
Comparative account of brain in vertebrates Autonomic nervous system, Spinal cord, Cranial nerves in mammals.

Unit V: Neurons and Sense Organs: [5 Hrs]
Type of neurons, classification of receptors. Chemoreceptor, mechanoreceptor in vertebrates.

Unit VI: Reproduction: [7 Hrs]
Anatomy of gonads in vertebrates; Spermatogenesis and oogenesis vitellogenesis in birds; Fertilization: external (amphibians), internal (mammals); Early development of vertebrates; types of morphogenetic movements; Fate of germ layers.

Unit VII: Development: [6 Hrs] Control of early embryonic Development; Intercellular communication; cell proliferation, differentiation and movements; cell death.

Textbooks

1. Kardong, K.V. (2005) Vertebrates' Comparative Anatomy, Function and Evolution. IV Edition. McGraw-Hill Higher Education.
2. Balinsky, B.I. (2008). An introduction to Embryology, International Thomson Computer Press.
3. Gilbert, S. F. (2006). Developmental Biology, VIII Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA.

DSC-9

MBIN 206: Microbiology **L2- T1- P0-CR3**

Course outcome

CO1: Ability to identify microbial diversity, morphology, physiology and nutrition.
CO2: Ability to identify and demonstrate how to control microbial growth, demonstrate.
CO3: Ability to evaluate the interactions between microbes, hosts and environment

Course content

Unit I: Brief history and development of microbiology: [6 Hrs]
Introduction to study of Microbiology, conflict over spontaneous generation, role of microorganisms in disease, scope of microbiology, development of Koch's postulate.

Unit II: Microbial Taxonomy: **[6 Hrs]**
Classification system- phenetic, phylogenetic, numerical, morphological, biochemical and molecular characteristics; Novel genomic tools including signatures, uncultured microbes.

Unit III: Prokaryotic cell structure: **[6 Hrs]**
Bacterial cell wall, cytoplasmic structure and inclusions bodies, sporulation and spore, diversity in bacterial structure actinomycetes, rickettsias, mycoplasma; archaea.

Unit IV: Viruses: **[6 Hrs]**
Basic structures, classification, double stranded and single stranded DNA and RNA viruses, replication strategies of DNA and RNA viruses; viroids and prions; bacteriphages with suitable examples.

Unit V: Microbial growth and Nutrition: **[8 Hrs]**
Culture media, microbial growth curve, influence of environmental factors on growth; Common nutrient requirements, introduction to nutritional types in microorganisms, uptake of nutrient by the cell, energetic of biosynthetic reactions; photosynthesis (oxygenic an anaoxygenic), autotrophs, heterotrophs, assimilation of inorganic phosphorous, sulphur and nitrogen.

Unit VI: Microbial diseases and their control: **[6 Hrs]** Host-pathogen relationship, mechanisms of virulence, quorum sensing, pathogenesis in plants and animals.
(6 Lectures)

Unit VII: Applications of Microbes: [5 Hrs] Antimicrobial chemotherapy, microbial biofilm, microbiome.

Textbooks

1. Willey, J., Sherwood, L. and WoolvertonC., *Microbiology*, 10th edition (McGraw-Hill Science, 2017).
2. Pelczar, M.J., Chan, E.C.S. and Kreig, N.R., *Microbiology*, Publisher McGraw Hill Education (India) Private Limited, ISBN-10 0074623206, 5th Edition, 2001.
3. Tortora, G.J., Fernke, B.R. and Case, C.L., *Microbiology – An Introduction,* 9th Edition,
4. Benjamin Cummings, 2009.

Suggested Reading

1. M. T. Madigan, J. M. Martinko, K. S. Bender, D. H. Buckley, D. A. Stahl, T. Brock, *Brock Biology of Microorganisms, 14th* Edition , Pearson Hall International, 2017.
2. Molecular and Cell Biology (Schaum's Outlines series special Indian edition) by W. D. Stansfield, J. S.C. Colome, R. J. Cano and R. N. Sharan (2010), McGraw Hill Education.

DSC-10

MBIN 208: Biology Lab 1: (Plant anatomy and Physiology) L0-T0-P3-CR3

Course outcome

CO1: Ability to dissect and analyze monocot and dicot plants, and plant reproduction and embryo developments stages.
CO2: Ability to dissect and identify different stages of embryo development.
CO3: Ability to analyze physiological processes like seed germination and plant nutrition.

Course content: [6 Hrs per week]

1. Study of vegetative and floral characters of the following families (Description, V.S. flower, section of ovary, floral diagram/s, floral formula/e and systematic position according to Bentham & Hooker's system of classification):Brassicaceae -Brassica, Alyssum / Iberis; Asteraceae - Sonchus/Launaea, Vernonia/Ageratum, Eclipta/Tridax; Solanaceae -Solanum nigrum, Withania; Lamiaceae -Salvia, Ocimum; Liliaceae - Asphodelus / Lilium / Allium.
2. Preparation of root stem and leaf transverse and longitudinal sections, differential staining and study the different anatomical structures.
3. Mounting of a properly dried and pressed specimen of any plant with herbarium label.
4. Seed germination (under light and dark condition; under different chemicals).
5. Seed exudates characterization with respect to protein, carbohydrate and polyphenol during seed imbibitions.
6. Starch hydrolysis in germinating seed.
7. Preparation of Plant nutrition solution.

Practical Books

1. Simpson, M.G. (2006). Plant Systematics. Elsevier Academic Press, San Diego, CA, U.S.A.
2. Singh, G. (2012). Plant Systematics: Theory and Practice. Oxford & IBH Pvt. Ltd., New Delhi. 3rd edition.

GE-6/DSE-2

MBIN 210: Basics in Bioprogramming and Biostatistics L2-T1-P0-CR3

Course outcome:

CO1: Provide an understanding of the fundamental principles of statistics
CO2: Provide Statistical application in designing and analyzing experiments in the context of biological research.
CO3: Acquire understanding in computer programming languages, particularly Python and R, with a focus on their application in biological data analysis and research.

Course content:

Unit I:Basics of Biostatistics: [7 Hrs]

Descriptive and inferential statistics, Statistical terms, Discrete and Continuous data, mean, mode, median, variance, standard deviation, coefficient of variation, measures of skewness and kurtosis.

Unit II: Probability: **[7 Hrs]**

Introduction to theory of Probability, Conditional Probability, Bayesian Rules, Random variable, Distributions of random variables, Binomial, Poisson Fundamental concepts in applied probability.

Unit III: Data analysis: [6 Hrs]
Exploratory data analysis and statistical inference, Chi-square test for independence, P-value and z-score of the statistic, statistical software and their use for data analysis.

Unit IV: Basic computer skills: [6 Hrs]
Basics of computers, working on a Unix system, File system basics, commands for working with directories and files, shell scripts, Sharing software among multiple users.

Unit V: Introduction to Python Programming: [7 Hrs]
Variables, data types, and basic input/output, Control Structures, Data Structures, Functions and Modular Programming, File Handling and Data I/O.

Unit VI : Introduction to R Programming: [8 Hrs]
Introduction to R and RStudio, basic R syntax, and data structures, Data manipulation and exploration using data frames, Control structures, Functions and packages in R, Data analysis and visualization.

Textbooks

1. Jhonson RA et al. (2015) Miller & freud's probability and statistics for engineers.
2. Ross S (2018) Introduction to probability and statistics for engineers and scientists.
3. Swaroop, C. H. (2005). A byte of python. (Free book)
4. Gardener, Mark. *Beginning R: the statistical programming language*. John Wiley & Sons, 2012.

Suggested Reading

1. The Comprehensive R Archive Network (https://cran.r-project.org/)
2. https://www.python.org/

SEC-3 **L0 –T0-P3- CR3**

MBSE 212: Basic microbial techniques

Course Outcome
CO1: Ability to implement safety protocols for microbiology laboratory.
CO2: Ability to operate different equipments used in microbiology laboratory.
CO3: Ability to examine microbial contamination in a given sample.

Course content: [6 Hrs per week]

1. General instructions: Microbiology laboratory and its discipline/standards, laboratory safety measures.
2. Sterilization: Principles & operations – Autoclave, Hot Air Oven, Filtration devices, Laminar Air Flow. Sterilization techniques for glassware and other materials.
3. Microscopy: Description and operation of compound microscope, use of oil immersion objective. Micrometry and cell size measurement - Use of ocular and stage micrometer, Cell counting using haemocytometer - bacterial, fungal cell and human/animal cell (blood cell).
4. Preparation of microbiological media: Culture plates and tubes, minimal media, basic media, enrichment media, differential media etc.
5. Microbial culture: Pure culture techniques for bacteria and fungi from soil, water, air and milk.

6. Staining techniques – Simple staining, negative staining, Gram's staining; staining of fungus.
7. Study of bacterial growth curve
8. Enumeration of total and faecal coliforms in water samples

Suggested Readings

1. Basic and practical microbiology. Atlas, R.M. 1984. Mac Millan Publishers, USA.
2. Microbiology principles and explorations. 7th Edition. 2008, Black, J.G. John Wiley and Sons Inc., New Jersey.
3. Microbiology Laboratory Manual, James G. Cappucciino and Natalie Sherman, 5th Edition, 1998, Benjamin-Cummings Pub Co, Menlo Park, CA, USA

AEC-4. From University pool

Semester V

DSC-11

MBIN 301: Plant Physiology **L2-T1-P0- CR3**

Course outcome

CO 1*: Ability to identify different physiological processes in plant.*
CO 2**:** *Ability to understand absorption, transpiration and photosynthesis.*
CO3*: Ability to understand plant growth hormones and mechanism of action.*

Course content

Unit-I: Introduction to physiology and homeostasis: **[7 Hrs]**
Plant nutrition: essential nutrients; nutrient deficiencies and plant disorders; heavy metal stress and homeostasis; mechanism of ion uptake by plants.

Unit-II: Transport mechanism in plant: **[7 Hrs]**
Osmosis, Active transport and Passive transport, Xylem transport, Phloem Transport; loading and unloading mechanism of food, Short Distance Intracellular transport.

Unit-III: Water relations in plants: **[5 Hrs]**
Polarity; water potential in plants; movement of water in plants; soil-plant-atmosphere continuum.

Unit-IV: Photoperiodism: **[7 Hrs]**
Photoperiodic response, Physiology of flowering, phytochrome chemistry and mechanism; Senescence and its molecular aspects; Dormancy & Vernalization mechanism; plant biological clock.

Unit-V: Photosynthesis: **[6 Hrs]**
Photophosphorylation, Thylakoid membrane in photophosphorelation, C3 cycle, C4 cycle and CAM pathways, photorespiration.

Unit-VI: Plant growth regulators: **[6 Hrs]**
Auxins, gibberellins, cytokinins, ethylene, abscissic acid, brassinosteroids, salicylic acid, jasmonic acid, mode of senescence.

Unit-VII: Rhizosphere physiology: **[5 Hrs]**
Root respiration, rhizosphere and allelopathy, types of chemicals and volatiles.

Textbooks

1. Taiz, L. and Zeiger, E., Plant Physiology, 5th edition (Sinauer Associates, USA, 2012).
2. URL: http://www.sinauer.com/media/wysiwyg/tocs/PlantPhysiology5.pdf

Suggested Readings

1. Lambers, H. and Chapin, F. S., Plant Physiological Ecology (Springer, 2000).
2. Mukherji, S.and Ghosh, A.K., Plant Physiology, 1st edition (New Central Book Agency Private Ltd. Kolkata, 2009).
3. http://www.annualreviews.org/journal/arplant
4. Hormones: http://nptel.ac.in/courses/102103012/27

DSC-12

MBIN 303: Animal Physiology **L2- T1- P0-CR3**

Course outcome

CO1: Ability to identify different physiological process in animal.
CO2: Ability to understand the mechanism of digestive, circulatory, respiratory and nervous system in animals.
CO3: Ability to understand the diseases related to physiological systems

Course content

Unit I: Introduction to Physiology: [4 Hrs]
An overview of animal anatomy and body plan; Homeostasis, Organs and Organ systems.

Unit II: Circulatory system: **[6 Hrs]**
Closed and Open circulatory system, Structure and function of heart in higher vertebrates (mammals); Blood as connective tissue- Components of Blood; Blood groups; Blood clotting; Lymph and lymph nodes.

Unit III: Respiratory system: **[5 Hrs]**
Anatomy of lungs in mammals; Mechanism and regulation of breathing; Hemoglobin & Oxyhemoglobin dissociation curve, oxygen and carbon dioxide transport; Acid-Base balance of the blood.

Unit IV: Digestive system: **[5 Hrs]**
Anatomy of alimentary canal in mammals. Role of liver and pancreas in digestion. Mechanism of digestion and absorption of food in mammals.

Unit V: Muscular system: [6 Hrs]
Structure and type of muscles; neuromuscular junction, muscle contraction; Energy requirements of skeletal muscles and metabolism, Neural control of skeletal muscles.

Unit VI: Nervous system: **[5 Hrs]**
Types of neurons and supporting cells. Nerve impulse and mechanism of impulse conduction, Neurotransmitters, Synaptic Integration, Synaptic Plasticity and inhibition.

Unit VII: Excretory system: **[5 Hrs]**
Structure and function of mammalian kidney, Nephron as a functional unit of kidney, Process of filtration and urine formation: Renal control of electrolyte and acid-base balance.

Unit VIII: Reproductive and Endocrine system: **[8 Hrs]**
Female reproduction system – reproductive cycle, Structure of Ovary. Male reproductive system: Structure of testis, mechanism of spermatogenesis, structure of sperm. Endocrine organs and hormones in vertebrates (mammals); Mechanism of hormone action and signal transduction; thyroid and pancreatic metabolic disorders.

Textbooks

1. Guyton, C. and Hall, E., Text book of Medical Physiology, 12th edition (W.B. Saunders Company, 2010).
2. Hill, R.W., Wyse, G. A. and Anderson, M., Animal Physiology, 3rd edition (Sinauer Associates, 2012).

Suggested Readings

1. Kim E. Barrett. et. al., Ganong's Review of Medical Physiology, 24th Edition (Lange Basic Science, Tata McGraw Hill, 2012.)

DSC-13

MBIN 305: Wildlife Conservation and ManagementL2-T1-P0-CR3

Course outcome

CO1: Ability to understand the value of wildlife and its conservation
CO2: Ability to apply the knowledge of Biodiversity, in view of Conservation.
CO3: Ability to identify, formulate, and solve complex environmental issues and to design and evaluate solutions for environment issues
CO4: Ability to communicate with society and aware society about the need of conservation.

Unit I: Introduction to Wildlife: [6 Hrs]

Concept of wildlife; Wildlife of India; Values of wild life – Consumptive and non- consumptive; Causes of depletion; Importance of conservation; Conservation strategies- *In situ* and *Ex situ* conservation. Concept of keystone Umbrella, flagship, endemic, rare and cryptic species.

Unit II: Wild life Ecology: [6 Hrs]

Biomes, Animal as individual, Food and Nutrition, Ecology of behaviour, Population growth, Population regulation, fluctuation, interaction and competition within species, Predation, Parasites and Pathogens, Man- animal conflict and mitigation, Animal corridors and importance.

Unit III: Evaluation and management of wildlife: [7 Hrs]

Habitat types and analysis, Restoration of habitats. Physical parameters; Biological Parameters; Use of modern tools in wildlife management (camera trap, radio collaring, remote sensing, GIS and GPS, DNA finger printing and Bar Coding); Land Use and Land Cover (LULC).

Unit IV: Management of habitats: [7 Hrs]

Setting back succession; Grazing logging; Mechanical treatment; Cover construction; Preservation of general genetic diversity; Conservation Acts: Wild life Protection Act, wildlife trade and related laws. Wildlife conservation organisation: IUCN, WWF, Birdlife, BNHS, CITES. Indian case studies on conservation/management strategy (Project Tiger, Biosphere reserves).

Unit V: Population estimation: [6 Hrs]

Census and survey methods: Faecal analysis of ungulates and carnivores: Faecal samples, slide preparation, Hair identification, Pug marks, point count, transect. Bio- telemetry-Radio and satellite telemetry.

Unit VI: Protected Areas: [6 Hrs] Biosphere Reserve, National parks & sanctuaries, Tiger Reserve, Community reserve; Important features of protected areas in India with special reference to NE India. Conservation Project: Project Tiger, Project elephant, Project Snow Leopard.

Text Books

1. Gopal Rajesh (2011) Fundamentals of Wildlife Management, Natraj Publishers. ISBN-10: 81-8158-162-8
2. John M. Fryxell, Graeme Caughley, Sinclair Fryxell (2014) Wildlife Ecology, Conservation, and Management (Wiley Desktop Editions) (3rd Edition) ISBN-10: 1-118-29107-7

DSC-14

MBIN 307: Evolutionary Biology **L2- T1- P0-CR3**

Course outcome:
CO1: Ability to understand evolution and molecular evolution.
CO2: Ability to identify and analyze mutation, variation, genome evolution.

Course content:

Unit I: Evolutionary biology: [6 Hrs]
Definition, scope and applications, theories of evolution, experimental evidence for evolution, speciation.

Unit II: Selection, mutation and drift: [6 Hrs]
Selection theory vs. neutral theory of evolution, genome sequence, genome composition, genome complexity, selection-mutation and drift theory.

Unit III: Base Substitution: [7 Hrs] Base substitutions in DNA, parity rules, mutation bias between the strands, AT and GC skews in DNA strands, transition and transversion bias, Gene distribution asymmetry, transcription induced mutation bias.

Unit IV: Genetic code and Evolution: [6 Hrs]
Codon degeneracy, codon usage bias, measures of codon usage bias, selection on codon usage bias, ribosome profiling, tRNA modification role.

Unit V: Macromolecular evolution: **[4 Hrs]**
Protein evolution, role of protein folding, intrinsically disordered proteins.

Unit VI: Genetic drift and Evolution: [7 Hrs]
Mutation within and across genomes, genome wide association studies (GWAS).

Textbooks

1. Bergstrom C. T., Dugatkin L. A., (2012) Evolution, I S Edition, W. W. Norton & Company.
2. Griffiths A.J., Griffiths A.J.F., Miller J.H., Suzuki D.T. and Lewontin R.C. (2008)
3. An Introduction to Genetic Analysis, W.H. Freeman. 3. Hartl (2011) Genetics: Analysis of Gene and Genomes, Jones & Bartlett Publisher.
4. Graur D. (2016)Sinauer Publisher: Molecular and Genome evolution.

DSC-15

MBIN309: Biology Lab. III (Animal anatomy and Physiology) **L0-T0-P3-CR3**

Course outcome
CO1: Ability to do experiments related to various physiological processes in plants and animals.
CO2: *Ability to do blood cell counting, seed metabolism, and characterization of body fluids.*

Course content: [6 Hrs per week]

1. Study and identification of permanent slides of different human tissues.

2. Study of developmental stages - whole mounts and sections through permanent slides –(cleavage stages, blastula, gastrula, neurula, tail bud stage, tadpole external and internal gill stages of frog).
3. Study of the different types of placenta- histological sections through permanent slides or photomicrographs.
4. Haematological analysis: Preparation blood film and Leishman's staining.
5. Identification of blood corpuscles. Differential count of WBC. Total count of RBC andWBC.
6. Blood grouping (ABO and Rh).
7. Preparation of blood plasma and study of clotting time.
8. Estimation of Glucose, Protein, blood & bile in urine.

Practical books

1. Dr. P S Verma A Manual of Practical Zoology: Invertebrates, ISBN: 9788121908290
2. Dr. P.S.Verma A Manual of Practical Zoology : Chordates. ISBN 9788121908306

GE-7/DSE-3

MBIN 213: Introduction to Bioinformatics L2-T1-P0-CR3

Course outcome:

CO1: Develop the ability to utilize common computational tools
CO2: Develop databases to investigate molecular biology and evolution-related concepts.
CO3: Acquire the ability to employ computational approaches for critical analysis and interpretation of study results.

Course content:

Unit I: Introduction to Bioinformatics: [7 Hrs]
History of bioinformatics, Bioinformatics and its connection to the internet, Utilization of information technology in the study of biosciences, Observables and data archives, Information flow in bioinformatics.

Unit II: Basics in Mathematical Biology: [6 Hrs]
Central dogma of molecular biology, Basics of Modelling and simulation, Intersection of classical biology, mathematics, and computer science.

Unit III:Sources of biological data: [9 Hrs]
The structure of DNA and RNA, gene structure and control, the tree of life and evolution, protein structure, protein structure prediction and engineering, introduction to genome sequencing, next-generation sequencing, DNA microarray, RNA-sequencing, mass spectrometry.

Unit IV:Biological databases: [8 Hrs] Concept of database, biological databases, database indexing and specification of searching terms, searching and retrieving biological data from online databases, examples of biological databases (nucleic acid, genome, protein sequence, protein structure, pathways, etc.), data formats and their significance in bioinformatics: FASTA, GenBank, PDB, etc.

Unit V: Overview of Bioinformatics Software Tools: [8 Hrs]
Categories of bioinformatics software: sequence analysis, structural analysis, functional analysis, etc., Sequence Analysis Software, Gene Prediction Tools, Sequence visualization and editing tools, structural analysis software tools, Visualization and analysis tools for protein structures, functional annotation and enrichment analysis, evolutionary analysis tools.

Unit VI: Emerging areas in Bioinformatics: [6 Hrs]
Big data in biology, Artificial intelligence and Machine Learning in Bioinformatics, Systems and synthetic biology, personalized medicine.

Textbooks

1. Lesk, A. M. (2002). Introduction to Bioinformatics. Oxford: Oxford University Press.
2. Mount, D. W. (2001). Bioinformatics: Sequence and Genome Analysis. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.
3.

Suggested Readings

1. Baxevanis, A. D., & Ouellette, B. F. (2001). Bioinformatics: a Practical Guide to the Analysis of Genes and Proteins. New York: Wiley-Interscience.
2. Pevsner, J. (2015). Bioinformatics and Functional Genomics. Hoboken, NJ.: Wiley-Blackwell.
3. Bourne, P. E., & Gu, J. (2009). Structural Bioinformatics. Hoboken, NJ: Wiley-Liss.
4. Lesk, A. M. (2004). Introduction to Protein Science: Architecture, Function, and Genomics. Oxford: Oxford University Press.

Internship

MBIN 311: Summer Internship **L0-T0-P2-CR2**

Details of internship to be carried out

A student will apply to Universities/HEIs/Research Organizations/Industries/Registered NGOs for carrying out internship during the semester break. On completion of the internship, the student will submit the internship report duly endorsed by the host supervisor to the department. A committee constituted by the Head of the Department will evaluate the report and award the grade.

Semester VI

DSC-16

MBIN 302: Developmental Biology **L2- T1- P0- CR3**

Course outcome

CO1: *Ability to understand the molecular basis of development in animals and plants.*
CO2*:Ability to understand how multicellular organism develops from a single cell through differentiation and development in animal and plants.*
CO3: *Ability to understand plant meristem cells and body plan in animal.*

Course content

Unit I: History of developmental biology: **[6 Hrs]**
Historical perspective and different techniques in developmental biology, Model Organisms: An overview of model organisms Criterion of model organism. Key features of some model organisms.

Unit II: Developmental genetics: **[6 Hrs]**
Developmental events and genetics: Genes in early development, control of gene expression and cell signalling, Early embryonic development: Gametogenesis, Fertilization, Cleavage I, Cleavage II, Gastrulation I, Gastrulation II.

Unit III: Patterning of body plan in model Invertebrate: **[6 Hrs]**
Early pattern formation and laying of body axis planes, Axis formation and anterior/posterior patterning and dorsal/ventral patterning in Drosophila/C.elegans (maternal effect genes, segmentation, zygotic genes).

Unit IV: Patterning of body plan in model Vertebrate: **[7 Hrs]**
Early embryogenesis: morula and blastula formation, early cell differentiation, Cell lineages and developmental controls, formation of germ layers, gastrulation, Axis formation and anterior/posterior patterning and dorsal/ventral patterning in zebra fish/mouse/human.

Unit V: Cell differentiation: **[5 Hrs]**
Cell fate determination, Differentiation of Specialized Cells: Stem cell differentiation, tissue regeneration, morphogenesis, Cancer stem cells.

Unit VI: Plant Embryonic Development and Patterning: **[6 Hrs]**
Embryogenesis in plant: Development of Male and Female Gametophyte. Embryogenesis. Axial and Radial patterning in plants. Developmental control genes in a model plant (*Arabidopsis*).

Unit VII : Plant Meristems and Differentiation: **[5 Hrs]**
Organization of Shoot Apical Meristem (SAM) and Root Apical Meristems (RAM). Floral meristems and development. Leaf Ontogeny.

Unit VIII: Factors influencing Plant Development: **[5 Hrs]**
Photomorphogenesis and Skotomorphogenesis. Role of Micro RNAs. Recent advances in apomixes and Self-incompatibility**.**

Textbooks

1. Scott F. Gilbert. Developmental Biology, (Sinauer Associates Inc; 10 edition (2013)
2. Lewis Wolpert. Principles of Development, (Oxford University Press, 5th edition, 2015)

Suggested Readings

1. Bruce Alberts et al, Molecular Biology of the Cell, (Garland Science; 6th edition, 2014).
2. Benjamin Lewin, Gene XII (Jones and Bartlett Publishers, 12th edition, 2017).James D. Watson et al., Molecular Biology of the gene (Pearson Prentice Hall, 6th edition, 2013).

DSC-17

MBIN 304: Molecular Biology **L2- T1- P-0- CR3**

Course outcome

CO1: Ability to understand the molecular basis of various biological processes.
CO2: Ability to understand three fundamental aspects in biological phenomenon: The central dogma
CO3: Ability to understand the molecular basis of life.

Course content

Unit I: Nucleic acid structure and function: **[6 Hrs]**
Introduction to molecular biology, chemical nature of the genetic material: Avery et al experiment; Hershey and Chase experiment; Structure of DNA and RNA: DNA double helix; Base pairings in DNA, A, B and Z DNA, RNA secondary structures.

Unit II: DNA to Chromosome: **[7 Hrs]**
Introduction to genomes of bacteria, eukaryotes, organelle and viruses: linear and circular chromosomes, single stranded and doubles stranded DNA/RNA viral genome, Organization DNA into chromosomes: DNase I sensitive regions, heterochromatin and euchromatin, DNA methylation (e.g. X chromosome inactivation).

Unit III: Replication and repair: **[7 Hrs]**
DNA replication: Chemistry of replication, DNA polymerases, synthesis of leading and lagging strands Errors in DNA and repair: pyrimidine dimer, nick and gap in DNA, AP sites, base mispairing; photolyase; mismatch, base excision and nucleotide-excision repair mechanisms, SOS response.

Unit IV:Recombination: **[3 Hrs]**
Homologous recombination, site specific recombination, transposition.

Unit V: Transcription: **[7 Hrs]**
Prokaryotic transcription:RNA polymerase, promoters, sigma factors, initiation, elongation and termination (Rho-dependent and independent), Eukaryotic transcription: types of RNA polymerases, promoters and enhancers, transcription factors, TBP and TAFs, RNA modification and processing.

Unit VI: Translation: **[4 Hrs]**
Translation in prokaryotes and eukaryotes: Ribosome, tRNA, amino-acyl tRNA synthetases, genetic code, translation-initiation, elongation, termination and ribosome recycling,

Unit VII: Regulation of gene expression in prokaryotes: **[4Hrs]**
Transcriptional regulation in bacteria: regulation of lac and trp operons in bacteria, regulation by sigma factors, anti-sigma factors, anti-sense RNA, two component regulatory system in bacteria.

Unit VIII: **Regulation of gene expression in eukaryotes**: **[5 Hrs]**
Concept of eukaryotic gene regulation, nucleosomes, chromatin structure remodeling, activation of transcription factors.

Textbooks:

1. Lewin's Genes XII by J. E. Krebs, E. S. Goldstein and S. T. Kilpatrick (Edn 12th 2017) (Alternatively, Lewin's Gene X and Lewin's
2. Genex XII by same authors)
3. Molecular Biology of the Gene by J. D. Watson, T.A. Baker, S.P. Bell, Gann, M. Levine and R. Losick (Edn 6th 2007).

Suggested Readings

1. B. Alberts, A. Johnson, J. Lewis, M. Raff, K. Roberts, D, Morgan Molecular Biology of the Cell (Edn 6th, 2014).

DSC-18

MBIN 306: Immunology I **L2-T1-P0- CR3**

Course outcome
CO 1: Ability to understand innate and acquired immune system.
CO2: Ability to understand organs in immune system.
CO3: Ability to identify the type of infection using cytokine profile.

Course content

Unit I: Introduction: **[6 Hrs]**
Basics of an immune response, discrimination between self and non-self, innate and acquired immune response, comparative immunity and evolution of immune system.

Unit II: Innate Immunity: **[6 Hrs]**
Anatomic and Physiological Barriers, Inflammation, Toll receptors and PAMPs, DAMPs ,Defensisns, and Complement system, NK Cells.

Unit III: Cells, tissues and organs of the immune system: **[5 Hrs]**
Haematopoeisis, cells of innate and adaptive immune system, organs of the immune system.

Unit IV: Antigen: **[5 Hrs]**
Antigenicity vs immunogenicity, factors that influence immunogenicty, B and T cell epitopes, haptens.

Unit V: Immunoglobulins: **[7 Hrs]**
Basic structure, Ig fold and domains, Classes and subclasses of Ig, Biological activities of Igs, B cell receptor, Antigenic determinants on immunoglobulin, Ig diversity -multigene organization of Ig genes, Class switching, Affinity maturation and somatic hypermutation, Monoclonal antibodies.

Unit VI: MHC and Antigen Presentation: [7 Hrs]
General organisation and inheritance of the MHC, MHC molecules and genes, Cellular distribution of MHC molecules, Intracellular and extracellular antigen processing pathways.

Unit VII: Cytokines and cytokine receptors: **[5 Hrs]**
Properties of cytokines, cytokine receptors, Cytokine signal transduction, cytokines secretion by Th1 and Th2 subsets and cross regulation.

Unit VIII: T cell and B cell maturation and activation: **[6 Hrs]**
Basics of T and B maturation, Self-MHC restriction of T and of B cells, T and B cell activation and differentiation. Effector T cells, cytotoxic T cells, NK cells, ADCC, and hypersensitivity.

Textbooks

1. Basic Immunology: Functions and Disorders of the Immune System, Abul K. Abbas, Andrew H. Lichtman, Shiv Pillai (Elseviers Saunders 4 th Edition).
2. Kuby Immunology, Thomas J. Kindt, Barbara A. Osborne, Richard A . Goldsby (W.H. Freeman Publishers, Sixth Edition).

Suggested Readings

1. Delves, P., Martin, S., Burton, D., Roitt, I. Roitt's Essential Immunology (WileyBlackwell, 11th Edition).

DSC-19

MBIN 308: Biotechniques **L2- T1- P0- CR 3**

Course outcome
CO1: Ability to understand thebasic principles of the new technologies and other research tools.
CO2: Ability to apply the new technologies in solving complex biological questions in life-sciences.
CO3: Ability to apply these technologies for project and research.

Course content

Unit I: Microscopy: **[5 Hrs]**
Techniques Principles and application of electron microscopy, optical microscopy, phase contrast and fluorescence microscopy. Confocal microscopy, FRET, FRAP, TIRF.

Unit II: Spectroscopy: **[5 Hrs]**
UV, Visible, Photoluminescence; and Raman Spectroscopy; Theory and application of Circular Dichroism; FTIR, MS, NMR, PMR, ESR and Plasma Emission spectroscopy.

Unit III: Chromatography: **[7 Hrs]**
Techniques Principles of chromatography; TLC and Paper chromatography; Chromatographic methods for macromolecule separation – Gelpermeation, Ion exchange, Hydrophobic, Reverse-phase and Affinity chromatography; HPLC andFPLC; Criteria of protein purity, Ultrafiltration and other membrane techniques, dialysis.

Unit IV: Electrophoretic: **[5 Hrs]**
Theory and application of Polyacrylamide and Agarose gel electrophoresis; Capillary gel electrophoresis; 2D-gel Electrophoresis; Disc gel electrophoresis; Gradient electrophoresis; Pulsed field gel electrophoresis.

Unit V: Centrifugation: **[7 Hrs]**
Basic principles; Mathematics & theory (RCF, Sedimentation coefficient etc); Types of centrifuge - microcentrifuge, High speed & Ultracentrifuges; Preparative centrifugation; Differential & density gradient centrifugation; Applications (Isolation of cell components); Analytical centrifugation; Determination of molecular weight by sedimentation velocity & sedimentation equilibrium methods.

Unit VI: Radioactivity: **[7 Hrs]**
Radioactive materials and Radiological techniques Radioactive & stable isotopes; Pattern and rate of radioactive decay; Units of radioactivity; Measurement of radioactivity; Geiger-Muller counter; Solid & Liquid scintillation counters (Basic principle, instrumentation & technique); Autoradiography; Measurement of stable isotopes. Use of radioactivity in biochemistry.

Unit VII: Protein crystallization: [5 Hrs]
Theory and methods; API-electrospray and MALDI-TOF; Mass spectrometry; Enzyme and cell immobilization techniques; DNA & Peptide Synthesis, FACS.

Textbooks

1. Freifelder D., Physical Biochemistry, Application to Biochemistry and Molecular Biology, 1. 2nd Edition, W.H. Freeman & Company, San Fransisco, 1982.
2. Keith Wilson and John Walker, Principles and Techniques of Practical Biochemistry, 5th
3. Edition, Cambridge University Press, 2000. 4. D. Holme& H. Peck, Analytical Biochemistry, 3rd Edition, Longman, 1998.

Suggested Readings

1. Molecular and Cell Biology (Schaum's Outlines series special Indian edition) by W. D. Stansfield, J. S.C. Colome, R. J. Cano and R. N. Sharan (2010), McGraw Hill Education.
2. R. Scopes, Protein Purification - Principles & Practices, 3rd Edition, Springer Verlag, 1994.

DSC-20

MBIN 310: Biology Lab IV (Molecular Biology) **L0-T0-P3-CR3**

Course outcome
CO1: Ability to perform experiments related to molecular biology using spectroscopy and microscopy.
CO2: Ability to isolation of vectors and cloning of gene into vectors for protein expression and purification.
CO3: Ability to prepare competent cells and visualized recombinant clones using reporter.

Course content: [6 Hrs] per week

1. Study of hyperchromic and hypochromic effect in DNA by spectrophotometry
2. Study of chromatin organization
3. Plasmid DNA isolation and agarose gel electrophoresis
4. Restriction mapping of plasmid DNA
5. Competent cell preparation
6. Transformation of plasmid to competent cells
7. Blue-white screening of transformed cells.

Practical books

1. Microbiology Laboratory Manual, 5th Edition, James G. Cappucciino and Natalie Sherman
2. Molecular Cloning A Laboratory Manual 1 3rd Edition, J. Sambrook, E.F Fristsch and T. Maniatis
3. Molecular Cloning A Laboratory Manual 2 2nd Edition, J. Sambrook, E.F Fristsch and T. Maniatis

DSC-21

MBIN 312: Biology Lab –V (Immunology) L0 -T0- P3 CR3

Course outcome
CO1: Ability to identify tools and techniques used to study immune system as well as their function.
CO2: Ability to carry out immunological assays.
CO3: Ability to understand and perform industrially related immunological tests.

Course content: [6 Hrs per week]

1. Blood film preparation and identification of leucocytes by Giemsa stain.
2. Antibody titre by ELISA method.
3. Ouchterlony's double diffusion assay
4. Immunoelectrophoresis and radial immune diffusion.
5. SDS-PAGE and immune blotting.
6. Immunodiagnostics using commercial kits.
7. Enzyme linked immunosorbent assay (DOT-ELISA)

Practical books
1. Practical Immunology, 4th Edition Frank C. Hay, Olwyn M. R. Westwood Wiley-Blackwell, ISBN: 978-0-86542-961-1.
2. Molecular Cloning A Laboratory Manual 1 3rd Edition, J. Sambrook, E.F Fristsch and T. Maniatis.
3. Molecular Cloning A Laboratory Manual 2 2nd Edition, J. Sambrook, E.F Fristsch and T. Maniatis.

GE-8/DSE-4

MBIN 214: Biological Database management System L2-T1-P0-CR3

Course outcome:
CO1: Ability to generate data, data management concepts, data mining strategies
CO2: Effective utilization of computational tools in database
CO3: Ability to comprehend the aspects of data integration, data Management, data mining for defined applications.

Course content:

Unit I:Introduction: [9 Hrs]
Database -System Applications- Purpose of Database Systems, View of Data, Database Languages, introduction to Relational Databases, Database Design, Data Storage and Querying, Transaction Management, Database Architecture, Database Users and Administrators, History of Database Systems.

Unit II:Database design and E-R model: [7 Hrs]
Overview of the Design Process, The Entity-Relationship Model, Constraints, Removing Redundant Attributes in Entity Sets, Entity-Relationship Diagrams, Reduction to Relational Schemas, Entity-Relationship Design Issues, Extended ER Features, Alternative Notations for Modeling Data, Other Aspects of DatabaseDesign.

Unit III:Structure and Language: **[8 Hrs]**
Overview of the SQL Query Language, SQL Data Definition, Basic Structure of SQL Queries, Additional Basic Operations, Set Operations, Null Values, Aggregate Functions, Nested Subqueries, Modification of the Database.

Unit IV: Types of Biological Databases: [8 Hrs]
Microbiological Databases, Virological Databases, Organism Databases, Primary Sequence Databases, Carbohydrate Databases, RNA databases, Biodiversity, Sequence Database (Nucleotide and Protein Sequence DB), Structural Databases, Gen bank sequence database, submitting sequences to database: NCBI, EMBL, PDB etc.

Unit V: Biological Data Integration: **[7 Hrs]**
Introduction to Biological Data Integration, standards and specifications, NatureofBiological data,Data sources in Life Sciences, data integration.

Unit VI: Challenges in Data Management: [6 Hrs]
Big data, Data storage, Data quality, lack of processes and systems, Data governance, security, automation and analysis.

Textbooks

1. Abraham Silberschatz, Henry F. Korth, S. Sudarshan, "Database System Concepts", McGraw-Hill, 6th Edition, 2011.
2. Date C.J, "An Introduction to Database", Addison-Wesley Pub Co, 7th Edition, 2001
3. Elmashri & Navathe, "Fundamentals of Database System", Addison-Wesley Publishing, 3rd Edition, 2000

Suggested Reading

4. Raghu Ramakrishnan, Johannes Gehrke, "Database Management System", McGraw Hill, 3rd Edition 2003
5. Jeffrey D. Ullman, Jennifer Widom, "A First Course in Database System", Prentice Hall, AWL 1st Edition, 2001

Semester VII (Honours/Research)

DSC-22

MBIN 401: Biochemistry II **L2- T1- P0- CR3**

Course outcome

CO1: Ability to understand the chemistry of biomolecules and metabolism.
CO2: *Ability to identify biomolecules such as carbohydrates, lipids. proteins and nucleic acids. Role of enzymes and vitamins in biochemical reaction.*
CO3: *Ability to understand the molecular basis of various pathological conditions from the perspective of biochemical reactions.*

Course content

Unit I: Metabolism: [3 Hrs]
Basic concept and function of metabolism, metabolic pathways, regulation of metabolism.

Unit II: Enzyme: **[8 Hrs]**
Enzyme nomenclature, unique features of enzyme catalysis, concept of enzyme –substrate complex, thermodynamic principles – effect of catalyst on activation energy; enzyme kinetics, significance of Km/Kcat, allosteric enzymes, enzyme regulation-feedbackregulation, covalent and non-covalent mechanisms of enzyme regulation; coenzymes. Isolation and purification of enzymes. Methods of enzyme isolation and purification, determination of molecular mass and purity of enzymes; some examples of industrial application of enzymes.

Unit III: Biochemistry of polypeptide and steroid hormones: **[5 Hrs]**
Hormones and hormonal cascade system, structure, biosynthesis, hormone-receptor interaction and regulation

Unit IV: Carbohydrate metabolism and biological oxidation: [8 Hrs]
Glycolysis and citric acid cycle, glyoxalate cycle, gluconeogenesis,Calvin cycle, pentose phosphate pathwayand glycogen metabolism; oxidoreductases, redox potential, electron transport chain, oxidativephosphorylation and photophosphorylation;Diseases related to impaired carbohydrare metabolism.

Unit V: Lipid metabolism: [6 Hrs]
Metabolism of fatty acids, ketone bodies – formation and utilization, biosynthesis of cholesterol. Diseases related to impaired lipid metabolism.

Unit VI: Protein metabolism: [6 Hrs]
Pathways of amino acid metabolism, transamination, transdeamination and deamination; Biosynthesis. Diseases related to impaired protein metabolism.

Unit VII: Nucleic acid metabolism: [6 Hrs]
Synthesis and degradation of nucleotides; metabolism of purines and pyrimidines. Diseases related to impaired nucleic acid metabolism.

Textbooks

1. Stryer L. (2007) Biochemistry, W.H.Freeman.
2. Voet D and VoetJ.G.,. Fundamentals of Biochemistry (John Wiley and Sons, 2004).

3. Nelson D.L. and Cox M.M. (2017) Lehninger's Principles of Biochemistry, Freeman & Co, New York.
4. Thomas M Devlin(2010) Text of Biochemistry with Clinical Correlations, Wiley-Liss

Reference books

1. Zubay G. (1999) Biochemistry, 4th Ed., Win C. Brown Comm.,lnc.
2. Devlin, T.M., Text book of Biochemistry (John. Wiley and Sons. 2002).

DSC-23

MBIN 403: Cell Biology II **L2 -T1-P0- CR3**

Course outcome

CO1: Ability to understand the basic of cellular interaction with the environment and intracellular signaling and their relation in the understanding of various biological processes.
CO2: Ability to understand cellular aspects of cancer biology and other cellular biological processes
CO3: *Ability to understand the structure and function of cellular organelles associated with energy metablosim***.**

Course content

Unit I: Techniques in Cell Biology: [5 Hrs]
Advanced Microscopy - Confocal and Immunofluorescence microscopy; FISH; Scanning and Transmission electron microscopes - Fixation and Staining techniques for EM; Techniques for detection of Cancer.

Unit II: Cancer Biology: [8 Hrs]
Difference between normal cell and cancer cell; Cell cycle dysregulation and cancer; Genetic rearrangements in progenitor cells, oncogenes, tumor suppressor genes, virus-induced cancer, metastasis; Therapeutics for Cancer.

Unit III: Interaction of the cell with its environment: [8 Hrs]
General principles of cell communication - cell-cell communications, cell-environment communications; Role of different adhesion molecules; Desmosomes, Hemi-desmosomes, Gap junctions, Tight Junctions, Plasmodesmata.

Unit IV: Unit IV: Cellular energy utilization: [5 Hrs]
Mitochondria - structure, function and its role in aerobic respiration; Chloroplast - structure and function.

Unit V: Organelle interconnectivity and inheritance: [6 Hrs]
Organelle interconnectivity and communication of mitochondria with the endomembrane system; Inheritance of mitochondrial and chloroplast genes, maternal inheritance.

Unit VI: Cell signalling: [7 Hrs]
Bacterial two component system; Plant two component system; Bacterial chemotaxis and quorum sensing; Cytokine signalling; Signaling pathways in apoptosis; Signal transduction associated with cancer.

Text books:
1. Karp, G. et al, Karp's Cell Biology, 8th Edition (Wiley, 2018); ISBN: 978-1119454175
2. Alberts, B. et al., Molecular Biology of the Cell, 7th Edition (WW Norton & Co, 2022); ISBN: 978-0393884821

Reference books:
1. Pecorino, L., Molecular Biology of Cancer: Mechanisms, Targets, and Therapeutics. 5th Edition (Oxford university press, 2021), ISBN: 978-0198833024
2. Cooper, G. and Adams, K., The Cell: A Molecular Approach, 9th Edition (Sinauer Associates, Inc., 2022); ISBN: 978-0197583722
3. Hardin, J., and Bertoni, G., Becker's World of the Cell, 10th Edition (Pearson, 2021); ISBN: 978-0135259498
4. Lodish, H. et al, Molecular Cell Biology, 9th Edition (W. H. Freeman, 2021); ISBN: 978-1319365493

DSC-24

MBIN 405: Plant metabolism & secondary metabolites L2-T1-P0-CR3

Course outcome
CO 1*: Ability to understand classification and structure of plant secondary metabolites.*
CO2: *Ability to understand role of plant secondary metabolites with respect to plant, insects and herbivores interaction.*
CO3: *Ability to understand importance of plant secondary metabolites in plant defence against pathogens.*

Course content

Unit I: Secondary Metabolites: [6 Hrs]
Secondary metabolites defend plants against herbivores and pathogens, three major groups.

Unit II: Terpenes: **[5 Hrs]**
Isoprene units, terpene biosynthesis, IPP and its isomer, larger Terpenes, terpenes in growth and development, terpenes against herbivores.

Unit III: Phenolic Compounds: [6 Hrs]
Phenylalanine, biosynthesis of phenolics, ultraviolet light and phenolics, release of phenolics into the soil, lignin, four major groups of flavonoids, anthocyanins attract animals, flavones and flavonols for ultraviolet protection, isoflavonoids, tannins.

Unit IV: Nitrogen-Containing Compounds: [5 Hrs]
Alkaloids, cyanogenic glycosides, glucosinolates, nonprotein amino acids toxicity.

Unit V: Induced Plant Defences against Insect Herbivores: [6 Hrs]
Plants recognize insect saliva, jasmonic acid defensive responses, plant proteins inhibit herbivore digestion, insect herbivores and systemic defences, volatiles and ecological functions, insects strategies against plant.

Unit VI: Plant Defences against Pathogens: [6 Hrs]
Pathogens invasion, antimicrobial compounds, infection induction, phytoalexins, interactions of plants with non-pathogenic bacteria can trigger induced systemic resistance.

Textbooks:
1. Taiz, L. and Zeiger, E., Plant Physiology, 5th edition, Sinauer Associates, USA, 2012, ISBN-13: 978-0878938667.
2. Plant Secondary Metabolites: Occurrence, Structure and Role in the Human Diet, edited by Alan Crozier, Mike N. Clifford, Hiroshi Ashihara, John Wiley & Sons, 15-Apr-2008, ISBN 1-4051-2509-8.

Suggested Readings
1. Bioactive Compounds: Health Benefits and Potential Applications, edited by Maira Rubi Segura Campos, Woodhead Publishing, 01-Dec-2018, ISBN13 9780128147740.

DSC-25

MBIN 407: Endocrinology **L2-T1-P0-CR3**

Course outcome:
CO1: Understanding of endocrine systems in maintaining homeostasis and functions.
CO2: Description of the synthesis and modes of secretion of hormones.
CO3: Exploring the molecular, biochemical and physiological effects of hormone on cells and tissues.
CO4: Understanding of male and female reproductive systems including hormones and functions.

Course content

Unit I: Introduction: [6 Hrs]
History of endocrinology, characteristic of Hormones, Classification –Local and circulating hormones, chemical classification, Neurosecretions and neurohormones

Unit II: Pituitary endocrine system: [7 Hrs]
Pituitary Gland, structure of pituitary, its hormones, their secretion, transportation, storage, functions and hypothalamic regulation; disorders of pituitary gland. Pineal gland, secretions and their functions in biological rhythms and reproduction.

Unit III: Thyroid hormone and regulatory system: [5 Hrs]
Thyroid gland; structure of thyroid gland, synthesis and functions of thyroid hormones, regulation of thyroid hormone secretion; thyrocalcitonin. Disorders of thyroid gland.

Unit IV: Adrenal gland and its hormones: [8 Hrs]
Structural of Adrenal Gland – Synthesis and structure of hormones of the adrenal cortex and medulla; Biological Action of glucocorticoids, mineralocorticoids, adrenaline and noradrenaline on carbohydrate

and protein metabolism; and cardiovascular system, osmoregulation, Stress and diseases related to adrenal cortex and medulla.

Unit V: Pancreas and its hormones: [7 Hrs]
Structure of Pancreatic Islets of Langerhans and hormones secreted by it; insulin secretion (proinsulin) its activation, Glucagon secretion, mechanism of action of both hormones in controlling the blood glucose level. Diabetes mellitus.

Unit VI: Reproductive endocrinology: [7 Hrs]
Male Reproductive system; hormonal control of testes; chemistry and biosynthesis of testosterone, functions of testosterone. Female Reproductive system, role of hormones in Female Sexual cycle, placental hormones; parturition and lactation

SUGGESTED READINGS

1. J. Larry Jameson, editor. (2010). Harrison's Endocrinology. 2nd Edition. McGraw-Hill Press: New York.
2. Turner, D.C. and Bagnara, J.T. (Editor) (1976). General Endocrinology. W. B. Saunders Company, Philadelphia, Pennsylvania.
3. Hall, J.E. (2011). Guyton and Hall Textbook of Medical Physiology (Guyton Physiology).

DSC-26

MBIN 409 Applied Microbiology L2-T1-P0-CR3

Course outcome
CO1: Ability to identify industrially relevant microbe and their application.
CO2: Ability to apply bioprocess engineering techniques for large scale production
CO3: Ability to understand strategies for controlling pathogenic microbes.

Course content

Unit I: Microbial Diversity: [5 Hrs]
Molecular characterization of organisms; Principle of molecular phylogeny Methods in Taxonomy of Bacteria, Archaea and Fungi morphological Methods Chemotaxonomy. Genetic Methods of identification.

Unit II: Microbial Growth: **[6 Hrs]**
Isolation, screening and maintenance of industrially important microbes; Microbial growth and death kinetics; Microbial growth in Batch culture, Specific growth rate, Monod equation, Growth in continuous culture, chemostat models, Turbidostate and Fed batch culture, Strain improvement for increased yield and other desirable characteristics.

Unit III: Extremophiles: [6 Hrs]
Concept of extremophiles v/s conventional microbial forms Extreme habitats in universe, extreme communities in following econiches:desserts (Atacama, Mojave), rhizospheres, ore deposits/ mining areas (Fe,Mn, Cu), animal systems, deep biosphere (terrestrial and marine),hydrothermal vents. (10 Lectures)

Unit IV: Microbial pathogens and its control: [6 Hrs]
Emerging infectious diseases and microbial health hazards. Swine flu, Bird flu, Rabies, HIV,SARS CoV, Hepatitis B and Ebola virus infections.Emerging communicable bacterial diseases (Plague,Anthrax).

Opportunistic parasitic infections in immunocompromised patients. Chemotherapeutic agent for control of bacteria, virus, fungi and protozoa.

Unit V: Bioremediation: **[6 Hrs]**
Waste water treatment - Aerobic and Anaerobic processes, Treatment schemes for waste waters of dairy, distillery, tannery, antibiotic industries. Sewage disposal, compost making, methane generation. Microbiology of degradation of xenobiotics in environment: hydrocarbons, oil pollution, surfactants, pesticides, Microorganism for waste treatment.

Unit VI: Microbes in Industry: [7 Hrs]
Microbial biotechnology. Microorganisms as factories for the production ofnovel compounds, Microbial polysaccharides; Biopolymersand bioplastics, Beer brewing, cheese manufacture, mold–modifiedfoods, Wine, Vinegar. The fermentation process, procedure and equipments, Ideal bioreactors,Batch, fed batch, CSTR, PFR, Multiphase bioreactors, packed bed, bubble column fluidizedtrickle bed, immobilization. Aseptic, septic and anaerobic fermenters.

Unit VII: Microbes in Food and Agriculture: [7 Hrs]
Microbial Food Spoilage and Food PreservationFactors affecting the growth and survival of microorganisms in foods: Intrinsic,Extrinsic. Plant growth promoting Rhizobacteria, nitrogen fixation, phosphatemobilization and bio-control of plant pathogens, Mycorrhiza – Ectomycorrhiza, Endomycorrhiza , VAM structure &significance; Plant growth promoting hormones from microbes viz. bacteria and fungi &their significance; Nitrogen Fixing Microbes – Free living N2 fixing bacteria, symbiotic N2-fixers, Azolla, Cyanobacteria, Frankia.

Suggested books:

1. Barnett, H. L. and Hunter, B. B. 1960. Illustrated Genera of Imperfect Fungi.Burgess Publishing Co., Minnesota.
2. Breed and Buchanan. Bergey's Manual of Systematic Bacteriology. 2nd Edition, (Volumes. 1 – 5) (2001 – 2003).
3. Cook T. (2002) Microbial Biodiversity: Saving Bacteria to save ourselves, Harvard Science Review, 26-28.
4. Keller M. and Zengler K. (2004) Tapping in to Microbial Diversity. Nature Reviews 2, 141-150.
5. Pace N. (1997) A Molecular View of Microbial Diversity and the Biosphere, Science, 276, 734-740.
6. Principles of Fermentation Technology. Stanbury Pf, Whitaker A, Hall Sj. Elsevier India P Ltd.

DSC-27

MBIN 411: Biology Lab. VI (Biochemistry and microbiology) L0-T0-P3-CR3

Course outcome: [6 Hrs per week]
CO1: Ability to investigate, design and conduct experiments, analyze and interpret data, and apply the laboratory skills to solve complex bioprocess engineering problems.
CO2: Ability in solving problems typical of bio industries and research.
CO3: Ability to recognize and demonstrate the principles of laboratory instruments used in *biochemical experiments.*
CO4: Ability to perform biochemistry experiments.
CO5: Ability to interpret the results of biochemical experiments

Course content:

1. Comparative studies of Ethanol production using different substrates.
2. Microbial production and downstream processing of an enzyme, e.g. amylase.
3. Various immobilization techniques of cells/enzymes, use of alginate for cell immobilization.
4. Validation of the Beer- Lambert's Law using UV-Vis Spectrophotometer.
5. Determination of concentration of unknown protein using BSA standard curve.
6. Separation of proteins by column chromatography.
7. Separation of proteins by SDS-PAGE and of molecular mass determination.

Practical book

1. An introduction to practical biochemistry, 3rd edition by David T Plummer
2. Stanbury RF and Whitaker A., Principles of Fermentation Technology, Butterworth Heinemann, 2nd Edition 2008. 2. Baily JE and Ollis DF., Biochemical Engineering fundamentals, 2nd Edition, McGraw-Hill
3. Shuler ML and Kargi F., Bioprocess Engineering: Basic concepts, 2nd Edition, Pearson IN, 2015.
4. Pauline M Doran., Bioprocess Engineering Principles , 2nd Edition, Academic Press, 2016

DSE-5

MBIN 315: Research Methodology L2-T1-P0-CR3

Core Outcome

CO1: Ability to identify research problems, design experiments and carry out research
CO2: Ability to understand ethical concerns, research ethics and biosafety issues.
CO3: Ability to understand research articles and gain skills in technical writings.
CO4: Ability to use computation tools in their research area.

Course Content:

Unit I: Foundations of Research: [7 Hrs]
Meaning, Objectives, Motivation, Utility. Concept of theory, empiricism, deductive and inductive theory. Characteristics of scientific method – Understanding the language of research – Concept, Construct, Definition, Variable. Research Process.

Unit II: Methods of Research: [5 Hrs]
Survey, observation, case study, experimental, historical and comparative methods, Difficulties in Biological Research Literature review.

Unit III: Research problem and design: [7 Hrs]
Defining the research question, identification, selection, formulation of research objectives. Components and Importance, Documentation, presentation and analysis of data: Types of data, Data collection, Methods and tools of data collection, presentation of data, analysis and interpretation of data.

Unit IV: Hypothesis testing: [7 Hrs]
Normal and Binomial, Poisson distributions and their property. Tests of significance: Student t – test, F-test, Chi – square test Correlation and Regression ANOVA –One - way and Two - way, Multiple - range test.

Unit V:Ethics in research: **[5 Hrs]**
Research ethics, Pitfall, Plagiarism, Institutional ethical committee for human and animal research. IPR, Copy right, Cyber laws.

Unit VI: Use of research tools/techniques for research: [6 Hrs]
Search engines for research articles; reference management software; plagiarism detection software, statistical software. AI software.

Text Books:

1. Ranjit Kumar, Research methodology: A step by step guide for beginners, 2nd edition, SAGE Publications Ltd., 2005.
2. John W. Creswell, Research Design: Qualitative, Quantitative, and mixed methods approaches, 2nd edition, SAGE Publications, 2009.
3. Diane O. Fleming (Editor), Debra L. Hunt (Editor) Biological Safety: Principles and Practices, 4th Edition. ISBN: 978-1-683-67177-0 ASM Press

Reference Books:

1. PetterLaake, HaakonBreienBenestad and Bjorn Reino Olsen, Research Methodology in the Medical and Biological Sciences,1st edition, Academic Press, 2007.
2. https://www.who.int/publications/i/item/9789240011311

MBIN 415 Minor Project [For those opting for B.Sc. (Research)] L0-T0-P3-CR3

CO1: Ability to identify a research problem in diverse areas of Life Science
CO2: Ability to design research experiments to validate hypothesis
CO3: Ability to carry out problem based research activities

Detailes of Minor Projects to be carried out:

The students will select research areas provided by the faculty members of the department. The student will be allotted research areas in order of CGPA. At the end of the semester, the student has to submit dissertation report and defend the same by presentation. They will be evaluated by external examiner as well as faculty members of the department.

Semester VIII (Honours/Research)

DSC-28

MBIN 402: Economic Biology **L2-T1-P0-CR3**

Course outcome

CO1: Ability to understand culture techniques of prawn, pearl and fish, silkworms rearing and their products, Bee keeping and management, dairy animals management, and lac cultivation.
CO 2: Ability to understand the economic important of plants and plant parts, their habitat and conserve.
CO 3: *Ability for self-employment through aquaculture, diary, silk worm poultry and economically important plants*

Course content

Unit I: Aquaculture: [5 Hrs]
Fish farming; integrated Fish cum livestock farming; construction and management of Pond (Nursery, Rearing and Stocking Pond). Harvesting and preservation of fish; common fish diseases and control. Prawn culture (fresh water prawn; marine prawn) and management; Pearl Culture and management.

Unit II: Apiculture, Lac culture and Sericulture: [7 Hrs]
Principle and practices of bee keeping; properties and medicinal value of honey; diseases of bees and their control. Lac insect and its life cycle; cultivation of lac insect and host plants; processing and uses of lac. Silkworm and their host plant; different species of silkworm of Assam; rearing of silkworms; types of silk; diseases and their control.

Unit III: Dairy management and poultry farming: [7 Hrs]
Common dairy animals; milk and milk products; cattle diseases and control. Poultry birds: layers and broilers; hatching of eggs; poultry housing and equipment; diseases and control.

Unit IV: Cultivated Plants: [6 Hrs]
Domestication, evaluation, bioprospecting of crops; evolution of new crops/varieties; cereals (Wheat, Rice and millets); legumes and its importance to man and ecosystem; sugarcane and its by- products. Diseases of crop and control.

Unit V: Spices and Drug-yielding plants: [6 Hrs]
Economic importance of spices with special reference to fennel, saffron, clove and black pepper. Beverages: Tea, Coffee (morphology, processing). Drugs yielding plants with special reference to Cinchona, Digitalis, Papaver and Cannabis. Tobacco (Morphology, processing, uses and health hazards).

Unit VI: Oils & Fats: [4 Hrs]
extraction of oils; comparison of oils with fatty oils; uses and health implications of groundnut, coconut, linseed and Brassica.

Unit VII: Rubbers, Timbers and fibres: [5 Hrs]
Rubber yielding plants and their cultivation; rubber tapping, processing and uses. Timber plants with special reference to teak and pine. Fibers classification based on the origin; cotton and jute morphology, extraction and uses. (5 Lectures)

Textbooks:

1. A Textbook of Economic Zoology, Islam Aminul, (2002), Publisher: I K International Publishing House Pvt. Ltd ISBN: 9789384588809, 9789384588809

2. A Text Book of Economic Botany by V Verma, (2009)Anne Books Pvt Ltd, New Delhi

Reference Books

1. Textbook of applied Zoology, Jabde Pradip V (2005). Discovery Publishing House, New Delhi.
2. Economic Botany- A comprehensive study by S L Kochhar, Fifth Edition(2016), Cambridge University Press, UK
3. Economic Botany: Principles and Practices by G.E. Wickens (2012) Kluwer Academic Publishers, New York

DSE-29

MBIN 404: Biosafety and Bioethics **L2-T1-P0-CR3**

Course outcome

CO1: Ability to understand historical perspective of biosafety and its need
CO2: Ability to identify risk and manage
CO3: Ability to understand bioethics
CO4: Ability to understand bioethical issues related to Healthcare & medicine Food & agriculture Genetic engineering

Course content

Unit I: Introduction: [5 Hrs]
Historical Background; Definition of biosafety; Necessity for biosafety; Application of Biosafety.

Unit II: Hazards and Risk: [6 Hrs]
Definition and types of hazard: Chemical, Physical and biological; Hazard identification and management. Definition of risk; Risk assessment; Evaluation process in risk assessment; factors for assessing risk; risk group; risk management

Unit III: Biosafety levels: [6 Hrs]
Different levels of biosafety and practices; Safety equipment: Laminar flow hood; types of biological safety cabinets and its applications; good laboratory practices

Unit IV: Biowaste management: [6 Hrs]
Identification and segregation of waste; biohazard waste categories; Biowaste handling; methods of biowaste treatment and disposal. CBMWTF

Unit V:Biosafety guidelines and Regulation: **[7 Hrs]**
Definition of GMOs & LMOs; Roles of Institutional Biosafety Committee, RCGM, GEAC etc.; GMO applications in food and agriculture; Environmental release of GMOs; Overview of National Regulations and relevant International Agreements; Bio-Medical Waste (Management and Handling) Rules, 1998; Cartegana Protocol.

Unit VI. History of Bioethics: **[6 Hrs]**
Introduction to Morality, Ethics and Law. Philosophy and Historical Evolution of "Bioethics". Universal Principles of Bioethics. Clinical trial., Bioethics in health care - patient confidentiality, informed consent, euthanasia, artificial reproductive technologies, prenatal diagnosis, genetic screening, gene therapy, transplantation. Bioethics in research – cloning and stem cell research, Publication ethics

Unit VII Ethics in Biotechnological Research: **[8 Hrs]**
Human and animal experimentation, Basic philosophies of animal ethics, (3 'R's), Animal Ethics Committee. animal rights/welfare. Institutional Ethics Committees. Agricultural biotechnology - Genetically engineered food, environmental risk, labeling and public opinion. Sharing benefits for sustainable future - Protection of environment and biodiversity – biopiracy

Textbooks:

1. Sateesh MK (2010) Bioethics and Biosafety, I. K. International Pvt Ltd.
2. Sree Krishna V (2007) Bioethics and Biosafety in Biotechnology, New age international publishers

Suggested Readings

1. https://www.who.int/csr/resources/publications/biosafety/Biosafety7.pdf
2. https://dbtindia.gov.in/guidelines-biosafety

DSC-30

MBIN 406: Genetic Engineering **L2- T1-P0-CR3**

Course outcome
CO1: Ability to use techniques associated with engineering of animals and plants using molecular biology and genetic engineering.
CO2: Ability to express recombinant protein and characterize.
CO3: Ability to take up biotechnological research as well as placement in the relevant biotech industry.

Course content

Unit I: Introduction to genetic engineering: [4 Hrs]
Brief history and overall impact of genetic engineering in modern society.

Unit II: Tools for genetic engineering experiments: **[7 Hrs]**
Restriction endonucleases, restriction mapping, restriction-modification methylases; DNA and RNA ligase,DNA ligation using: cohesive-ended and blunt-ended DNA fragments; linkers, adaptors; homopolymeric tailing, nucleic acids modifying enzymes;. Methods for protein-DNA, protein-RNA and protein-protein interactions (co-immunoprecipitation, pull-down assay, mammalian two-hybrid and yeast-two hybrid assay).

Unit III: Nucleic acid hybridisation methods: **[5 Hrs]**
Radioactive and non-radioactive labelling of nucleic acids and proteins, southern, northern, western, south-western, far western, eastern, colony, fluorescence in situ hybridisation (FISH) and detection of chromosomal abnormalities.

Unit IV: Polymerase chain reaction and its application: **[7 Hrs]**
Principles of PCR: primer design; fidelity of thermostable DNA polymerases; types of PCR – multiplex, nested; reverse-transcription PCR, real time PCR, touchdown PCR, hot start PCR, colony PCR, asymmetric PCR; site-specific mutagenesis *in vitro* and *in vivo*; methods of mutation detection (SSCP, DGGE, RFLP). PCR in molecular diagnostics (viral and bacterial detection).

Unit V: **Molecular vectors**: Plasmids; Bacteriophages; **[6 Hrs]**
M13 vectors; pUC19 and Bluescript vectors, phagemids; Lambda vectors; Insertion and replacement vectors; Cosmids; Artificial chromosome vectors (YACs; BACs); Ti plasmid and Ri plasmid based vectors. Transformation, transduction and transfection methods.

Unit VI: DNA Libraries: **[4 Hrs]**
Construction of cDNA and genomic DNA libraries; library screening methods.

Unit VII: Overexpression of recombinant protein: **[5 Hrs]**
Expression vectors. Overexpression in bacteria system, Baculovirus, yeast and mammalian cells; Inclusion bodies formation and strategies to overcome; purification of recombinant proteins.

Unit VIII: Application of Genetic engineering: [6 Hrs]
Gene silencing techniques: siRNA and miRNA construction of shRNA vectors; methods to generate transgenic animals and plants; DNA and protein microarrays genome editing technologies; ZFNs, TALEN, Cre-Lox and CRISPR/Cas9) system): Gene therapy.

Textbooks
1. Old, R. W., Primrose, S. B., & Twyman, R. M. (2001). Principles of Gene Manipulation: an Introduction to Genetic Engineering. Oxford: Blackwell Scientific Publications.

Suggested Reading:
1. Green, M. R., & Sambrook, J. (2012). Molecular Cloning: a Laboratory Manual. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.
2. Brown, T. A. (2006). Genomes (3rd ed.). New York: Garland Science Pub. 4. Selected papers from scientific journals, particularly Nature & Science.
3. Technical Literature from Stratagene, Promega, Novagen, New England Biolab etc.

DSC-31

MBIN 408: Plant Biotechnology **L2-T1-P0- CR3**

Course outcome
CO1: Ability to manipulate plants using biotechnological tools.
CO2: Ability to use biotechnological intervention in plant for benefit of human being
CO3: Ability to conduct experiments like tissue culture, genetic transformation and molecular breeding of plants

Course content

Unit I: Plant tissue culture: [5 Hrs]
Historical perspective; totipotency; organogenesis; Somatic embryogenesis; tissue culture media-nutrients and plant hormones, sterilization techniques; initiation and maintenance of callus and suspension cultures; single cell clones, applications of tissue cultures micropropagation.

Unit II: **Somaclonal variation: [6 Hrs]**
Androgenesis and embryogenesis, their applications. Protoplast culture and somatic hybridization - isolation; culture and usage; somatic hybridization - methods and applications; cybrids and somatic cell genetics; plant cell cultures for secondary metabolite production. Synthetic seed production.

Unit III: **Genetic engineering: [7 Hrs]**
Agrobacterium-plant interaction; Ti and Ri plasmids: disarmed Ti plasmid, opines and their significance; Molecular mechanism of T-DNA transfer; Genetic transformation - *Agrobacterium*-mediated gene delivery; cointegrate and binary vectors and their utility; screenable and selectable markers; characterization of transgenic plants.

Unit V: Other methods of gene transfer into plants: [6 Hrs]
Direct gene transfer - PEG-mediated, electroporation, particle bombardment, alternative methods, chloroplast transformation; marker-free methodologies; advanced methodologies - cisgenesis, intragenesis and genome editing (ZFN, CRISPR/Cas, TALEN)

Unit VI: Application of transgenics: [6 Hrs]
Insect resistance, virus resistance, abiotic stress tolerance, longer shelf life (including strategies for suppression of endogenous genes), male sterility, enhanced nutrition (golden rice), edible vaccines, phytoremediation, synthetic biology- production of biochemicals for healthcare (Phytopharmaceuticals) and industry

Unit VII: Omics technologies: [7 Hrs]
Genomics, Transriptomics, Metablomics; genome sequencing strategies, Bioinformatics tools and genome annotation, forward and reverse genetic strategies; gene, promoter and enhancer traps for gene discovery, differential gene expression analysis- microarray and RNAseq. VIGS and RNAi.

Textbooks
1. Slater, A., Scott, N. W., & Fowler, M. R. (2008). *Plant Biotechnology: an Introduction to Genetic Engineering*. Oxford: Oxford University Press.
2. Slater, A., Scott, N. W., & Fowler, M. R. (2003). *Plant Biotechnology: The Genetic Manipulation of Plants*. Oxford: Oxford University Press.

Suggested Readings
1. Buchanan, B. B., Gruissem, W., & Jones, R. L. (2015). *Biochemistry & Molecular Biology of Plants*. Chichester, West Sussex: John Wiley & Sons.
2. Umesha, S. (2013). *Plant Biotechnology.* The Energy And Resources.

DSC-32

MBIN 410: Animal Biotechnology **L3-T0-P0- CR3**

Course outcome
CO1: Ability to manipulate animal using biotechnological tools
CO2: Ability to improve the quality and yield of animals using biotechnological interventions.
CO3: Ability to do experiments related to genetic transformation and molecular breeding of animals.

Course content

Unit-I: Animal Cell Culture: [7 Hrs]
Brief history of animal cell culture; Basic requirement for animal cell culture; Cell culture media, serum and reagents; Culture of mammalian cells; tissue and organs; Primary and secondary cell culture; Continuous cell lines; Suspension culture; Common cell culture contaminants; Application of animal cell culture for toxicity study and production of vaccines and pharmaceutical proteins; Stem cells and their application.

Unit-II: Animal Reproductive Biotechnology: [6 Hrs]
structure of sperms and ovum; cryopreservation of sperms and ova of livestock; artificial insemination; super ovulation, embryo recovery and in vitro fertilization; cryopreservation of embryos; embryo transfer technology.

Unit-III: Diagnostic methods: [6 Hrs]
Radio immunoassays; Immunoblotting; nucleic acid probe hybridization; PCR, Real time PCR; Nucleic acid sequencing; Molecular diagnostics of pathogen in animals.

Unit-IV: Vaccinology: [6 Hrs]
History of development of vaccines, introduction to the concept of vaccines, conventional methods of animal vaccine production, recombinant approaches to vaccine production, modern vaccines.

Unit-V: Animal genomics: [6 Hrs]
Different methods of characterization of animal genomes; SNP, STR, QTLs, RFLP, AFLP, RAPD; Genetic basis for disease resistance in animals; Gene knock out technology and Animal models for human genetic disorders.

Unit-VI: DNA forensics: [8 Hrs]
Immunological and nucleic acid based methods for identification of animal species; detection of adulteration in meat using DNA based methods; identification of wild animal species using DNA based methods using different parts including bones, hair, blood, skin and other parts of the confiscated by anti poaching agencies; Human forensics; bio-terror agents; Bio-crimes and Bio-terrorism.

Textbooks
1. Pörtner, R. (2007). Animal Cell Biotechnology: Methods and Protocols. Totowa, NJ: Humana Press.
2. Glick, B.R., & Pasternak, J.J. (2010). Molecular Biotechnology: Principles and Applications of Recombinant DNA. Washington, D.C.; ASM Press.

Suggested Readings
1. Pinkert, C. (2006). Transgenic Animal Technology, Academic Press.
2. Masters, John R.W. (2000). Animal Cell Culture – A Practical Approach, Oxford University Press.
3. Gordon, I. (2005). Reproductive Technologies in Farm Animals. Oxford. CAB International.

DSC-33

MBIN 412: Biology lab VII (Genetic Engineering) L0- T0- P3 CR3

Course outcome
CO1: *Ability to understand and perform advanced genetic engineering techniques.*
CO2*: Ability to design and perform experiments for amplifying DNA.*
CO3**:** *Ability to clone, express and purify recombinant proteins*

Course content: [6 Hrs per week]

1. Amplification of gene of interest by Polymerase Chain Reaction and analysis by agarose gel electrophoresis
2. Restriction digestion of insert and vector; Ligation of digested insert and vector

3. Confirmation of the insert by Colony PCR and Restriction mapping
4. Expression of recombinant protein, concept of soluble proteins and inclusion body formation in *E. coli*, SDS-PAGE analysis
5. Purification of His-Tagged protein on Ni-NTA columns

Practical Book:

1. Green, M. R., & Sambrook, J. (2012). Molecular Cloning: a Laboratory Manual. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.

DSE-6

MBIN 314: Computational Biology **L2-T1-P0-Cr3**

Course outcome

CO 1: Ability to use the knowledge of genomic, proteomic and metabolomics courses and their further applications
CO 2: Ability to apply different tools and techniques for sequence and structural analysis related to genome and proteome
CO 3: Ability to apply biophysical and computational tools for drug designing

Unit I: Data search and sequence Alignments: [6 Hrs]

BLAST, FASTA, Multiple sequence alignments (CLUSTALW and CLUSTALX), Aminoacid substitution matrix (BLOSUM, PAM), Nucleotide Substitution Patterns: Jukes Cantor Model, Kimura's model etc.

Unit II: **Phylogenetic Analysis: [6 Hrs]**

Phylogeny, Distance based methods and character based methods, Statistical approaches to Gene Prediction.

Unit III: Molecular modeling: [7 Hrs]

Protein structure prediction, *ab-initio*, Threading and Homology modeling, backbone construction and side chain addition; scoring method, model evaluation.

Unit IV: Methods for comparison of 3D structure of proteins: [6 Hrs]

Analysis and superimpose protein 3D structures, protein structure comparison.

Unit V: Docking of molecules: [8 Hrs]

Protein-ligand interactions,Drug designing, induced fit, Rigid and flexible docking,buried and exposed residues; *in silico* drug design; Virtual screening.

Unit VI: Molecular Mechanics: [8 Hrs]

Calculation of conformational energy for biomolecules, Molecular dynamics simulations and quantum mechanics, Energy minimization, Monte Carlo simulation.

Text books

1. Brown, T. A. *Genomes II* (2nd Edition, Wiley – Liss2002).
2. Primrose. *Principles of Genome Analysis and Genomics* (3rd Edition, Blackwell2003).
3. Baxevanis A. D *Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins*, (Wiley-Interscience.2001).