SYLLABUS FOR THE

(Revised on 07.07.2021)

M.Sc. in ZOOLOGY

Four-Semester Course

DEPARTMENT OF ZOOLOGY

SCHOOL OF LIFESCIENCES

RAVENSHAW UNIVERSITY

CUTTACK-753003, ODISHA

Course: PG (Semester-I)	Paper **Theory:** 40 marks end semester and 10 marks mid semester examination **Practicals:** 80 marks end semester and 20 marks mid semester examination	Marks
ZO-1.1.1	Microbiology	50
ZO-1.1.2	Molecular Cell Biology	50
ZO-1.1.3	Biochemistry	50
ZO-1.1.4	Animal Diversity (Non-Chordates & Chordates) &Animal Behaviour	50
ZO-1.1.5	Practical related to Theory	100
PG (Semester-II)		
ZO-1.2.1	Physiology & Endocrinology	50
ZO-1.2.2	Genetics	50
ZO-1.2.3	Molecular Biology	50
ZO-1.2.4	Instrumentation & Analytical Techniques	50
ZO-1.2.5	Practical related to Theory	100
PG (Semester-III)		
ZO-2.3.1	Ecology	50
ZO-2.3.2	Immunology & Cancer Biology	50
ZO-2.3.3	Developmental Biology & Animal Biotechnology	50
ZO-2.3.4	Taxonomy, Biosystematics & Paleozoology	50
ZO-2.3.5	Practical related to Theory	100
PG (Semester-IV)	**Theory:** 40 marks end semester and 10 marks mid semester examination Project (Dissertation & presentation) 100 marks	
Special Paper (A: Neural and Behavioral Biology)		
ZO-2.4.1 A	Anatomy of Nervous system	50
ZO-2.4.2 A	Developmental Neurobiology	50
ZO-2.4.3 A	Cellular Neurophysiology & Biophysics	50
ZO-2.4.4 A	Neurochemistry	50
ZO-2.4.5 A	Project (Dissertation & presentation)	100
Special Paper (B: Biochemistry & Molecular Biology)		
ZO-2.4.1 B	Proteomics & Enzyme Technology	50
ZO-2.4.2 B	Intermediary Metabolism & Metabolomics	50
ZO-2.4.3 B	Genomics	50

ZO-2.4.4 B	Cell Signalling, Apoptosis & Cancer	50
ZO-2.4.5 B	Project (Dissertation & presentation)	100
Special Paper (C: Aquatic Biology and Toxicology)		
ZO-2.4.1 C	Marine Biology	50
ZO-2.4.2 C	Estuaries and Coastal Zone Management	50
ZO-2.4.3 C	Freshwater Biology, Aquatic Microbiology and Marine Biotechnology	50
ZO-2.4.4 C	Environmental Toxicology and EIA	50
ZO-2.4.5 C	Project (Dissertation & presentation)	100

***Value and Add on courses is also offered by the Department.**

Course Code	Year	Course Name	Credit
VA-01	2021	Fermentation Technology for Food and Beverages	2
VA-02	2021	Aquaculture	2
VA-03	2021	Environmental Impact Assessment	2
AO-01	2021	Environmental monitoring and Disaster management	2
AO-02	2021	Fermentation Technology for Food and Beverages	2

SEMESTER - I

Paper ZO- 1.1.1: Microbiology

50 Marks (3 hours) (40 marks end semester and 10 marks mid semester examination)

Course Objective

- The course has been designed to give an overview on microbial world and their close association with human beings in our environment.
- The first unit describes about historic development of microbiology and its various methods of classification. It also explains on microbial growths and maintenance and their application in agriculture and industry.
- The second unit emphasizes on structure and cellular proliferation of archaea and bacteria. It also describes mechanism of pathogenicity in mycoplasma, and cyanobacteria.
- Similarly, the third unit has been elaborated for study on viruses, mechanism of their transmission and preventive measures by various anti-virals and vaccine. It also gives preliminary idea on viroid structure and nature of prions. The fourth unit has been kept for studies on microbial antibiotics and toxins. The study of antibiotics also include mode of their action in therapeutics approaches.

Course Outcome

- This course enables the learner to understand the role of microbes in environment. The study imparts sound knowledge of bacteria growth, propagation and importance in industrial application.
- The mechanism of virus transmission in human health can be interpreted for its control measure and therapy. Similarly, the synthesis of antibiotics from a microbe against other microbes towards defense could implants several innovations in antibiotic production in drug and food industry.

UNIT –I

History and development of microbiology, General features of Bergy's manual for classification of microbes, Whittakar's five kingdom concept, Carl Woese's 3 domain classification, Isolation, culture and maintenance of microorganisms, Microbial growth, continuous culture (chemostat), Factors influencing growth of microbes, Role of microbes in agriculture and industry.

UNIT -II

General features of Archaea, Structure, Nutrition and Reproduction of Eubacteria, Genetic recombination in bacteria (Transformation, Conjugation and Transduction), General features and pathogenecity of mycoplasma, Rickttsia and Spirochaetes.

UNIT-III

Virus: General characteristics and classification of viruses, nature , morphology and chemistry of virus, transmission of virus, virus-vector relationship, replication of Bacteriophage, Oncoviruses & HIV: structure, transmission, pathogenicity and replication, Treatment and prevention by anti-virals and vaccine, Viroids and Prions.

UNIT –IV

Microbial toxins: types, mode of actions and pathogenicity.

Bacterial toxins: Endo and exotoxins

Fungal toxins: ergot alkaloids, aflatoxins, ochratoxins, fumonisins, trichothecenes and zearalenone.

Antibiotics and their mode of action; Chemotherapeutic agents.

Paper ZO 1.1.2: Molecular Cell Biology

50 Marks (3 hours) (40 marks end semester and 10 marks mid semester examination)

Course Objectives

- Introducing the general concepts of cell theory, prokaryotic and eukaryotic cell constituents and their structural and functional differences.
- To understand the properties of genetic material & genome organization and aspects of cell division & cell cycle.
- To know the role of mitochondria in aerobes and how it in oxidative phosphorylation & ATP synthesis.
- To make the students' understanding on the mechanism of transportation across plasma membrane and cell organelles.

Course Outcomes

- Recalling the postulates of cell theory and molecular machineries of living cells.
- Deciphering the knowledge and understanding the mechanism of cell division and its regulation.
- Understanding the involvement of mitochondria in cellular respiration and energy production.
- Untangling the basic mechanism of macromolecular transportations in different cellular compartments and across plasma membrane.

UNIT –I

Cell Theory, Variability, Size, Shape, Complexity and functions. General organization of Prokaryotic and Eukaryotic cells

Plasma membrane: Composition and dynamics, membrane carbohydrates and their role in cell recognition.

Social context of cells: Cell junction, cell adhesion and extra-cellular matrix.

Cell motility: Cilia and flagella of prokaryotes and eukaryotes.

Cytoskeleton: Microtubules, intermediate filaments and microfilaments.

Cell Wall: Structure & functions, biogenesis, growth.

UNIT-II

Nucleus: Structure and function of nuclear envelope, nucleolus & Chromatin organization and its packaging role of nuclear matrix in chromosome organization and function, matrix binding proteins. Lampbrush chromosome, Polytene chromosome, telocentric chromosome, Inter-phase chromatin, Euchromatin and Heterochromatin, karyotype and its significance

Cell cycle: Molecular models and events. Regulators and checkpoints in cell cycle.

Molecular mechanisms of cell division: Mitosis (Behavior of chromosomes, formation of mitotic spindle, Sister chromatid separation), Cytokinesis (Role of mitotic spindle in determining cytoplasmic cleavage site), Meiosis: Events & mechanism

UNIT – III

Mitochondria: Structure, genome organization, Biogenesis, function, electron transport chain, oxidative phosphorylation & ATP synthesis.

UNIT – IV

Transport across cell membrane: Major types of membrane transport, Active transport, Co-transport, Symport, Antiport, Ion channels, Osmosis.

Macromolecular trafficking into and out of nucleus

Protein sorting: Transport of proteins into mitochondria and lysosomes.

Vesicular traffic: Coated and un-coated vesicles, Transport of secretory materials, Endocytosis.

Paper ZO-1.1.3: Biochemistry

50 Marks (3 hours) (40 marks end semester and 10 marks mid semester examination)

Course Objectives

- To understand the structural and molecular basis of macromolecules such as carbohydrates, proteins, lipids, nucleic acids and their level of organizations.
- To provide knowledge on three dimensional structure of proteins and their structural patterns like motifs and domains, Protein denaturation and folding.
- To make understand the students on different pathways involved in carbohydrate metabolism and regulatory mechanisms.
- To learn the kinetics and mechanism of enzyme action that make life processes happen at ambient conditions.
- To understand the structural composition of Nucleic acids, Lipids, Coenzymes, vitamins and their biological importance.

Course Outcomes

- Enabling the students to aware the composition, classification, features of macromolecules and their role in sustenance of life.

- Accumulating knowledge on various metabolic processes involved in synthesis and degradation of macrobiomolecules maintain homeostasis.

- Imparting knowledge on the mechanism of enzyme action, determination of Michaelis-Menten kinetics and Enzyme inhibition.

- Acquiring knowledge on composition of lipids, structural features of genetic material, biosynthesis of nucleic acid.

UNIT-I

Amino acids: Classification and properties, Acid–base properties, The Peptide bond, ionization behavior of peptides, biologically active peptides. Levels of protein structure: Determination of primary structure of protein. Three dimensional structure of proteins (Secondary, tertiary and quaternary structures, structural patterns: motifs and domains), Protein denaturation and folding.

Amino acid catabolism (transamination, oxidative deamination and urea cycle). Protein degradation (proteosomal pathway) and Solid phase synthesis of peptides.

UNIT - II

Carbohydrates: Classification, configuration and conformation of monosaccharides, sugar derivatives, important disaccharides. Structural and storage polysaccharides, glucosaminoglycans, proteoglycans, glycoproteins and glycolipids

Carbohydrate metabolism: Glycolysis, TCA cycle, pentose-phosphate pathway. Gluconeogenesis, glycogen metabolism, regulation of carbohydrate metabolism.

UNIT –III

Enzymes: General properties, nomenclature and classification, extraction and assay. Michaelis-Menten kinetics and its significance, Brigg's-Halden modification, determination of Vmax and Km. Mechanism of enzyme action: general acid-base catalysis, covalent catalysis, metal catalysis. Mechanism of action of RNAse, Lysozyme and Chymotrypsin. Enzyme inhibition: competitive, non-competitive inhibition, determination of Ki, allosteric regulation, covalent modification

UNIT – IV

Nucleic acids: Chemical composition and structure of Nucleic acids, DNA as genetic material, the double helix, denaturation & renaturation kinetics, DNA topology, A, B & Z DNA. Nucleic acid synthesis (de nove & salvage pathway).

Lipids: Classification, storage lipids, structural lipids (glycerophospholipid and sphingolipids), signaling lipids, cofactors, terpenes, and pigments.

Coenzymes and vitamins. Biosynthesis and oxidation of fatty acids, regulation of fatty acid metabolism.

Paper ZO-1.1.4 Animal Diversity (Non-Chordates & Chordates) & Animal Behavior

50 Marks (3 hours) (40 marks end semester and 10 marks mid semester examination)

Course Objectives

- The diversity, important physiological processes, emphasizing the attributes, functional anatomical structures associated with non-chordate & chordate taxa, will be studied.
- Understand and interpret general evolutionary relationships and their significance among animal groups.
- Learn and analyze behavior patterns, comprehend the physiology underlying behavioral expressions, and acquire knowledge regarding field and laboratory study of animal behavior.

Course Outcomes

- Evaluate the significance of specific structures and physiological life processes of taxa for survival in the context of its environment.
- Utilize information to understand interrelationships between taxa and defined mechanisms for survival.
- Demonstrate the ability to comprehend, gauge animal behavior in context.
- Be able to evaluate behavior with the tools and techniques learned.

UNIT-I (Animal diversity-I: Non-chordates)

Nutrition in protozoa - Types and mode of feeding, Protozoan parasites in brief (Trypanosoma, Plasmodium), Canal system in Sponges, Coral reef formation and significance, Polymorphism in Coelenterates, Excretory structures and functions in Annelids, Helminth parasites (Taenia, Ancylostoma), Vision In insects.

UNIT-II (Animal diversity-II: Non-chordates & Protochordates)

Torsion in Gastropoda, Nervous system in Cephalopods, Water vascular system in Echinoderms, Reproduction and development in Echinoderms with evolutionary significance, General characters & interrelationship of Proto-chordates and Siphon mechanism in Tunicates

UNIT-III (Animal diversity-III: Chordates)

General characters of Cyclostomes , Accessory respiratory organs in fishes, Origin of Amphibia, Adaptive radiation in reptiles, Classification of reptiles based on skull pattern, Flight adaptation in Birds General characters of Prototheria and Metatheria, Adaptive radiation in mammals

UNIT-IV (Animal behavior)

Classification & analysis of behavior patterns, Tools and Techniques in behavioural study, Neural & hormonal control of behavior , Communication in animals, Social organization of insects and mammals, Biological rhythms: Circadian, Parental care, Orientation & navigation: Migration of fish and bird

Reference Books

1. Invertebrate structure by Barrington & Nelson
2. Invertebrates by Pough
3. The invertebrates Vol I to VI by LH Hyman
4. Protozoology by R Kudo
5. A text book of zoology (vol-I & II) by TJ Parker & WA Haswell
6. Phylum Chordata by H Newman
7. The life of vertebrates by JZ Young
8. Biology of Animals. By Ganguly, BB., Sinha, A.K., Adhikari, S., New Central Book Agency, Kolkata
9. Invertebrate Zoology. By R D Barnes
10. The Invertebrates: Function and Form. By Sherman W and and Sherman VG
11. Animal Behavior by J Alcock
12. Principles of animal communications by JW Bradbury

Paper ZO – 1.1.5 PRACTICAL

100 marks (6 hours) (80 marks end semester and 20 marks mid semester examination)

1. Study of museum specimens and micro-slides from phylum protozoa to mammalia

Protozoa	Euglena, Plasmodium, Paramoecium,
Porifera	Sycon, Hyalonema, Euspongia
Coelenterata	Physalia, Gorgonia, Pennatula, Aurelia, Fungia
Platyhelminthes	Dugesia, Fasciola, Ascaris, Taenia
Annelida	Hirudinea, Sabella, Aphrodite, Nereis, Heteronereis, Arenicola, Trochophore larva
Arthropoda	Lepas, Sacculina, Eupagurus, Larval forms in Arthropoda, Leaf insect and Stick insect
Mollusca	Chiton, Dentalium, Larval forms in Mollusca, Sepia, Nautilus, Loligo
Echinodermata	Larval forms , Antedon, Asterias, Echinus, Sea cucumber
Hemichordata	Balanoglossus
Cephalochordata	Amphioxus
Urochordata	Salpa, Doliolum, Ascidea
Cyclostomata	Petromyzon , Myxine
Pisces	Lung fish, Torpedo, Trygon, Exocoetus, Echines,Eel, Clarias, Hippocampus
Amphibia	Hyla, Alytes, Ichthyophis, Axolotl Larva, Salamander, Necturus
Reptilia	Chelone, Varanus, Draco, Russel viper, Naja naja, Gavialis
Aves	Psittacula, Dinopium, Type of Beaks, claws and feet
Mammalia	Echidna, Macropus, Pteropus, Rattus, Squirrel

2. Mounting of mouth parts of mosquito-identification of genera

3. Study of mitosis and meiosis

4. Estimation of protein by Biuret/Folin-Lowry method.

5. Estimation of Carbohydrate by Anthrone method.

6. Estimation of lipid by Vanillin method.

7. Assay of Enzyme activity of alkaline phosphatase (Effect of temperature, Substrate, Concentration and time)

8. Determination of pK value of Glycine

9. Study tour and collection of specimens

SEMESTER -II

Paper ZO – 1.2.1 PHYSIOLOGY & ENDOCRINOLOGY

50 Marks (3 hours) (40 marks end semester and 10 marks mid semester examination)

Course Objectives

- Critical physiological processes of blood coagulation events, cardiac cycle and regulation, blood grouping systems; respiration; excretion, transmission of nerve impulse, muscle contraction, and structural organization of anatomical structures study.
- Understand anatomical attributes of different endocrine glands, hormones, functions, biosynthesis, interaction with target-cell receptors, signaling pathways, and control checkpoints.
- Learn and develop an understanding of vital life-sustaining physiological processes.

Course Outcomes

- Appraise the significance of anatomical structures and physiological events.
- Apply information to understand the functioning of organisms.
- Demonstrate the ability to appreciate the occurrence of physiological actions.
- Understand interrelationships of life processes.

UNIT-I

Composition of blood, RBC anatomy, RBC Breakdown cycle, Structure of haemoglobin, blood groups and mechanism of platelet plug formation and blood coagulation

The heart: cardiac cycle & its regulation, pulmonary ventilation, respiratory surface & gas exchange, regulation of respiration, transport of gases, acid-base balance

Excretory system: Urine formation, glomerular filtration, tubular function, renal

Mechanism of concentrating & diluting urine (selective reabsorption & secretion)

UNIT-II

General organization of central nervous system, Type of neuronal cells, Structure and function of neuron and glia, Types of ion channels, Action potential, Electrical and Synaptic transmission, Neurotransmitters & Neuropeptides, Neuromuscular Junction, Blood brain barrier

Ultra structure of muscles, Regulatory, Structural and Contractile proteins, mechanism of contraction in Skeletal, Smooth and Cardiac muscle

UNIT-III

Chemical messengers, Hormones & their feedback systems, Mechanism of hormone action (fixed membrane- and mobile receptor mechanisms), hormonal signaling

Pineal, Thymus & gastrointestinal hormones, Anatomy, chemistry and biological action of adenohypophysial & neurohypophysial hormones, Thyroid gland: Anatomy, biosynthesis & function of thyroid hormones, Parathyroid gland: Anatomy & function of parathyroid hormone

UNIT-IV

Endocrine pancreas: Anatomy, Biosynthesis, chemistry & functions of pancreatic hormones, Adrenal gland: Anatomy, biosynthesis, functions of cortical & medullary Hormones, Gonads: Anatomy and biological actions of gonadal hormones, hormonal regulation of uterine cycle, placental hormones.

Reference Books

1. Guyton's Physiology

2. Human physiology- Tortora

3. Endocrinology - Hadley

4. Endocrinology - Turner & Bagnora

5. Bentley, P. J. Comparative vertebrate endocrinology

6. Bern, H. A. Text book of comparative endocrinology

7. Colour Atlas of Physiology- Thieme

8.Harper's Illustrated Biochemistry(26th Edition)

Paper ZO-1.2.2: Genetics

50 Marks (3 hours) (40 marks end semester and 10 marks mid semester examination)

Course Objectives

- This paper is designed to give the basic principle of genetics, polygenic inheritance, maternal effects and cytoplasmic inheritance.

- To provide the mechanism of sex determination and maternal inheritance, meiotic behavior of chromosomes.

- To learn the process of DNA recombination, chromosomal mapping, role of polyploidy in evolution and crop improvement.

- To learn the process of DNA recombination, transposons and mutation.

Course Outcomes

- Explaining the fundamentals of Mendelian and non-Mendelian genetics, and interaction of genes. Polygenic inheritance, pleiotrophy
- Providing the knowledge to understand the process of linkage, crossing over, sex determination and role of extra-chromosomal inheritance.
- Obtaining knowledge on chromosomal aberration, cause and consequences of mutations.
- Understanding the application of Hardy-Weinberg's Law, and genetics of quantitative traits in population.

UNIT-I

Mendel's experiments and laws of inheritance, gene interaction with epistasis or modified mendelian dihybrid ratios: masking gene action, supplementary gene action, duplicate gene action, complementary gene action

Multiple allele in human (ABO blood group); eye colour in Drosophila, self -incompatibility in plants;

Polygenic inheritance, pleiotrophy

Maternal effects and cytoplasmic inheritance, mitochondrial genome

UNIT-II

Sex chromosomes, Chromosomal sex determination: XX-XY, XX-XO and ZZ-ZW systems, Compound sex chromosome,

Meiotic behavior of chromosomes: Primary & Secondary non-disjunction, Genic balance theory of sex determination, Sex determination in humans and Drosophila with special reference to SRY and sex lethal genes.

Sex linkage: Sex linked genes in man, sex chromosome disorders in man, Sex influenced dominance by sex-linked gene expression.

UNIT-III

Linkage groups: Complete and incomplete linkage

Crossing over: Relationship between genetic and cytological crossing over, Relationship between crossing over and chaisma formation, molecular mechanism of crossing over

Detection of linkage & Linkage maps: Test cross, test for linkage on the basis of F2 generation, LOD score, gene mapping, three point test cross in Drosophila, construction of linkage maps,

identification of particular linkage groups with specific chromosome, physical distance and map distance

Interference and coincidence

Mitotic Recombination, Recombination within gene

Unit-IV

Structural and numerical alterations in chromosomes: Spontaneous and induced mutations, physical and chemical mutagens, chromosomal aberrations, meiotic behavior of deletion, duplication, inversion and translocation.

Euploids and aneuploids-classification, origin, induction, role of polyploidy in evolution and practical significance in crop improvement

Population genetics: Hardy-Weinberg's Law, genetics of quantitative traits in population

Paper ZO-1.2.3: Molecular Biology

50 Marks (3 hours) (40 marks end semester and 10 marks mid semester examination)

Course Objectives

- Introducing the general concepts of Central dogma of molecular Biology.
- To learn the mechanism of DNA replication, transcription & translation in prokaryotes and eukaryotes, and their post-processing mechanisms & regulations.
- To understand the concepts, scopes and applications of genetic engineering in the fields of molecular biology and medical biotechnology.
- To study the concepts of DNA cloning, tools and techniques involved, host-vector relationships and various ways of cloning and screening of clones.

Course Outcomes

- Recollecting and understanding the basic phenomenon of flow of genetic information at molecular level as the basis of life-sustaining processes of living beings.
- Updating understanding on the process of DNA replication, transcription & translation and their post-processing regulatory mechanisms.
- Understanding the role of genetic engineering in molecular diagnostics and biomedical engineering.
- Applying the knowledge gained through the understanding of the mechanism of gene cloning and its practical applications.

UNIT –I

DNA replication: Replication in prokaryotes, replication fork, initiation, elongation, termination, Replication in eukaryotes, D-loop model of DNA replication, DNA replication in single stranded DNA, rolling circle replication,

DNA synthesis by reverse transcription

DNA Repair: mismatch repair, base excision, nucleotide excision, direct repair, SOS repair

UNIT –II

Prokaryotic transcription: Mechanism of transcription, Principle of gene regulation, The Operon concept, lac- & trp-operon. Processing of tRNA and rRNA

Eukaryotic transcription and regulation: RNA polymerases structure and assembly, Eukaryotic promoters and enhancers, General and specific transcription factors, transcriptional repressors, mechanism of transcription regulation, Transcriptional and post-transcriptional gene silencing.

Modifications in RNA: 5'-cap formation, transcription termination, 3'-end processing and polyadenylation, splicing, editing, synthesis and processing of non-coding RNAs.

UNIT –III

Prokaryotic and eukaryotic translation: The translation machinery, mechanism of initiation, elongation and termination

Co- and post-translational modifications of proteins

Cell Signaling: Signaling molecules and signal receptors, second messengers, G protein coupled receptors, activation of gene transcription by G protein coupled receptors.

UNIT –IV

Scope of Genetic engineering, Milestones in genetic engineering

Molecular tools: Enzymes (Nucleases, Restriction endonucleases, Phosphomonoesterase, Alkaline phosphatase, Polynucleotide kinase, DNA ligase, DNA polymerases, Reverse transcriptase, terminal deoxynucleotidyl transferase, Poly A polymerase), Hosts (E. coli, yeast, animal cells and Plant cells) and Vectors (Plasmids, Bacteriophages, Cosmids, Phagemids and artificial chromosomes).

Basics of DNA cloning: Various ways of cloning. Cloning into different vectors – plasmids,

phages, and phage-derived PACs, BACs and YACs, Selection and screening of clones.

Paper ZO-1.2.4: Instrumentation & Analytical Techniques

50 Marks (3 hours) (40 marks end semester and 10 marks mid semester examination)

Course Objectives

- To make the students aware about the basic principle, instrumentation and their applications of various instruments involved in the fields of biological sciences.

- To measurement of various biological parameters in living systems, need aware the students various useful techniques and their applications such as Microscopy, spectrophotometry, radioisotope techniques, centrifugation, chromatographic and electrophoretic techniques.

- To understand Blotting techniques such as Southern, northern and western blotting to analyze DNA, RNA and protein respectively.

- To deliver the statistical knowledge to the students that will be useful for analyzing the obtained biological data from different experiments.

Course Outcomes

- Enabling the students to know the importance of instrumentations for the measurement of various parameters of biological samples.

- Accumulating knowledge on working principle of various instruments using in the field of biological sciences.

- Imparting knowledge on blotting technique to analyze the expression of genes at transcription and translation level.

- Acquiring knowledge on statistical methods pertaining to measure the central tendency and dispersion, Probability distribution, Parametric and nonparametric statistics ANOVA, linear and non-linear regression and correlation.

UNIT –I

Principle of operation and Instrumentation of Light, Fluorescence and Electron Microscopes

Ultraviolet-visible absorption spectroscopy: Principle, Instrumentation and application,

Fluorescence spectrophotometry: Principle, Instrumentation and application

Radioisotope techniques: Nature of radioactivity, isotopes in biochemistry, measurement of radioactivity (carbon dating, Geiger-Muller counting and liquid scintillation counting).

UNIT –II

Principles of electrochemical techniques: Electrochemical cells and reactions, potentiometry and voltametry, the pH electrode

Centrifugation techniques: Basic principles of sedimentation, Types of centrifuges, Types of rotors, Methods in preparatory ultracentrifugation (differential and density gradient centrifugation).

Chromatographic techniques: Principles of chromatography (Adsorption and Partition chromatography), Planar chromatography (Paper and Thin-layer chromatography), Column chromatography (Gas chromatography, Gel exclusion/permeation chromatography, Ion exchange chromatography, Affinity chromatography, HPLC).

UNIT III

Electrophoretic techniques: General principles, support media, electrophoresis of proteins (SDS-PAGE, native gels, gradient gels, isoelectric focusing gels and two dimensional gels), electrophoresis of nucleic acids (Agarose, pulse-field and sequencing gels).

Blotting techniques (Southern, northern and western blotting)

Flow cytometry;basic principle and application

UNIT –IV

Statistical Methods: Sampling methods, sampling distribution, measures of central tendency and dispersion,

Probability distribution: normal, binominal and poisson distribution. Sample homogeneity and heterogeneity analysis by binomial and poisson distribution,

Parametric and nonparametric statistics: paired and unpaired t-test and $\chi 2$ test, analysis of variance: one factor and two factor ANOVA, linear and non-linear regression and correlation

PAPER ZO-1.2.5: PRACTICALS

100 Marks (6 hours) (80 marks end term and 20 marks mid term evaluation)

1. Estimation of DNA
2. Estimation of RNA
3. Separation of proteins, lipids & nucleic acids from tissues and their quantification
4. Isolation of genomic DNA from animal tissue/blood
5. Agarose gel electrophoresis of DNA
6. SDS PAGE (Demonstration)
7. Microscopy, Microtomy and Histological techniques.
8. Isolation of Mitochondria
9. WBC & RBC counting
10. Estimation of haemoglobin
11. Study of slides of endocrine glands
12. Preparation of karyotype and Pedigree analysis
13. Population genetics and Hardy-Weinberg Law (Blood group, Ear lobe and Tongue rolling experiment)

SEMESTER - III

PAPER ZO-2.3.1: Ecology

50 Marks (3 hours) (40 marks end semester and 10 marks mid semester examination)

Course Objectives

- The objective of the course is to acquaint the students with basic knowledge of the environment comprising of factors, population, communities and their interaction with the variables of the environment.
- The course will also provide the understanding of the sources and importance of different types of pollution and their impact on human health .
- The course will help students in understanding the chemical composition of the different matrices of the environment (air, water, soil) and the interaction between them.

Course Outcomes

- At the end of this course the student will be able to develop a theoretical /empirical model pooling all the components of the environment together.
- Define environment and describe the structure and significance of the spheres of the environment.
- Describe the important environmental issues pertaining to pollution, types of anthropogenic stressors and its preventive steps required to save the Earth.

UNIT-I

Abiotic and biotic components;

Primary and secondary production, methods of measuring productivity.

Energy flow: sources and pattern; food chain and food web in terrestrial and aquatic ecosystems

Biogeochemical cycles - Carbon, Nitrogen, Sulphur, Phosphorus.

UNIT-II

Community ecology: nature, structure and gradient analysis, structural analysis of plant and animal community

Niche and Random Niche model of species association

Species diversity in ecological gradient, Experimental and field test of diversity-stability Hypothesis, Ecotone and edge effect

Competition theory and coexistence

Succession - models of succession (monoclimax and polyclimax theories), Mechanism of succession in natural communities - facilitation, tolerance, and inhibition

Plant communities association

UNIT-III

Population ecology: Basic concept, population characters, biotic potential.

Kinetics of population growth, population growth curves, laws of population growth, regulation of population density, limiting factors of population growth, population fluctuation, r & k selection, Population interactions: positive and negative interactions, interspecific relationship

Population regulation: competitive exclusion, density dependent and independent regulation

UNIT-IV

Environmental pollution: Kinds and sources of pollutants, classification of pollutants, Soil pollutants: sources, types, and effects.

Water & Air pollutants: fates and effects, Global climate change, green house effect, ozone depletion- causes and effects. Bioremediation.

ZO-2.3.2 IMMUNOLOGY AND CANCER BIOLOGY

50 Marks (3 hours) (40 marks end semester and 10 marks mid semester examination)

Course Objectives

- The students will be introduced to the basic concepts of immunology as it relates to human health.
- Elucidate the functioning of the immune system, antigen behaviour, immunoglobulin's structure and diversity.
- Have understanding of the molecular mechanisms of innate and adaptive immunity, complement system, MHC, antigen presentation and other cell-mediated effector responses mechanism.
- Understand the nature and functioning of cancer cells, significance of apoptosis associated with cancer and normal cells.

Course Outcomes

- At the end of the course, students will be able to understand how the immune system helps our body in fighting against various pathogens .
- Develop basic understanding of all pathways involved in the defence mechanism (Non-specific, MHC, Complement etc)
- Learn about apoptosis, protooncogenes and tumour suppressor genes.
- Able to define and differentiate between normal and cancerous cells.

UNIT I

Phylogeny of Immune system, Innate and acquired Immunity, Haematopoiesis and differentiation, Cells of the Immune system- B lymphocytes, T-lymphocytes, Macrophages, Dendritic cells, Natural Killer cells, Eosinophils, Neutrophils and mast cells , Organization and Structure of Lymphoid Organs,MALT, CALT, NALT, BALT,Nature and Biology of antigens and super antigens, Structure and function of antibody molecule, Antigen – Antibody interaction (Antibody affinity, Radial and Double immunodiffusion, Radioimmunoassay, ELISA- Indirect, Direct, Sandwich, ELISPOT, Competitive, Western blotting)

UNIT-II

Major histocompatibility complex and MHC restriction, Antigen Processing and Presentation, Generation of humoral and cell mediated immune response, BCR and TCR, generation of diversity, Complement system(Classical, Alternate and lectin pathway), Cytokines- Types and their role in immune regulation

UNIT-III

Activation and regulation of B and T lymphocytes, Cell-mediated cytotoxicity and Antibody dependent cell mediated cytotoxicity, Hypersensitivity, Autoimmunity and Transplantation, vaccines, monoclonal antibodies: production and application

UNIT-IV

Biology of cancer cell, Genetic basis of cancer-I: Proto-oncogenes, Viral and cellular oncogenes, Genetic basis of cancer-II: Tumor suppressor genes from humans: structure, function and mechanism of action of pRB and p53 tumor suppressor proteins, Role of carcinogens and DNA repair in cancer

1. Kuby's Immunology, 5th edition, By R. A. Goldsby et al.
2. Clinical Immunology By Brostoff, Seaddin, Male and Roitt
3. Fundamentals of immunology By William Paul.
4. Immunology by Janeway
5. Principles of Immunology by N.V. Shastri, Himalaya Publishing House
6. Cellular and Molecular Immunology- Abul Abbas and Andrew Lichtman
7. Immunology-Weir

ZO-2.3.3 DEVELOPMENTAL BIOLOGY AND ANIMAL BIOTECHNOLOGY

50 Marks (3 hours) (40 marks end semester and 10 marks mid semester examination)

Course Objectives

- To study the doctrines early theories of Developmental biology, and understanding the pattern of growth, development and differentiation following standard model organisms.
- To know the basic concept and processes of gametogenesis, mechanism of fertilization, types of eggs and the patterns of cleavage.
- To understand the process of morphogenesis, organizer concept, mechanism of regeneration, apoptosis and aging.
- To demonstrate in vitro fertilization, embryo transfer and embryo sexing techniques and their applications in developmental biology and animal husbandry.
- To reveal the role of embryonic stem cell in development, genetic errors of human development, inborn errors of nuclear RNA processing and inborn errors of translation and impact of teratogens on development.
- To know the basic animal cell culture technique and its maintenance, design and layout of culture room, Sterilization, cryopreservation cultured cells.

Course Outcomes

- Introducing the importance of model organisms for the study of developmental biology and understanding the process of gametogenesis, fertilization, cleavage patterns etc.
- Obtaining the knowledge on the process of regeneration, apoptosis and aging.
- Revealing the techniques of in vitro fertilization and medical applications.
- Studying the causes and consequences of genetic errors of human development, inborn errors at transcriptional and translational levels and impact of teratogens on embryonic development.
- Illuminating students mind on the basics animal cell culture techniques and its maintenance and applications

UNIT-I

Introduction to developmental biology: Early theories of Developmental biology Concepts of Developmental biology – Growth, cell division, cell differentiation, cell communication, signalling, patterning, induction and competence.

Model Organisms: Invertebrate: Drosophila melanogaster, Pisces: Zebra Fish- Danio rerio, Amphibians: Xenopus laevis, Birds: Chicken, Mammals: Mouse.

Gametogenesis: Spermatogenesis: spermatogenesis, structure of sperm, regulation of sperm motility, Oogenesis: structure of ovum, previtellogenesis, vitellogenesis and post-vitellogenesis

Fertilization: Concept of fertilization, types of fertilization, Species specific sperm attraction, recognition of egg & sperm, acrosome reaction, signal transduction, molecular strategy to avoid polyspermy in fertilization

Types of eggs & cleavage: Based on amount of distribution of yolk, Cleavage: types and significance.

UNIT-II

Morphogenesis: Blastulation: Amphiouxus, Frog, Chick, Mid Blastula Transition, Comparative study of Gastrulation in Amphioxus, Frog, Chick Neurulation: Frog, Chick Organogenesis: Development of the vertebrate eye –formation of eye field, cell differentiation

Pattern formation: Setting up the body axis (Animal vegetal axis: Amphibians; Dorsal ventral axis: Amphibians, and Antero-posterior axis: Drosophila-role of bicoidnanos hunchback).

Organizers: Spemann and Mangold: Primary embryonic induction, Functions of organizer, Molecular mechanisms of Amphibian axis formation

Regeneration: Limb regeneration: Salamander, Regeneration in Hydra

Apoptosis, aging and senescence.

Application of developmental biology in medicine and animal husbandry: In vitro fertilization and embryo transfer, embryo sexing

UNIT-III

Embryonic stem cells, stem cell niche, their role in development, Genetic errors of human development: Nature of human syndromes- Pleiotropy, genetic heterogeneity, phenotypic variability, mechanism of dominance, Gene expression and human disease: Inborn errors of nuclear RNA processing, inborn errors of translation, Teratogenesis: Environmental assaults on human development, teratogenic agents like alcohol, retinoic acid etc

UNIT – IV

Equipments and materials for animal cell culture: Design and layout of culture room, Basic equipments used in cell culture, Sterilization and aseptic techniques, Culture media (Composition) : Natural media, Synthetic media, Nutritional compounds of media, Role of serum in cell culture, Primary culture and its maintenance: Various techniques of tissue disaggregation, Monolayer and suspension cultures, Growth curve, Culture of Cell lines, LSE culture, Scaling up of cultured cells: Anchorage dependent cell culture, Suspension culture and Cryopreservation

1. Developmental biology by Gilbert

2. Introduction to embryology by Balinsky

3. Fertilization FT Longo

4. Culture of animal cells by R.I. Freshney

5. Tissue Culture – Methods and Applications by Paul F. Kruse Jr. and M. K. Patterson Jr.

6. Cell Culture Lab Fax by Butler and Dawson.

7. Cell and Tissue culture: Laboratory procedures by Doyle and Griffiths

8. Basic Cell Culture by J.M. Davis

ZO-2.3.4 TAXONOMY, BIOSYSTEMATICS AND PALEOZOOLOGY

50 Marks (3 hours) (40 marks end semester and 10 marks mid semester examination)

Course Objectives

- Emphasize importance of the subject and its varied applications.
- Learn basic concepts of Biosystematics and Taxonomy and theories of biological classification, species formation, taxonomic hierarchies.
- Learn and develop an understanding of taxonomic procedures, identification, ICZN rules, nomenclature, taxonomic publication types and manuscript preparation.
- Acquire new skills of modern taxonomy.
- Learn the process of fossilization, and gain insights into fossil taxa and their evolutionary significance.

Course Outcomes

- Consider the significance of the science of taxonomy and Biosystematics
- Apply information to study and understand biodiversity.
- Demonstrate the ability to name organisms scientifically.
- Gain basic knowledge of procedures to conduct faunal studies.

UNIT-I

Definition and basic concepts of Biosystematics and Taxonomy, Historical resume of

Systematics, Importance & Applications of biosystematics in biology, Different attributes of biosystematics, Dimensions of speciation and taxonomic characters, Species concept (species category-Polytypic species, Population systematics and other Infraspecific categories), Theories of biological classification and Hierarchy categories

UNIT-II

Procedure keys in taxonomy, Taxonomic procedures: Taxonomic collections, preservation, curetting, process of identification, International code of Zoological Nomenclature (ICZN): Its operative principles, interpretation and application of important rules, Zoological nomenclature, Formation of scientific names of various taxa,

Taxonomic publications: Strategy, Documentation, Kinds of Publication, Major features and Preparation of manuscript for publication

UNIT III

Evaluation of biodiversity indices: Shannon-Winner Index, Dominance Index, Similarity & Dissimilarity Index

Traditional taxonomy and newer trends in systematics

Chemo and sero taxonomy, Cytotaxonomy, Numerical taxonomy, Cladistics, Molecular systematic and DNA bar coding

UNIT-IV

Paleontology: Fossils and their significance; modes of fossilization , Study of morphology, range and broad classification of major invertebrate phyla viz. coelenterata, brachiopoda, mollusca, arthropoda (trilobite) and echinodermata (echinoidea), Introduction to micro fossils, Introduction to Paleobotany, Evolution and classification of vertebrates, Origin of Jaws (Class Placodermi: Armour-Plated Monsters, Class Chondrichthyes: The First Sharks, Class Acanthodii The Spiny Skins), Archaeopteryx, Flightless Birds: Division Palaeognathae, Ice Age Extinction of Large Mammals

Recommended Books

1. Invertebrate Fossils by Moore, R.C., Lalicker, C.G. & Fischer, A.G., 1952, McGraw Hill.

2. Principles of Paleontology by Raup, D.M. & Stanley, S.M., 1985, W.H. Freeman & Co.

3. Vertebrate Paleontology by Romer, A.S., 1966, University Chicago Press

4. Principle of Animal Taxonomy; G.G. Simpson. Oxford IBH Publishing Company.

5. Elements of Taxonomy. E. Mayer.

6. The diversity of life (The College Edition), E.O.Wilson. W.W. Northern & co.

7. Theory and Practice of Animal Taxonomy. V.C. Kapoor. Oxford & IBH Publishing Co. Pvt. LTD.

8. Advancement in Invertebrate Taxonomy and Biodiversity. Rajeev Gupta. Agrobios International.

9. Principles of animal taxonomy by GG Simpson

PRACTICALS ZO-2.3.5

100 marks (6 hours) (80 marks end semester and 20 marks mid semester examination)

1. Antigen-Antibody interaction: Blood grouping

2. Preparation of Blood smear for Differential count and type of leucocytes

3. Study of Lymphoid organs

4. Study of life cycle of different anurans

5. Effect of thyroxin on amphibian development

6. Whole mount preparation of chick embryos

7. Study of Frog development through prepared slides

7. Sterilization & Preparation of media (liquid & solid)

8. Study of Fossils

9. Estimation of Dissolved oxygen content of water

10. Estimation of alkalinity of water samples

11. Estimation of Total hardness.

12. Estimation of primary productivity

13. Collection and preservation of water sample for qualitative and quantitative analysis of Plankton.

15. Diversity indices

SEMESTER - IV

Special paper/ Elective

ELECTIVE-I: Neural and Behavioral Biology (A)

ZO 2.4.1 Anatomy of Nervous system – 4 credits

50 Marks (40 marks end semester and 10 marks mid semester examination)

Course Objectives

- Introducing the students about the structure, function and types of neurons.
- Enable the learner to understand the central nervous system at cellular and molecular level, gross anatomy of adult brain and to reveal the principles of synaptic transmission.
- To develop the depth knowledge on the neural circuits, basis of synaptic actions, sensory and motor pathways.
- Give an understanding on the functional operation of auditory, visual olfactory and limbic system.

Course Outcomes

- Providing Broad and deep understanding on central and peripheral nervous system and their functioning.
- Familiarize the students with gross anatomy of adult brain and to reveal the principles of synaptic transmission.
- Impart knowledge and understanding on Classification of cranial and spinal nerve components.
- Broad and deep understanding on different regions of brain and their functional anatomy.

UNIT I

Neurons

Introduction to neurons; The Neuron Doctrine; Components of neurons; Classification of neurons; The Nissl and Golgi stains; Types of neurons; Cytology of neurons; Dendrites structure and function; Axons structure and functional aspects; Ultrastructure; Myelination and synapses.

Glial cells

Structure and function of glial cells; Different types of glial cells: astrocytes, oligodendrocytes and Schwann cells; Types of astrocytes – type I & II astrocytes, fibrous and protoplasmic astrocytes; Function of other glial cells: oligodendrocyte and microglial cells; Overview of glial and neuronal relationship in the CNS; Importance of astrocytes in glutamate metabolism and blood brain barrier; Microglial phenotypes; Glial –neuronal interplay in the CNS.

UNIT II

Constitutions of CNS: Overview

Gross anatomy of the adult brain; Organization of the nervous system; Subdivisions of the nervous system; Concept of CNS, ANS & PNS; The scalp, skull and meninges; Cerebrospinal fluid, Neuronal elements, basic circuit, synaptic action, dendritic properties and functional operation of: Peripheral nervous system: General organization: nerves, roots and ganglia; sensory endings; Spinal cord: Gross anatomy, internal structure, tracts of the ascending and descending fibers, spinal reflexes; Brainstem: Medulla oblongata, pons, fourth ventricle, midbrain, nuclei and tracts, reticular formation

UNIT III

Cranial nerves: Functional aspects, Classification of cranial and spinal nerve components

Neuronal elements, basic circuit, synaptic action, dendritic properties and functional operation of: Thalamus: Scheme of thalamic organization, nuclei of the thalamus; Basal ganglia: Corpus striatum, subthalamic nucleus, substantia nigra; Ascending sensory pathways

UNIT IV

Neuronal elements, basic circuit, synaptic action, dendritic properties and functional operation of Cerebellum: Gross anatomy, cerebellar cortex, central nuclei, cerebellar peduncles; Functional anatomy of cerebellum; Cerebral cortex: Histology, general organization, functional localization; Descending motor pathways

Neuronal elements, basic circuit, synaptic action, dendritic properties and functional operation of: Auditory system; Visual system; Olfactory and Limbic system; Autonomic system

ZO 2.4.2 Developmental Neurobiology - 4 Credits

50 Marks (40 marks end semester and 10 marks mid semester examination)

Course Objectives

- To understand the organizer concept, early neural morphogenesis in vertebrates and invertebrates and molecular nature of the neural induction.
- To acquire knowledge on the mechanism of cell movement, migration of neurons, neurogenesis in post-embryonic and adult age.
- To learn the mechanism of programmed cell death, target dependent and innervation dependent neuronal death.
- To understand the embryonic organizer, inductions, differentiation and regeneration in lower vertebrates and mammalian nervous system.

Course Outcomes

- Providing deep understanding of Vertebrate neural induction and molecular basis of morphogenesis.
- Understand the mechanism of cell migration, neuronal migration and neurogenesis during development.
- To impart knowledge and understanding on embryonic development, differentiation and regeneration.

UNIT I

Major events in early embryonic development: Role of nucleus and cytoplasm, cleavage, formation of blastula and gastrula; Embryonic origin of nervous system; Early neural morphogenesis in vertebrates and invertebrates; Compensatory phenomenon in embryonic forms; Neural Induction: The organizer concept; Molecular nature of the Neural inducer; Conservation of neural induction; Dorsal neural tube and neural crest; Neural crest cells and its derivatives.

UNIT II

Patterning; Polarity and regionalization of the nervous system: The anterior-posterior axis and Hox genes; Forebrain development; prosomeres and Pax genes; Patterning; Polarity and regionalization of the nervous system: Dorsal-ventral polarity in the neural tube; Neuronal determination and differentiation: Fate mapping of cell determination, Differentiation of nerve cells and cell lineage; Acquisition of neurotransmitter property and electrical excitability; Neurotrophic factors: Nerve growth factor (NGF), biological system of NGF; Agents analogous to NGF in functions; Role of NGF as trophic agents; Survival factors

UNIT III

Birth and migration of neurons; Mechanism of cell movement; Migration of neurons in PNS and CNS; Control of neuronal and glial cell population; Histogenesis of cerebral cortex and cerebellar cortex Neurogenesis in post-embryonic and adult age; Neuronal death during development: Programmed cell death, target dependent and innervation dependent neuronal death

Axon growth, path finding and nerve patterns: Axonal navigation, cell adhesion molecules; Factors influencing axon guidance; Target recognition; Synapse formation and elimination: Initiation of synaptic contacts, structure and function of newly formed synapses; Presynaptic and postsynaptic elements, target selection and synapse elimination; Selective synaptic connections: Skeletal muscle, autonomic ganglia, spinal cord and CNS

UNIT IV

Rearrangement of developing neuronal connections: Synaptic rearrangement in different parts of the nervous system; Refinement of synaptic connections; Maintenance of synapses; Denervation and regeneration of synaptic connections; Effects of Denervation on the postsynaptic cell; Denervation super-sensitivity, susceptibility to innervation, and axonal sprouting; Regeneration in lower vertebrates and mammalian nervous system.

ZO 2.4.3 Cellular Neurophysiology and Biophysics - 4 Credits

50 Marks (40 marks end semester and 10 marks mid semester examination)

Course Objectives

- This paper is aimed to introduce the students about the electrical properties of excitable membranes, chemical and electrical Signaling within a circuit, Methods to Record electrical activity of a **neuron**.
- To be familiar with the voltage-clamp experiments, biophysical, biochemical and molecular properties of voltage gated channels.
- To develop the depth knowledge on electrical and chemical synapses, control of transmitter release, synthesis and trafficking of neuronal proteins.

Course Outcomes

- Acquainting the students on electrophysiology and mechanism of synaptic transmission.
- Providing the experimental basis of Hodgkin & Huxley's analysis on squid giant axon.
- Impart knowledge and understanding on the regulation of transmitter release, synthesis and trafficking of neuronal proteins.

UNIT I

Electrical properties of excitable membranes: Basic electricity and electric circuits; Neurons as conductors of electricity; Equivalent circuit representation; Electrical properties of excitable

membranes: Membrane conductance, linear and nonlinear membrane, ionic conductance, current-voltage relations; Ion movement

in excitable cells: Physical laws, Nernst-Planck Equation, active transport of ions, movement of ions across biological membranes; Membrane potential and role of sodium and potassium pumps

UNIT II

Neural Signals

Overview of Neurons, Synapses and Networks

Stimulus à Sensory Perception à Motor Action / Higher Brain Function

Chemical and Electrical Signaling Within a Circuit; Methods to Record Electrical Activity of a Neuron.

UNIT III

Action potential; Non-gated ion channels and generation of action potential; Electrical properties of neurons, quantitative models of simulations; Hodgkin & Huxley's analysis of squid giant axon: Voltage-clamp experiments; Voltage gated channels; Biophysical, biochemical and molecular properties of voltage gated channels.

UNIT IV

Synaptic vesicles; Principles of synaptic transmission: Electrical and chemical synapses; Calcium hypothesis: Control of transmitter release; Synthesis and trafficking of neuronal proteins.

Synaptic transmission at nerve-muscle synapses; Synaptic transmission at central synapses; Ligand gated channels; Second messengers and synaptic transmission.

ZO-2.4.4 Neurochemistry - 4 Credits

50 Marks (40 marks end semester and 10 marks mid semester examination)

Course Objectives

- To understand the organizer concept, mechanism of release of synaptic vesicles and classification of neurotransmitters and neurotransmitter receptors, Determination of affinity and binding capacity of receptor.

- To acquire knowledge on the role of neuropeptides, Cholinergic and dopaminergic neurons and their role in Alzheimer's disease and Parkinson's disease.

- To learn the mechanism of autonomic controls of homeostasis, hierarchically organized CNS circuits, chemical control of brain and behaviour

Course Outcomes

- Providing broad and deep understanding on chemical and molecular basis of neurotransmitters and neurotransmitter receptors and mechanism of synaptic transmission.
- Familiarize the students with voltage dependent calcium channel and their blockers, drug effects on synapse and channelopathies.
- Impart knowledge and understanding on Organizational Principles of the Adult Hypothalamus, ANS in regulation of brain and behaviour.

UNIT I

Synaptic Transmission

Electrical and chemical synapses; Structure and their properties; Transmission; Synaptic vesicles; Vesicle release mechanism; EPSP and IPSP; Temporal and spatial summation; Presynaptic modulation; Voltage dependent calcium channel and their blockers; Drug effects on synapse, Channelopathies; Classification of neurotransmitters and neurotransmitter receptors; Receptor binding assays; Determination of affinity and binding capacity of receptor; Scatchard plot; Receptor agonists and antagonists.

UNIT II

Acetylcholine

History; Neuromuscular transmission; End plate potential; Nicotinic and muscarinic acetylcholine receptors and their classification; Structure; Agonist and antagonists; Clinical chemistry; NMJ diseases; anti-ChE agents and their applications; Cholinergic projections in the brain; Cholinergic neurons and Alzheimer's disease.

UNIT III

Amino acid neurotransmitters

Excitatory and inhibitory neurotransmitters: GABA glycine and glutamate and their receptors, GABA receptor agonists and antagonists, AMPA, Kainate and NMDA receptors; Glutamate mediated synaptic transmission; Glutamate excitotoxicity; NMDA receptor and LTP; Neurolathyrism.

Catecholamines, Opiate and Peptide Neurotransmitters

Dopamine receptors structure; Function; Agonist and antagonists; Dopaminergic pathways; Dopamine transporters; MPTP; Parkinson's disease; Schizophrenia; Amphetamine cocaine and their mode of action;

Opiate and their receptors; Agonist and antagonists; Drug addiction tolerance and withdrawal; Morphine and pain relief; Neuropeptides: precursors' structure, common features, synthesis, processing and regulation; Catecholamines and serotonin: structures, classifications and their receptors.

UNIT IV

Chemical Control of Brain and Behaviour

Organizational Principles of the Adult Hypothalamus; Role of hypothalamus and pituitary hormones; Diffuse modulatory systems of the brain: Locus coeruleus, rafe nucleus, substantia nigra, etc.; ANS in regulation of brain and bahaviour; ANS Pharmacology- Transmitter and Receptor Coding; Autonomic Controls of Homeostasis; Hierarchically Organized CNS Circuits

References:

Fundamental Neuroscience by Zigmond

Principles of Neural Science by Kandel

Fundamental Neuroscience by Squire

ZO 2.4.5 Project : 100 Marks (Dissertation & presentation)

ELECTIVE-II: Biochemistry & Molecular Biology (B)

Paper 2.4.1 PROTEOMICS & ENZYME TECHNOLOGY

50 Marks (40 marks end semester and 10 marks mid semester examination)

Course Objectives

- To teach the students about the basic Chemical foundation, reactivity, bonding, configuration and conformation and steriospecificity of biomolecules.
- To aware the students about laws of thermodynamics and chemical equilibrium, pH and buffers, Blood buffering system. Interactions in aqueous solution
- To understand Purifications, characterization and determination of Primary structure of proteins,
- To deliver in-depth knowledge on protein & enzyme engineering and their applications.
- To learn industrial and medical applications of enzymes, immobilized enzymes based bioreactors and its applications.

Course Outcomes

- Enabling the students to know the importance of chemical basis of life dealing with chemical reactivity, buffers and buffering system.
- Understanding involvement of entropy, enthalpy and free energy, standard free energy and chemical equilibrium in biological system,

- Accumulating knowledge on site-directed mutagenesis and protein engineering to produce recombinant proteins, applications of artificial abzymes, DNAzymes and ribozymes.
- Acquiring knowledge on electro-catalysis enzymes, applications of enzymes in detergent industry, food processing and medical applications.

UNIT-I (Chemical foundations)

Chemical basis of life: Chemical composition and bonding, three dimensional structure (configuration and conformation, Isomerism and steriospecificity), Chemical Reactivity: Oxidation-reduction reactions, Nucleophilic substitution, Internal rearrangements, Group transfer reactions, Condensation.

Water: Structure of water, water as a solvent, ionization of water, Weak Interactions inaqueous solution (Dipole movement, van der Waal's, ionic and hydrophobic interactions,Hydrogen bonding). Weak acids and bases, pH and buffers, Blood buffering system.

Bioenergetics: Laws of Thermodynamics, entropy, enthalpy and free energy, standard free energy, chemical equilibrium. Phosphoryl group transfer and ATP.

UNIT – II (Protein chemistry)

Purifications & characterization of proteins: Objective and strategy, Choice of source, Methods of homogenization, Methods of separation: Basis of solubility (pH treatment; Salting in & salting out; Changing dielectric constant; Heat treatment). Basis of size and mass (Centrifugation; Dialysis; Ultrafiltration; Gel filtration), Basis of charge/polarity (Ionexchange chromatography; iso-electric focusing; Electrophoresis; hydrophobic chromoatography) Basis of specific binding (Affinity binding; Affinity elution; Dye-ligand binding; Immunoadsorption, Covalent binding), Crystallization, Evaluation of purification, Recovery and fold of purification, Homogeneity of the purified protein (Native and denaturing electrophoresis; Isoelectrofocussing; Ultracentrifugation), Selection of purification methods.

Determination of Primary structure: Amino acid composition, N- & C- terminal determination, Amino acid sequence determination, assignment of disulfide bonds.

Forces and interactions involved in structural organization of fibrous and globular proteins, Prediction of higher order structure from the amino acid sequences, Structure-function relationship.

Protein denaturation, Molecular chaperones and protein folding

UNIT-III (Protein and Enzyme Engineering)

Site-directed Mutagenesis and protein engineering

Processing of recombinant proteins: Purification, refolding & characterization of recombinant proteins, Stabilization of proteins.

Abzymes or catalytic antibodies: Naturally occurring abzymes in normal and pathological states, there physiological role and mechanism of action, artificial abzymes and their application

Ribozymes: Discovery, Types, Structure, mechanism of action and applications of ribozyme technology, Basic idea about DNAzymes and aptazymes and their application potentials

UNIT – IV (Enzyme technology)

Problems with the use of enzymes in solution and objectives of immobilization, Methods of enzyme immobilization: Adsorption, entrapment, Direct covalent linking, crosslinking, Kinetics of immobilized enzymes, effect of solute partition & diffusion on the kinetics of immobilized enzymes, Measurement of enzyme activity, Regeneration of cofactors

Enzyme electro-catalysis (Biosensors): General approach to immobilization of enzymes into electrodes and their applications, Immobilized enzymes based bioreactors.

Industrial application of enzymes: Enzymes used in detergents, Application of enzymes in food processing; Medical applications of enzymes.

Reference Books

1. Nelson et al: Lehninger Principles of Biochemistry (3rd Ed.), MacMillan Worth, 2000

2. Berg et al.: Biochemistry (5th Ed.), Freeman, 2002

3. Mathews et al.: Biochemistry (3rd Ed.), Pearson, 2004

4. Zubay et al: Principles in Biochemistry (2nd Ed.), WCB, 1995

5. Rawn: Biochemistry, Neil Patterson, 1989

6. Molecular Clonning: A laboratory manual by J. Sambrook and E.F. Fritsch.

7. Molecular Biotechnology by S.B. Primrose

8. Molecular Biotechnology by Glick and Pasternack.

9. Enzymes in industry: Production and application by W.Gerhartz, VCH Publishers, New York

10. Principles of enzymology for technological applications, Butterworth Heinemann Ltd.

11. Enzyme technology by M.F. Chaplin and C. Bucke. Cambridge University Press.

12. Biochemical Engineering by Aiba, Humphery and Mills.

Paper 2.4.2 INTERMEDIARY METABOLISM & METABOLOMICS

50 Marks (40 marks end semester and 10 marks mid semester examination)

Course Objectives

- The major objective of this paper includes study of different bio-molecules interplaying in cellular physiology.

- The first unit gives an exemplary notation of various metabolic pathways and role of proteins, carbohydrate and lipids.
- Second unit explains about various sources of synthesis of amine and polyamine and its various processes of post translational modification, conversion and reutilization/recycle.
- Third unit is elaborated for regulation of biosynthesis and catabolism of nucleic acids. Similarly, the fourth unit gives an idea on different kinds of health disorders associated with abnormal or dysfunction in metabolic regulations.

Course Outcomes

- This paper encourages the students towards in-depth learning of various intermediary metabolic pathways in cellular functions.
- It also gives a basic understanding of structure and functions of key metabolic regulators and principal mechanisms underplaying within.
- The course module had also been designed to enable a reader to correlate the functional application of primary macromolecules responsible during diseases manifestation.

UNIT I

Intermediary metabolism and metabolic pathways

Carbohydrates: Pathways, their integration and regulation

Lipids: Cholesterol: Biosynthesis and degradation, Lipid transport and storage, Biosynthesis of eicosanoids: Prostaglandins, leucotrienes and thromboxanes.

UNIT II

Sources of amino acids: Dietary proteins and intermediates of carbohydrate metabolism, Amino acids as sources for nitrogen. Molecules derived from amino acids: Porphyrin, bilirubin, creatine, glutathione, dopamine, noradrenaline, adrenaline, GABA, serotonin, histamine, melanin, thyroxine. Synthesis and significance of polyamines.

Nucleotides: Biosynthesis and regulation of purine and pyrimidine nucleotides. Catabolism of purines and pyrimidines

UNIT III

Biochemical basis of diseases/disorders

Disorders of enzyme deficiency: Alkaptonuria, Hartnup'sdesease , Phenylketonuria, Lesh-Nyhan syndrome

Disorders of protein deficiency/defects: Cystic fibrosis, Thalassemia, Diabetes and obesity

Storage and transport associated disorders: Glycogen storage disorders, Hypercholestrolemiaand atherosclerosis, Tay-Sachs disease, Gout

Neurological disorders: Hutingston's disease

Biochemistry of aging

UNIT IV

Introduction to Metabolomics

Metabolites and metabolite profiling, Metabolomics - applications and its role in systems biology.

Targeted and untargeted metabolomics, General work flow including quenching and sample preparation, Detection and quantification of metabolites by advanced analytical techniques (NMR/Mass spectroscopy, HPLC). Statistical methods (PCA, PLS, PLS-DA) in metabolomics.

Pathway and metabolome databases. Software tools available for metabolomics analysis

Books Recommended

1. Nelson et al: Lehninger Principles of Biochemistry (3rd Ed.), MacMillan Worth, 2000

2. Berg et al.: Biochemistry (5th Ed.), Freeman, 2002

3. Mathews et al.: Biochemistry (3rd Ed.), Pearson, 2004

4. Zubay et al: Principles in Biochemistry (2nd Ed.), WCB, 1995

5. Rawn: Biochemistry, Neil Patterson, 1989

6. Bender, D.A.: Amino acid metabolism, John Wiley & Sons, 1985

7. Grisolia, S. et al. : The Urea Cycle, John Wiley & Sons, 1976

8. Voet & Voet: Biochemistry Vol. I & II (3rd Ed.), Wiley, 2004.

9. Metabolomics – A powerful Tool in Systems Biology, Edited by J.Nielsen and M.C. Jewett, Springer Publishers.

10. Metabolome Analyses: an Introduction by Dr. Silas G. Villas-Bôas, Dr. Ute Roessner, Dr. Michael A. E. Hansen, Dr. Jørn Smedsgaard, Dr. Jens Nielsen. John Wiley & Sons, Inc, Print ISBN:9780471743446

Paper 2.4.3 GENOMICS

50 Marks (40 marks end semester and 10 marks mid semester examination)

Course Objectives

- To understand the basic concept of genome organization, denaturation and renaturation kinetics and chromatin modifications.
- To know the principles and applications of genome mapping, cloning, DNA sequencing and DNA fingerprinting techniques in advance genomic studies.
- To give the adequate knowledge on strategies of DNA transfection and expression in different models of expression systems and their applications.
- To teach the advanced techniques in molecular biology to understand the mechanism of DNA-protein and protein-protein interactions, and knock-out & transgenic technology.

Course Outcomes

- Introducing the general concepts of properties of genetic material and genome organization.
- Conveying the students on the applications of DNA sequencing, genome mapping and DNA fingerprinting techniques.
- Acquiring the knowledge on DNA transfection and expression of foreign genes and their applications in different advanced biological fields.
- Studying the advanced molecular techniques and novel methods in medical biotechnology.

UNIT-I

Eukaryotic genome: Introduction to structural and functional genomics, Denaturation & renaturation kinetics of DNA, unique and repetitive DNA sequences, Chromatin organization: histones and non histonechromosomal proteins, nucleosomes and higher order structures, telomere, chromatin modifications.

UNIT-II

Mapping of genome: Genetic and physical maps, physical mapping (restriction mapping,fluorescence in situ hybridization, sequence tagged site mapping), map based cloning,choice of mapping population, simple sequence repeat loci, southern and fluorescence in situ hybridization for genome analysis, molecular markers in genome analysis (RFLP, RAPD,AFLP, SSLPs, STRs and SNPs)

Genome sequencing: Construction of libraries (genomic and cDNA), strategies forsequencing genomes, packaging, transections and recovery of clones, application of sequence information for identification of defective genes. Expression cloning, Jumpingor hopping libraries, South-western and Far-western.

UNIT-III

DNA transfection: Physical methods (microinjection, electroporation, biolistics, somatic cell fusion,Gene transfer by pronuclear microinjection), Chemical method (liposomes), Virusmediated transfection.

Expression Strategies for Heterologous genes: Bacterial expression systems, Saccharomycescerevisiae expression systems (S. cerevisiae vectors, intracellular cellular production of heterologousproteins, secretion of heterologous proteins by S. cerevisiae), Pichiapastoris and other yeastexpression systems, Baculovirus-insect cell expression systems, mammalian cell expression, systems.

UNIT-IV

Mapping and quantifying transcripts: Northern blot, S1 mapping, RNase protection assay, Primerextension, Run-off Transcription and G-less cassette transcription, Nuclear Run-on transcription andReporter gene assays.

DNA-protein interactions: EMSA, DNase foot printing, Methyl interference assay, CHIP

Protein-protein interaction: Yeast two hybrid system, Phage display.

Gene therapy, Knockout and transgenic technologies

Reference Books

1. Molecular Clonning: A laboratory manual by J. Sambrook and E.F. Fritsch.

2. Genome by T.A. Brown.

3. DNA Science. A First Course in Recombinant Technology by Mickloss and Freyer

5. Molecular Biotechnology by S.B. Primrose

6. Principles of gene manipulation by Primrose, Twyman and Old

7. Molecular Biotechnology by Glick and Pasternack.

8. Molecular Biology by Weaver

9. Genes and Genomes by Singer and Berg

10. Selected papers from Scientific journals

11. Technical literature from Stratagene, Promega, Novagen, New EnglanBiolab etc.

Paper 2.4.4 CELL SIGNALLING, APOPTOSIS AND CANCER

50 Marks (40 marks end semester and 10 marks mid semester examination)

Course Objectives

- This course is designed for basic learning of cellular process through cellular signaling and their implications in tumor genesis. The content in first unit describes about the various macro molecular components of cell participating in the process of signal transduction.

- The second unit elaborates on primary cell surface receptors and their mechanism of action. It also includes different energy mediated process activated during relay of signals through kinases.

- The third unit is specifically illustrated for various methods of desensitization signals and signaling networks. It also includes the mechanism of signal impairment for human health and disease. Similarly, the fourth unit has been emphasized on mechanism and regulation of apoptosis, necrosis and autophagy in cellular events and cancer.

Course Outcomes

- This course is immensely helpful in both academia and research.

- The course content described in the above course give an overview of various processes of cellular signaling and its associated networks.

- It will help the student in understanding and correlation of various cancer metabolisms in disease progression. This study is also implicative towards possible intervention for regulation of various signaling network in cancer diagnosis and therapy.

UNIT I

Ions channels, Transporters and Receptors

Introduction to signal transduction: Concept of cell-signaling (Autocrine, paracrine, exocrine, juxtacrine and endocrine signaling, neuronal), newer concepts in cell signaling: extracellular vesicles, exosomes, filopodia & tunneling nanotubes.

Signaling through intracellular receptors: Lipophilic hormones

Signaling through cell surface receptors-I: G protein linked receptors; signaling via cAMP, PKA IP3, Ca /calmodulin, PKC, Ca-MK, ion channels (exemplified by vision).

UNIT II

Signaling through cell surface receptors-II: (Enzyme linked receptors)

Receptor tyrosine kinase (RTK), signaling of growth factors

Tyrosine kinase associated receptors, JAK-STAT signaling pathway

Receptor protein tyrosine phosphatase (PTP)

Receptor serine/threonine kinase

Receptor guanylcyclase, cGMP, PKG

Histidine kinase associated receptors, bacterial chemotaxis

UNIT III

Receptor desensitization

Signaling by nitric oxide, carbon monoxide

Signaling network

Impairment of signaling mechanism: Tumorigenesis (Role of oncogenes &oncoproteins);

low level of receptors (NIDDM), Impairment of receptor function (LHR and FSHR mutation and fertility), Hormonal disbalance and diseases

UNIT – IV

Necrosis, programmed & induced cell death and autophagy

Process of apoptosis: Initiation, Execution: cytochrome C, caspases, Phagocytosis

Regulation of apoptosis: Extracellular & Intracellular

Significance in development, immunity and cancer

Reference Books

1. Albert et al.: Molecular Biology of the Cell (4th Ed.), Garland Publishing Inc., 2002

2. Lodish et al.: Molecular Cell Biology (5th Ed.), Freeman and Company, 2004

3. Berg et al.: Biochemistry (5th Ed.), Freeman and Company, 2002

4. Murray et al.: Harper's Biochemistry (26th Ed.), Appleton & Lange, 2003.

ZO 2.4.5 Project : 100 Marks (Dissertation & presentation)

ELECTIVE –III : AQUATIC BIOLOGY AND TOXICOLOGY (C)

Paper 1: ZO- 2.4.1 Marine Biology 50 Marks (40 marks end semester and 10 marks mid semester examination)

Course objectives

- Learn about the marine environment and the governing ecological factors.
- Develop an understanding of plankton, benthos, nekton and animal associations in the marine realm.
- Appreciate the existence of unique coastal vegetation such as mangroves, sea grass and kelp beds, and associated marine fauna.
- Know the marine resources and the importance of sustainable utilization.
- Recognize marine biodiversity and imminent threats.

Course outcomes

- An understanding of the marine environment and processes.
- Significance of exploring marine life.
- Gain knowledge on the importance of marine life conservation.

UNIT I

Marine environment-Introduction, Profile of sea floor Ecological factors: Physical - light, temperature, salinity, pressure, ocean currents, tides and waves. Chemical-Oxygen, Carbon

dioxide and carbonates, Hydrogen sulphide, Hydrogen ion concentration, inorganic salts and Dissolved organic matter.

UNIT II

Plankton and nekton: Phytoplankton, Zooplankton and Nekton- composition Benthic Communities: intertidal, sub tidal, deep sea. Animal associations in marine environment- Natural associations- community, commensalism, parasitism in different groups, symbiosis in different groups, types, nutritional relationships.

UNIT III

Marine ecosystem Coral reefs, mangroves, sea grass beds, kelp forests, polar seas & hydrothermal vents. Fouling and boring organisms Organic production in the sea - Primary production, food cycle in the sea, Marine food chains. Marine Resources-algal, animal, mineral. Drugs from the sea.

Unit IV

Marine biodiversity: patterns, threats and conservation needs. Human impact on the sea- impact on olive ridley turtle. Fisheries- Major fishing areas, commercial species, sustainable yield, Overexploitation, Regulation. Mariculture- Extent, Species cultivated problems and restrictions. Pollution-Oil, sewage and garbage, chemicals, radioactive wastes, miscellaneous pollution problems, Global warming and sea level change.

Paper 2: ZO- 2.4.2 Estuaries and Coastal Zone Management 50 Marks (40 marks end semester and 10 marks mid semester examination)

Course objectives

- Learn about the estuarine environment and the governing ecological factors.
- Develop an understanding of types, formation of estuaries, ecology, and biota.
- Appreciate the existence of unique estuarine coastal vegetation and their significance.
- Acquire knowledge on coastal zone management and coastal resources besides impacts of dredging, mining and pollution of coastal habitats.

Course outcomes

- An understanding of the estuarine environment and processes.
- Significance of coastal zone management.

- Gain knowledge on the importance of impacts on estuarine environments.

UNIT I

Estuaries- Nature, Origin, Classification, structure. Physico- chemical characteristics, sediments, circulation. Estuarine habitats of India.

UNIT II

Estuarine communities- Faunal composition- Plankton, nekton and benthic communities. adaptations (buoyancy, locomotion and defense), Distribution of estuarine organisms, problems of life in estuaries. Productivity, Organic matter and food sources, primary producers, secondary consumers, food webs, plankton cycles. Productivity in coastal waters

UNIT III

Salt marsh ecosystem – species composition, distribution, nutrient dynamics, primary productivity and ecological processes and fate of salt marsh plants.

Mangrove ecosystem – species composition, distribution, adaptations, primary productivity, heterotrophic production, secondary communities and energy flow. Mangrove wetlands of Odisha and Bioprospecting with Societal impacts.

UNIT IV

Coastal Zone Management: Coastal resources- Fin fish, Shell fish, non- living resources and their management. Impact of dredging, mining and pollution of coastal habitats. Coastal Zone Regulations. Remote sensing applications in Coastal Zone Management.

Paper 3 ZO-2.4.3 Freshwater Biology, Aquatic Microbiology and Marine Biotechnology

50 Marks (40 marks end semester and 10 marks mid semester examination)

Course objectives

- The objective of this course is to impart knowledge of biotechnological applications of marine resources.
- To introduce various freshwater ecosystems and its components.
- Train students in collection methodologies pertaining to planktons

- Provide knowledge about the biotechnological application of marine organisms and to understand biotechnological application of microbes with sampling, characterization of feacal coliforms in polluted waters.

Course outcomes

- Understand trends and significance of marine resources with their production.
- Acquire knowledge about the importance of bioactive compounds in health industry especially their role in cardiovascular disease and obesity.
- Knowledge about Ramsar sites and their role in maintaining ecosystem balance.
- Application of Biotechnological tools in Aquaculture.
- Comprehend the uses of marine resources, their significances, impacts and interaction.
- Correlate technology transfer from field to laboratory and gradual transition in the form of an industry.

UNIT I

Limnology: Lotic and Lentic environment, Wetlands: Definition and classification of freshwater wetlands, Ramsar classification of wetlands, Physicochemical properties of pond water, Rivers: characteristics and Functions, Ecology of phytoplankton and Zooplankton, Sampling and preservation technique of planktons

UNIT-II

Aquatic microbiology: Indicators of pollution, Faecal coliforms, MPN and Membrane filter method Marine Microbiology: Applications of Archaea; cyanobacteria; Actinomycetes; marine fungi; Extremophiles - psychrophiles, halophiles and barophiles.

UNIT – III

Biotechnological tools and their application in Marine biology - ELISA, FISH, Cryopreservation of eggs/gametes, development of marine natural products- chitosan, chitin, green mussel adhesive protein

UNIT IV

Algal biotechnology- single cell protein, hydrocolloids, agarose, carrageen alginates, Marine Enzymes - sources and their applications, Marine Lipids sources and their applications, Extraction and Characterization of Bioactive Compounds with Health Benefits from Marine Resources: Macro and Micro Algae, Cyanobacteria, and Invertebrates

Paper 4 ZO 2.4.4: Environmental Toxicology, Pollution and EIA

50 Marks (40 marks end semester and 10 marks mid semester examination)

Course objectives

- Course is designed to give a basic understanding of toxicology and pollution issues.
- Learners will be apprised with Environmental Impact Assessment methodologies, case studies, toxicity bioassay experiments, classification of heavy metals and their impact on human health.
- Learn about sewage treatment process with emphasis on biological treatment, biofilters, sludge, and removal of nutrients through biomass production

Course outcomes

- Understand and minimize the usage of heavy metals in our environment, differentiate between different type of toxins and bioassay tests.
- Understand the importance of EIA studies and the role of individuals in reducing the impact of Anthropogenic stressors.
- Know the impact of various projects on the environment.
- Understand the need for waste water treatment plants and reuse of treated water.

UNIT-I

Toxicology: Classification- Acute, sub-acute, chronic, dose- response relationship and effect, LD 50, LC 50, Bioassay- Types and significance of bioassay, Microbial bioassay for toxicity testing, algal, invertebrates and vertebrate toxicity tests (at least 2 representatives from each group)

UNIT- II

Classification of pesticides and Metals, Toxicity of Aluminium, arsenic, cadmium, chromium, lead and mercury, Bioconcentration, Bioaccumulation, Biomagnification of pesticides and metals, Biotransformation (Phase I and II)

UNIT-III

Environmental Impact Assessment, Principle, Characteristics and Components of EIA, EIA Wing, EIA Documentation and processes, Environmental management techniques, Risk characterization, EIA monitoring and auditing

UNIT-IV

Environmental Pollution – Classification, major sources, types and nature of pollutants, Air Pollution: Formation of Photochemical Smog and Acid Rain, General methods of Air pollution control, Water pollution: BOD and methods of water pollution control, Wastewater treatment processes: Biological treatment of wastewater (oxidation, nitrification, denitrification, role of biofilm), biofilters, activated sludge, nutrient removal through biomass production

ZO 2.4.5 Project: 100 Mark (Dissertation & presentation)

Value added Course

Course Code: VA-01 Fermentation Technology for Food and Beverages (PG)

(30 Hours; 2 Credits)

Course Objective & Outcome

Objective

The primary objective of this value added paper is to strengthen the basic understanding of students/learner towards routinely used various food and beverages available as consumer products. The course is emphasized up on basic principles of food and beverage making industries. It gives an idea about the quality measures on product formation and its value addition in human health. Simultaneously, the content of the course has been designed to understand and evaluate the consumer needs.

Outcome

This course is designed to give an additional value to the regular curriculum of undergraduate zoology programme. It will enable the learners for self sustainability in terms of setting up of small scale industries and entrepreneurship.

Unit-1

Introduction to fermentation technology. Solid and submerged fermentation system. Fermentation mediums and substrates. Fermenter designs and consoles. Basics principles of microbial growth and fermentation technology. Microbial growth kinetics, downstream processing and enzyme purification.

Unit-2

Innovative technologies in food and beverage industries. Commercial fermented products and application of microorganisms of industrial importance. Microbial fermentation and its end products: Enzymes, vitamins and biologically active peptides. Production of different fermented foods: Bread and dairy products. Preparation of beverages: Beer and wine.

Unit-3

Natural benefits and economic importance of fermented products. Advances in probiotics, prebiotics and nutraceuticals. Safety measures of fermented food and associated health risk. Innovative and safe packaging technologies for food and beverage industries. Role of consumer and IPR for food and beverages. Future prospects in food and beverage industry.

Value added Course

Course Name: Aquaculture (VA-02) PG

Credits: 2 Total marks: 50

Objectives:

The course will give the students an understanding of the principles of aquaculture, including production systems, water quality, nutrition, spawning, larval culture and culture methodologies with special reference to fish.

Learning outcomes:

Understand aquaculture systems

Unit I : Freshwater aquaculture **10 Lectures**

Aquaculture concept, Culture systems: Freshwater prawn culture, fish culture in paddy fields, Brackish water culture, Mariculture: Oyster culture, Crab culture, Lobster culture, mussel culture, Culture of aquatic weeds. Composite fish culture: Definition Techniques of composite culture.

Unit II: Preparation and management of fish culture ponds **10 Lectures**

Nursery ponds. Predatory and Weed fishes and their control. Fertilization. Supplementary feeding. Transport of fish seed and Brood fish. Causes of mortality in transport. Methods for packaging and transport. Harvesting: Fishing techniques, preservation & processing of fish.

Unit III: Technology in Pearl culture **10 Lectures**

Pearl culture: Introduction, Pearl producing mollusks, pearl formation, collection of oysters, Rearing of oysters, insertion of nucleus, harvesting of pearls, composition & quality of pearl.

Recommended readings

I. Jingran, V. G. (1983) Fish and fisheries of India , Hindustan pub. corp. New Delhi.

2. Hute, M. and Kahn, H. (2000) Textbook of fish culture, Blackwell Scientific Publication, Australia.

3. Srinivasulu, M., Reddy, K.R.S., Rao, S. (1999) Text book of Aquaculture, Discovery Publishing House New Delhi.

Value added course

VA-03 Environmental Impact Assessment (2 Credits) 50 Marks, 30 hours (PG)

Objective of the Course

To understand strengths & limitations of Environmental Management.

To understand the purpose of developing follow-up procedures, and options for designing these procedures.

Outcome

After learning about Environmental Impact Assessment a learner will be able to understand the role of every stakeholder about the possible environmental, social and economic costs of the proposed project.

Course Outline

Unit-1 EIA: Objectives, Concept and Scope of EIA , Structure of EIA: Environmental Assessment Process

Unit-2 EIA Analysis: Adhoc method, Overlays, Check list, Matrices, models, comparative studies , Prediction and Methods of Assessment of Impacts on Various Aspects of Environment; Application of various models for the Prediction of impact on Air Environment, Water Environment, Noise Environment and Land

Unit-3 EC Procedure for industrial and other developmental projects, Environmental Impact Statement (EIS), EIA of Air and Water Environment, Case Studies

1. **Environmental Impact Assessment- by R.R. Barthwal**
2. **Environmental Impact Assessment by S.R. Khandeshwar N.S. Raman, A.R. Gajbhiye**

Add on course

AO-01 Environmental monitoring and Disaster Management

(2 Credits) 50 Marks, 30 hours (PG)

Objective of the Course

1. Basic understanding of disasters.

2. Understand and Execute Response mechanism of Disaster Management

Course Outline

Unit: I Definition and types of disasters, Difference between Hazard and Disaster, Man-made and natural disasters type and examples, Disaster- Types of Disaster- Natural & anthropogenic, Changes in Coastal zone, coastal erosion, beach protection; Coastal erosion due to natural and man-made structures

Unit: II Mitigation measures and Management of Disaster, Disaster Management cycle, Disaster management policy, National and State Bodies for Disaster Management

Environmental monitoring: Working Principles of different environmental monitoring Instruments-pH meter, Conductivity meter, Spectrophotometer, Bod Incubator, High Volume Sampler, Noise Level meter , Determination of water parameters: pH, Dissolved Oxygen, Salinity, Total Suspended Solids, Total Dissolved Solids, BOD & COD, TOC, Plankton collection methods.

Unit III Awareness about disaster management, Remote sensing techniques in disaster management, Case studies of Disaster management, Advance technology for Cyclone warning and Tsunami

1. Gupta A.K., Niar S.S and Chatterjee S. (2013) Disaster management and Risk Reduction, Role of Environmental Knowledge, Narosa Publishing House, Delhi.
2. Murthy D.B.N. (2012) Disaster Management, Deep and Deep Publication PVT. Ltd. New Delhi

Add Course on

Course Code: AO-02 Fermentation Technology for Food and Beverages

(30 Hours; 2 Credits)

Course Objective & Outcome

Objective

The primary objective of this value added paper is to strengthen the basic understanding of students/learner towards routinely used various food and beverages available as consumer products. The course is emphasized up on basic principles of food and beverage making industries. It gives an idea about the quality measures on product formation and its value addition in human health. Simultaneously, the content of the course has been designed to understand and evaluate the consumer needs.

Outcome

This course is designed to give an additional value to the regular curriculum of undergraduate zoology programme. It will enable the learners for self sustainability in terms of setting up of small scale industries and entrepreneurship.

Unit-1

Introduction to fermentation technology. Solid and submerged fermentation system. Fermentation mediums and substrates. Fermenter designs and consoles. Basics principles of microbial growth and fermentation technology. Microbial growth kinetics, downstream processing and enzyme purification.

Unit-2

Innovative technologies in food and beverage industries. Commercial fermented products and application of microorganisms of industrial importance. Microbial fermentation and its end products: Enzymes, vitamins and biologically active peptides. Production of different fermented foods: Bread and dairy products. Preparation of beverages: Beer and wine.

Unit-3

Natural benefits and economic importance of fermented products. Advances in probiotics, prebiotics and nutraceuticals. Safety measures of fermented food and associated health risk. Innovative and safe packaging technologies for food and beverage industries. Role of consumer and IPR for food and beverages. Future prospects in food and beverage industry.