VIMALA COLLEGE (AUTONOMOUS), THRISSUR

SYLLABUS

FOR

POST GRADUATE PROGRAMME

IN

ZOOLOGY

Effective from 2019 admission

FIRST SEMESTER THEORY

ZOL1C01 - BIOCHEMISTRY AND CYTOGENETICS (90 hrs)

Part A. Biochemistry (54 hrs)

Unit - I - Chemistry and functions of Biomolecules

1. Introduction (2 hrs)

1.1Macromolecules and their subunits

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

2. Carbohydrates (8hrs)

Classification of carbohydrates with examples-

2.1.1 Structure of monosaccharides- glucose, fructose, galactose, mannose and ribose.

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

Isomerism - Structural isomerism (functional group isomerism) and stereo isomerism (optical isomerism)- mention epimer, anomer and enantiomer with examples, Mutarotation

Biological roles of monosaccharides.

Structure and biological roles of maltose, sucrose,,lactose, trehalose and cellobiose.

Hompolysaccharides - Structure and biological roles of cellulose, starch, glycogen, inulin and chitin

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

3. Proteins (6 hrs)

Amino acids

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

Amphoteric properties of amino acids

pK value and Isoelectric point (pI) of amino acids

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

Structure of protein

Primary structure, Secondary structure (Alpha helix, Beta-parallel & antiparallel and Beta-pleated sheet), random coil conformation, Tertiary structure, Quarternary structure.

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

Biological roles of proteins

4. Lipids (5 hrs)

Classification of lipids -Simple lipids (fats, oils and waxes), compound lipids (phospholipids, glycolipids, lipoproteins and sulpholipids) and derived lipids.

Biological roles of lipids - as food reserves (storage lipids), structural lipids in membrane, as signals, as co-factors, as pigments, as insulators, as vitamin carriers etc

Prostaglandins - Chemical nature and functions.

Fatty acids - definition; essential fatty acids

Classification with examples- Saturated, unsaturated, hydroxyl and cyclic fatty acids

Nomenclature of fatty acids - Genevan system

5. Nucleic acids (3 hrs)

Structural organization of DNA (Watson -Crick model)

Structural organization of t-RNA; brief note on micro-RNA

Biological roles of nucleotides and nucleic acids

Unit - II - Enzymes (7 hrs)

1. Classification- (I.U.B. system)
2. Mechanism of enzyme action: Formation of enzyme substrate complex- Michaelis-Menten theory, Fischer's template theory and Koshland's induced fit theory. Factors influencing enzyme action
3. Enzyme kinetics - Michaelis-Menten equation - derivation; significance of Km and Vmax Values. Lineweaver-Burk equation and double reciprocal plot of enzyme reaction.
4. Enzyme inhibition - Competitive, non-competitive and uncompetitive inhibition (distinguish kinetically), suicide inhibition and feedback inhibition
5. Classification, Structure and functions of Vitamins.Vitamins as co-enzymes.

Unit - III - Bioenergetics (2 hrs)

1. Laws of thermodynamics and biological system- Enthalpy, Entropy, Free energy concept .
2. Energy of activation, Standard free energy change.
3. Role of ATP as a free energy carrier in the biological system.

Unit - IV - Metabolism and biosynthesis of biomolecules

1. Carbohydrate metabolism (8 hrs)

Glycolysis - (PFK as pacemaker - Hexokinase conformation and change by glucose), Fate of pyruvic acid

Citric acid cycle; Pyruvate dehydrogenase complex and ketoglutarate dehydrogenase complex

Electron transport system and oxidative phosphorylation; Redox potential, Chemiosmotic hypothesis; inhibitors of electron transport chain

Gluconeogenesis, Glycogenesis, Glycogenolysis; regulation of glycogen synthesis and breakdown .

Pentose phosphate pathway (HMP pathway) and its significance

Uronic acid pathway

2. Amino acid metabolism (4 hrs)

Biosynthesis and degradation of amino acids - glutamic acid, phenyl alanine,methionine, tryptophan, isoleucine, histidine, valine.

Fate of amino acids in the body

Transamination, Decarboxylation and deamination reactions in the biological system.

3. Lipid metabolism (5 hrs)

Oxidation of fatty acids

Biosynthesis of fatty acids

Biosynthesis of cholesterol

4. Nucleic acid metabolism (4 hrs)

Biosynthesis and degradation of purines and pyramidines

Part B. Cytogenetics (36 hrs)

1. Introduction to Cytogenetics (1 hr)

2. Membrane structure and function . (4 hrs)

Molecular organization of cell membrane - Lipid bilayer and membrane protein. Molecular models of cell membrane.

Cell permeability-osmosis, diffusion, ion channels, active transport, membrane pumps.

Mechanism of sorting and regulation of intracellular transport.

Electrical properties of membranes.

Microvilli and cell coat.

3. Structural organization and function of intracellular organelles- (6 hrs)

Nucleus, Mitochondria, Golgi complex, Lysosomes, Endoplasmic reticulum, Ribosomes, Peroxisomes and Cytoskeleton.

4. Organization of chromosomes and genes. (6hrs)

Structure of chromatin and chromosomes, heterochromatin, euchromatin –unique and repetitive DNA

Chromosomal changes- euploidy, aneuploidy, chromosomal aberrations- Structural alterations- gene mutations- molecularchanges- deletion, duplication, translocation, inversion and sister chromatid exchange.

Interrupted genes and gene families.

Concept of gene- Allele, multiple alleles, pseudoallele, complementation tests.

Extrachromosomal inheritance- inheritance of mitochondrial and chloroplast genes, maternal inheritance.

5. Cellular communication (6 hrs)

General principles of cell communication

Cell-cell interactions – cell adhesion and roles of different adhesion molecules

Intercellular attachments- gap junctions, desmosomes, intermediary and tight junctions.

Interaction of cells with extracellular matrix: Integrins. Focal adhesion and hemidesmosomes.

Interaction of cells with other cells: Selectins, Immunoglobulins, Cadherins, Adherens.

6. Cell signaling (8 hrs)

Signal transduction

Concept of cell-signaling

Signaling through cell surface receptors: G protein linked receptors; signaling via cAMP, PKA, IP3, Ca2+/calmodulin, PKC, Ca-MK, 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 guanyl cyclase, cGMP, PKG, Histidine kinase associated receptors

Receptor desensitization

Signaling by nitric oxide, carbon monoxide

Signaling network

7. Apoptosis and its significance (5 hrs)

Necrosis; Programmed and induced cell death

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

Regulation of apoptosis - Extracellular and Intracellular

Apoptosis in *Caenorhabditis elegans*, *Drosophila*, mammals and bacterial population

Mechanism of cell death

Genes involved in apoptosis.

Referenc

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Biochemistry

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FIRST SEMESTER THEORY

ZOL1C02 - BIOPHYSICS AND BIOSTATISTICS (90 Hours)

Part A. Biophysics (54 hrs)

1. Colloidal System (3 hrs)

Crystalloids and Colloids,

Properties of colloids- Kinetic, optical and electrical properties- Electrosmosis, Cataphoresis, Coagulation.

Forms of colloids, Suspensions and Emulsions, preparation and properties of emulsions.

Biological importance of colloids.

2. Diffusion and Osmosis (4 hrs)

Fick's laws and diffusion coefficient.

Gibb's Donnan equilibrium.

Application of diffusion processes in biology: haemolysis.

Osmosis, Osmotic concentration, Osmotic pressure and osmotic gradient.

Vant Hoff's laws

Electrolytic and ionic balance in biological fluid.

3. PH (2 hrs)

3.1 Dissociation of water.

Dissociation of a weak acid.

Henderson Hasselbalch equation.

Electrometric determination of pH, pH meter

PH value calculation.

Buffer –Importance of buffers in biology.

4. Bioacoustics (5 hrs)

Characteristics of sound.

Physical basis of hearing.

Physical organization of ear.

Physical aspects of sound transmission in the ear.

Audible sound frequency.

Pitch perception and theories.

Infrasonic and ultrasonic sounds.

Echolocation; receiving and analyzing echoes

5. Radiation Biology (9 hrs)

Radioactivity, different types ionizing radiations and their sources

Radioactive disintegration. Decay curve, half-life.

Biological effects of ionizing radiations – effects at macromolecular, cellular and organ system level, effects of whole body irradiation-Radiation therapy.

Biological applications of radioisotopes.

Radiation dosimetry- dose units and dose measurement.

Radiation Detectors - GM Counter, Solid and Liquid Scintillation Counter, Proportional counter, Semiconductor detectors.

Autoradiography

6. Biophysical methods (Brief account of the following) (5 hrs).

Properties of electromagnetic radiations.

Molecular analysis using UV / visible spectroscopy.

Mass spectroscopy.

NMR and Electron Spin Resonance (ESR) spectroscopy -Applications

Structure determination using X-ray diffraction crystallography.

Circular dichroism.

Surface Plasma Resonance (SPR)

7. Electrophysiological methods (Brief) (3 hrs)

Single neuron recording.

Patch clamp recording.

ECG.

Brain activity recording.

Lesion and stimulation of brain.

Pharmacological testing.

PET (Positron Emission Tomography), MRI, fMRI, CAT.

8. Principles and applications of (8 hrs)

Fluorescent, Interference, Scanning and Transmission electron microscopes (SEM &TEM) .

Resolving powers of different microscopes.

Different fixation and staining techniques for EM (freeze-etch and freeze fracture methods for EM-image processing methods in microscopy).

Laser and its applications in Biology

9. Separation Techniques (10 hrs)

Chromatography - Different types - Adsorption, Partition and Ion exchange chromatography

Column chromatography

Paper chromatography

Thin- layer chromatography

Gel-filtration.

9.1.5. Gas chromatography,

Affinity chromatography,

HPLC

Electrophoresis

Paper electrophoresis

Disc electrophoresis

PAGE, Two dimensional PAGE, Highvoltage Electrophoresis

Isoelectric focusing.

10. Influence of gravity (3 hrs)

Human body posture in the gravitational field

Influence of G force.

sForce of centrifugal acceleration - importance of aviation and space travel

Effect of positive G. Force & negative G. Forces.

Protection against G. Force

Influence of linear acceleration on the body

11. Nanotechnology (2 hrs)

Definition

Nanotechnology and its applications in the field of health care.

Role of nanotechnology in environmental management.

Part B –Biostatistics (36 hrs)

1. Introduction (2 hrs)

Biostatistics: Definition,

Characteristics of Statistics

Importance and usefulness of statistics

Limitations of Statistics

2. Data (5 hrs)

Types of data: classification based on Source of data, Compilation, Variable, Nature .

Methods of data collection and classification.

Types of sampling methods.

Advantages and disadvantages of census and sampling method.

Class intervals- exclusive and inclusive method

Frequency curve (types. skewness, kurtosis, ogive)

3. Statistical Methods: Measures of central tendency and dispersal (4 hrs)

Mean, (raw data, discrete series and continuous series)

Standard deviation, Standard error, degree of freedom (raw data, discrete series and continuous series)

Quartile deviation- Box- whisker plot

4. Probability distributions (4 hrs)

Basic concepts and definition:

Laws of probability

Probability distribution: - Binomial, Poisson and Normal

5. Statistical inference (problems to be discussed) (7 hrs)

Difference between parametric and non-parametric statistics;

Testing of hypothesis

Errors

Confidence interval; levels of significance, Critical region;

Normality test

t-test, chi-square test, F-test, ANOVA

Kruskal-Wallis, Mann-Whitney

6. Correlation and Regression (problems to be discussed) (7 hrs)

Types of correlation.

Methods to measure correlation- Scatter diagram.

Karlpearson's coefficient of correlation, Spearman's correlation

Types of regression analysis

Regression equations

Difference between regression and correlation analysis

7. Ecological data analysis (problems to be discussed) (7 hrs)

Alpha diversity

Shannon diversity index, Simpsons Dominance index, Pielou‟s evenness index, Margalef species Richness, Fisher‟s apha,

Beta diversity

Morisita Horn index, Sorenson index, Bray-Curtis similarity

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FIRST SEMESTER THEORY

ZOL1C03 - ECOLOGY AND ETHOLOGY (90 Hours)

Part-A-Ecology (54 hrs)

1. Introduction (3hrs)

Habitat and niche

Concept of habitat and niche

Niche width and overlap

Fundamental and realized niche

Resource partitioning

Character displacement

2. Ecosystem (9 hrs)

Structure and function

Ecosystem energetics

Primary production

Energy flow models

Mineral cycling (CNP)

Trophic levels, Food chain, food web and secondary production

Decomposers and detritivores

3. Population Ecology (7 hrs)

Characteristics of a population

Methods of estimating population density of animals, ranging patterns through direct, indirect and remote observations

3.3 Sampling methods in the study of behaviour, habitat characterization

Ground and remote sensing methods

Population growth curves, Life tables, survivorship curves, population regulation, Life history strategies, r and k selection, Demes and dispersal, interdemic extinctions, age structure of populations.

Growth and regulation of human population

4. Species interaction (5 hrs)

Types of interactions, interspecific competition

Herbivory, Carnivory, Pollination, Symbiosis; mutualism, commensalisms and proto co- operation

5. Community Ecology (4 hrs)

Nature of communities**.**

Characteristics of a biotic community**.**

Species diversity and latitudinal gradients in diversity.

5.4 Edges and ecotones.

6. Ecological succession (4 hrs)

Types, mechanisms ,changes involved in succession .

6.2 Concept of climax

7. Biogeography (6 hrs)

Major terrestrial biomes: (a) Tropical rain Forest (b) Grassland (c) Desert (d) Chaparral (e) Temperate deciduous Forest (f) Temperate boreal forest (g) Tundra (h) Savanna

8. Biogeographical zones of India (4 hrs)

(a) Trans Himalayan zone; (b) Himalayan zone; (c) Desert zone; (d) Semiarid zone; (e) Western Ghats zone; (f) Deccan plateau zone; (g) Gangetic plain zone; (h) North east zone. (i) Coastal zone; (j) Islands present near the shore line.

9. Applied Ecology (8 hrs)

Carbon credit, Carbon trading, Blue Carbon

Green building technology and its ecological importance.

Discuss the benefits and disadvantages of the idea of (brief)

a. Inter linking of major rivers of India,

b. Sethusamudram ship canal project.

c. Biodiversity with special reference to India-status monitoring and documentation, major drivers of biodiversity change.

10. Conservation Biology (4 hrs)

Principles of conservation.

Major approaches to management,

Indian case studies on conservation & management strategy (concepts of project tiger, Biosphere reserves).

Part B. Ethology (36 hrs)

1. **Introduction (1 hr)**
2. **Concepts of Ethology (4 hrs)**

Ethology as different from the other schools studying animal behavior like behaviourism.

Behaviour as a reaction to stimuli - sign stimuli, social releasers, Ethograms, super normal stimuli, stimulus filtering.

Concepts of Fixed Action Patterns (FAP), Innate Releasing Mechanism(IRM),Action Specific Energy(ASE),Concepts of Learning and Imprinting.

3. **Motivating factors (3 hrs)**

General factors in motivation; Studies of motivation in guppies;

Mating systems-parental investment and reproductive success

4. **Conflict behaviour- stress-displacement activities- Ritualization. (2 hrs)**
5. **Instinctive behaviour & reflex action, neural basis of sleep and arousal. (2hrs)**
6. **Learning**- Neural basis of learning, memory, cognition, sleep and arousal **(3hrs)**

Biological clocks

7. **Adaptiveness of behaviour (3 hrs)**

JP Scott‟s categories of behaviour.

8. **External stimulus - circadian rhythms (3 hrs)**

8.1- Proximate and Ultimate factors.

8.2-Types of orientation-reafference theory of Von Holst & Mittel Steadt.

8.3-Navigation & migration

9. Parental care – (6 hrs)

Mating systems, Parental investment and Reproductive Success.

Development of behavior.

Social communication; Social dominance; Use of space and territoriality; domestication and behavioural changes; Social behaviour of termites & Primates;

10. Evolution and advaptiveness of behaviour (4 hrs)

Altruism, Kin selection, inclusive fitness, selfish gene theory, cultural transmission of behaviour.

11. Hormones and Behaviour- (5 hrs)

Hormones of gonads, adrenal gland , Pituitary gland,-Hormonal effects on different behavioural patterns , Maternal behavour- mechanism of hormonal action.

References

Ecology

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SECOND SEMESTER

THEORY ZOL2C04 - PHYSIOLOGY (90 Hours)

1. Nutrition (10 hrs)

Constituents of normal diet and their daily requirements.
Physiological calorie value of food stuffs.
Antioxidant nutrients.
Movements of GI tract: deglutition, gastric motility and emptying, intestinal motility and defecation.
The role of hormones and neurotransmitters in the control of gastrointestinal motility.

1.6 Energy balance and obesity-causes and consequences.

1.7. BMR and its significance.

2. Excretory System (12 hrs)

Introduction: Brief description of different types of excretory organs in different animal groups (flame cells, green glands, malpighian tubules).
Functional anatomy of mammalian kidney, nephron and juxtaglomerular apparatus structure, parts and function.
Urine formation (glomerular filtration, tubular reabsorption and tubular secretion)
Regulation of water balance -Mechanism of concentration of urine – Counter Current system (counter current multiplier and counter current exchanger)**.**
Renal regulation of acid- base balance & electrolyte balance**.**
Structure of urinary bladder, micturition reflex and micturition**.**
Renal clearance – definition, concept and significance; clearance value of urea,creatinine, phosphate, potassium, chloride and sodium.

3. Respiratory system (10 hrs)

Introduction: Brief description of major respiratory organs (tracheal system, book lungs, gills and ctenidia)**.**
Physiological anatomy and histology of respiratory passage and lungs.
Mechanism of pulmonary ventilation (inspiration & expiration) .
Alveolar ventilation, dead space and its effect on alveolar ventilation**.**
Role of surfactant in alveolar expansion**.**
Pulmonary volumes and capacities – definition & normal values (tidal volume, inspiratory reserve volume, expiratory reserve volume, residual volume, functional residual capacity, inspiratory capacity, vital capacity, total lung capacity)**.**
Exchange of gases- partial pressures involved-lung and tissues.
Oxygen dissociation curve – factors affecting binding of oxygen to haemoglobin (PO2, PCO2, CO, pH, body temperature, diphosphoglyceric acid level, foetal haemoglobin and also myoglobin).

3.8. Neural and chemical regulation of respiration: Respiratory centres & factors regulating respiration.

4. Nervous system (21 hrs)

Organisation of human brain.
Cerebrum and cerebral lobe.

Cerebral cortex and its functional areas- Motor cortex, Broca's area , somatosensory cortex and its association area, gustatory cortex, visual cortex and its association area, auditory cortex and its association area, olfactory cortex, wernick's area, Brodman map, cerebral dominance .
Cortical white matter- commissures, association fibers, projection fibers,corpus callosum and fornix, basal nuclei-organisation and function.

Brain stem- organisation and function.
Cerebellum- structure and function.
Diencephalon – organisation and function.

Functional brain systems - Limbic system and reticular formation.
Protection of brain – Meninges, cerebrospinal fluid- formation and function, blood brain barrier and its function.
Diseased states of brain - schizophrenia, Alzheimer's disease, Senile dementia & Parkinso's disease.
Memory- definition, types of memory- short term, intermediate long term and long term memory, consolidation of memory.
PNS and Autonomic nervous system.
Spinal cord – structure.
Reflex action, reflex arc, monosynaptic and polysynaptic reflexes, inverse stretch reflex and golgi tendon organ.

5. Special senses (16 hrs)

Vision:

Structure of eyeball
Fluid systems of the eye
Layers of Retina and photoreceptors (rods & cones)
Brief notes on the neuronal cell types and neural circuitary of the retina and visual pathways from retina to visual cortex
Image formation

Formation of image on the retina.

A brief general account of electrophysiology of vision
Photochemistry of vision & colour vision

Taste:

Primary sensations of taste (agents and site of sensation)
Taste buds (location, structure, receptors and nerve supply)
Physiology of taste (receptor stimulation, generation of nerve impulse by taste buds and its transmission to CNS)

Smell:

Olfactory membrane and receptor cells
Physiology of olfaction (stimulation of olfactory cells and transmission of smell signals to CNS)

6. Tactile response: (brief note**) (4hrs)**

Mechanoreceptors and their stimulation
Pain receptors and their stimulation

Thermal receptors and their stimulation

7. Cardiovascular system (8hrs)

Introduction: Brief description of vertebrate hearts
Structural organization of myogenic heart (in human beings).
Physiological anatomy of cardiac muscle – specialized tissue**.**
Heart as a pump.
Cardiac cycle**.**
Neural and chemical regulation of heart function**.**
Blood volume and blood pressure**.**
Physiological anatomy of coronary blood flow, coronary blood flow and its control**.**
Ischemic heart disease – mention causes.

8. Lymphatic System (5 hrs)

Lymph channels of the body**.**
Composition and formation of lymph**.**
Functions of lymph and lymphatic system including role of it in controlling Interstitial fluid protein concentration, interstitial fluid volume and interstitial fluid pressure.

9. Environmental Physiology (4 hrs)

Thermal regulation.

Comfort zone, normal body temperatures (oral, skin & core).
Temperature regulating mechanism (hot & cold), mention the role of hypothalamus, thyroid and adrenal glands.
Acclimatization

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SECOND SEMESTER

ZOL2C05 - MOLECULAR BIOLOGY (90 Hrs)

1. DNA replication (11 Hrs)

Semidiscontinuous synthesis-Okazaki fragments
Replication origin and replication fork
Unit of replication, extra chromosomal replicon of bacterial Ti plasmid
Enzymes/proteins of replication- Primase, Replisomes, Helicase, DNA polymerases, Single strand binding proteins, Topoisomerases and Ligase;
Fidelity of replication
Replication of the ends of eukaryotic chromosome – role of telomerase
Models of DNA replication –Rolling circle model and looped rolling circle model, D-loop model, θ-model.
Inhibitors of DNA replication – Methotrexate and Fluorodeoxyuridylate

2. Safeguard systems of DNA (5 Hrs)

Restriction: significance, role and features of Type I, II & III restriction enzymes
Modification: enzymes and significance
Repair:
Major kinds of damage to DNA and causes
Repair mechanisms: Direct reversal, Mismatch repair, Excision repair, Recombination repair, SOS response

3. Transcription of mRNA in prokaryotes and eukaryotes (10 Hrs)

Structural organisation and life span of mRNA; monocistronic and polycistronic mRNA
Transcription in prokaryotes and eukaryotes
- Promoter (mention Pribnow, TATA, CAAT and GC box), enhancer and silencer sites
- Transcription factors; Transcription activators and repressors

Characteristic features of RNA polymerases of phages, prokaryotes and eukaryotes and their functions
Post transcriptional modification of RNA
- Capping
- Polyadenylation
- Splicing

RNA editing: site specific deamination and role of gRNAs
mRNA transport

4. Genetic code (5 Hrs)

Characteristics of genetic code
Start codons and stop codons
Degeneracy of the code: Wobble hypothesis and isoacceptor tRNAs
Special features of the genetic code in mitochondria, mitochondrial tRNA
Variations in the genetic code in *Mycoplasma* and *Tetrahymena*
Point mutations that alter genetic code (missense, nonsense & frameshift)

5. Ribosome: The site of protein synthesis: (2 Hrs)

Structure

Composition; Reconstitution experiments
Active centres
Biogenesis of ribosome in eukaryotes

6. Translation in prokaryotes and eukaryotes: (8 Hrs)

Aminoacylation of tRNA & initiation, elongation and termination of protein synthesis
Aminoacyl tRNA synthetases & initiation, elongation and termination factors
Translational proof-reading
Differences in protein synthesis between prokaryotes and eukaryotes
Translational inhibitors in prokaryotes and eukaryotes – role of tetracycline, streptomycin, neomycin, chloramphenicol, erythromycin, puromycin and diphtheria toxin
Post- translational modification of proteins: protein folding (role of chaperones) and biochemical modifications

7. Control of gene expression at transcription and translation level: (9 Hrs)

Regulation of gene expression in Phages – alternate patterns of gene expression for control of lytic and lysogenic cycle in λ phage
Regulation of gene expression in bacteria – basic features of tryptophan, arabinose and galactose operons
Regulation of gene expression in eukaryotes –

- Role of chromatin in regulating gene expression
- Activation and repression of transcription
- Regulation of translation by gene arrangement
- Regulation of translation by alternate pathways of transcript splicing
- Antisense RNA strategies for regulating gene expression
- si RNA and mi RNA in regulation

8. Eukaryotic genome: (5 Hrs)

Special features of eukaryotic genome
Features, components and reassociation kinetics of Unique, Moderately repetitive and Highly repetitive DNA
Junk DNA, Satellite DNA and Selfish DNA
Cot value and complexity of genome
Organisation of human genome (brief account)

9. Interrupted genes (4 Hrs)

Definition and explanation
Organisation and special features of interrupted genes
Evolution of interrupted genes

10. Gene families: (6 Hrs)

Definition and concept
Classification with example

- Simple multigene family - organisation of rRNA gene in *Xenopus*
- Complex multigene family - organisation of histone genes in sea urchin and tRNA genes in *Drosophila*
- Developmentally controlled complex multigene family e.g., globin gene

Globin genes and its products

Organisation of globin genes and its expression in Man
Evolution of globin genes
Concept of an evolutionary clock
Pseudogenes

11. Transposable genetic elements - Transposons (6 Hrs)

Definition, features and types
Transposition and mechanism
Transposons in bacteria
IS elements
Tn family
Mu phage as a transposable element
Transposons in eukaryotes
SINE, Alu family; LINE, L1
P elements in *Drosophila*
Transposons in Maize
Retroviruses and transposition

12. Molecular mechanisms involved in recombination of DNA: (5 Hrs)

Genetic recombination – types with example
Site specific recombination
Non-homologous recombination
Homologous recombination
Molecular mechanism involved in homologous recombination of DNA in eukaryotes- Holliday model: Holliday intermediate, heteroduplex DNA, gene conversion
Role of Rec A protein in genetic recombination

13. Microbial genetics (5 Hrs)

Prokaryotic genome- *Escherichia coli* genome – basic features
Methods of genetic transfers in bacteria– transformation (in *Streptococcus pneumonia*), conjugation and sexduction, transduction
Brief note on mapping genes by interrupted mating (in bacteria)

14. Organelle genome (4 Hrs)

Chloroplast genome: special features
Mitochondrial genome
Special features of yeast mitochondrial genome, petite mutants
Special features of human mitochondrial genome.

15. Cancer (5 Hrs)

Genetic rearrangements in progenitor cells, oncogenes, protooncogenes and tumour suppressor genes
Virus-induced cancer
Alteration of cell cycle regulation in cancer
Interaction of cancer cells with normal cells
New therapeutic interventions of uncontrolled cell growth (immunotherapy and gene therapy).

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SECOND SEMESTER

ZOL2C06 - SYSTEMATICS AND EVOLUTION (90 Hours)

Part –A: Systematics (54 Hrs)

I. Introduction (1 hr)

2. Definition and basic concepts in Systematics and Taxonomy (4 hrs)

Levels of Taxonomy

(a) Alpha, Beta and Gamma taxonomy

Importance and applications of taxonomy

Goals of taxonomy

Definition of systematics

Definition of classification

3. Species (4 hrs)

Monotypic species

Polytypic species

Ecospecies and Cenospecies

Morphospecies

Super species

Species as a Population Complex

4. Species Concepts (6 hrs)

Typological Species Concept

Nominalistic Species Concept

Biological Species Concept

Evolutionary Species Concept

Difficulties in the application of the biological species concept

5. Classification (7 hrs)

Uses of Classification

Purpose of Classification

Theories of Classification

(a) Essentialism (b) Nominalism (c) Empiricism (d) Cladism (e) Evolutionary Classification

Hierarchy of Categories

The objectives of classification

6. Taxonomic Collections and the Process of identification (8 hrs)

Taxonomic collections: Types of collections, Value of Collection

Purpose of scientific collection

Preservation of Specimens

Labeling

Curating of collections

Curating of types

Identification- Methods of identification

Use of keys, types of keys.

Merits and demerits of different keys

6.9.1 Description and publication

7 .Taxonomic Characters (6 hrs)

Nature of taxonomic characters

Taxonomic characters and adaptation
Kinds of taxonomic characters
(a) Morphological (b) Physiological (c) Ecological (d) Ethological and (e) Geographical characters
Taxonomic characters and classification
Taxonomic characters and evolution
Functions of taxonomic characters

8. Zoological Nomenclature (6 hrs)

Brief History of nomenclature
International Code of Zoological Nomenclature
The nature of scientific names
Species and infraspecies names
Gender of generic names
Synonyms and Homonyms
The Law of Priority
Rejection of names
Type method and different kinds of types

9. Newer trends in systematics (4 hrs)

DNA Bar coding
Molecular systematics
Chemo taxonomy and serotaxonomy
Cytotaxonomy
Numerical taxonomy
Cladistics

10. Ethics related to taxonomic publications (4 hrs)

Authorship of taxonomic papers
Correspondence
Suppression of data
Undesirable features of taxonomic papers
Taxonomist and user communities

11. Taxonomic impediments (4 hrs)

Impediments in taxonomic collections and maintenance
Shortage of man power
Lack of funding for taxonomic research
Lack of training and library facilities

11-5 Impediments in publishing taxonomic work
Solutions to overcome the impediments
(a) Improve international co-operation (b) Development of taxonomic centers
(c) Need for efficient international networking (d) the desired end product

Part- B Evolution (36 Hrs)

I. Natural Selection: (7 hrs)

Mechanism of natural selection- directional, disruptive and stabilizing selection
Natural selection in islands
Sexual selection; intrasexual and intersexual selection- secondary sexual characteristics-sexy son hypothesis, good gene hypothesis

2 The Mechanisms (7 hrs)

Population genetics- populations, gene pool, gene frequency, Hardy-Weinberg law, founder principle, bottleneck effect and genetic drift as factors in evolution

Evidence for evolution: DNA evidence, fossil evidence, embryological evidence, geological evidence, evolution in action, imperfection of evolution

Co-evolution: microevolution, macroevolution, convergent evolution (homoplasy), divergent (parallel) evolution

3 Tempo of evolution (5hrs)

Gradualism Vs punctuated equilibrium

Anagenesis Vs Cladogenesis

4 Molecular evolutions (8 hrs)

Neutral theory of molecular evolution

Molecular divergence

Molecular drive

Molecular clocks, genetic equidistance, human mitochondrial molecular clock

Phylogenetic relationships- Homology, homologous sequence of proteins and DNA, orthologous and paralogous evolution, nucleotide sequence analysis

5 Evolutionary trends (9 hrs)

Biochemical evolution- Collapse of orthogenesis

Stages in primate evolution including Homo: dry and wet nosed primates, prosimians and simians, human and the African apes, African origin for modern humans, Y chromosome Adam and mitochondrial Eve

Can evolution explain language? Communication, speech, language and self awareness in primates.

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Part -A Systematics

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Part- B Evolution

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THIRD SEMESTER THEORY

ZOL3C07 – IMMUNOLOGY (90 Hours)

1. **Introduction (1 hour)**
2. **Hematopoiesis (7 hours)**

Hematopoiesis – Lymphoid and myeloid lineages.
Hematopoietic growth factors.
Genes that regulate hematopoiesis.
Regulation of hematopoiesis.
B- Lymphocytes, T- lymphocytes and Antigen presenting cells.

3. **Antigens (8 hours)**

Immunogenicity, Antigenicity.
Factors that influence immunogenicity.
Adjuvants.
Haptens.
Epitopes.
Properties of B-cell and T- cell epitopes.

4. **Immunoglobulins (Antibodies) (10 hours)**

Structure and function of Antibody molecules.
Generation of Antibody diversity.
Immunoglobulin gene.
Antigenic determinants of immunoglobulin - (a) Isotype (b) Allotype (c) Idiotype.
B-cell receptor (BCR).
Monoclonal Antibodies.
Production of Monoclonal Antibodies (Hybridoma technology).
Clinical uses of Monoclonal Antibodies.
Antibody Engineering.

5. **Antigen Antibody interactions (10 hours)**

Strength of antigen – antibody interactions. (a) Antibody affinity (b) Antibody avidity.
Cross- reactivity.
Precipitation reactions.
Immunotechnics – ELISA, RIA, Western Blot, Immuno-electrophoresis, Flow cytometry and fluorescence.

6. **Generation of B-cell and T-cell responses. (9 hours)**

Humoral immunity.
Cellular immunity.
T- Cell receptor, TCR-CD3 complex.
Activation, maturation and differentiation of B-Cells.
Activation, maturation and differentiation of T- Cells.

7. **Immune effector mechanism. (7 hours)**

Cytokines.
Properties of cytokines.

Cytokine antagonists.
Cytokine secretion by TH1 and TH2-cells.
Cytokine related diseases. (a) Bacterial septic- shock (b) chaga's disease) (c) lymphoid and myeloid cancers.
Therapeutic uses of cytokines.
Toll- like receptors.

8. The Complement system. (6 hours)

The complement components.
The functions of complement components.
Complement activation (a) Classical pathway (b) Alternate pathway (c) Lectin pathway.
Regulation of complement system.
Biological consequences of complement activation.
Complement deficiencies.

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

General organization and inheritance of MHC.
MHC molecules and genes.
Cellular distribution of MHC.
Antigen- processing and presentation- Exogenous and Endogenous pathways.
Presentation of non- peptide antigens.

10. Transplantation immunology (8 hours)

Auto graft, Allograft, Isograft and xenograft
Immunological basis of graft rejection.
Role of cell- mediated responses.
Transplantation antigens.
General immune suppressive therapy.

11. Hypersensitivity Reactions. (5 hours)

Allergens.
IgE- mediated (type- I) hypersensitivity.
Antibody- mediated cytotoxic (type- II) hypersensitivity.
Immune complex- mediated (type- III) hypersensitivity.
TDTH- mediated (type- IV) hypersensitivity

12. Vaccines. (5 hours)

Active and passive immunization.
Whole organism vaccines.
Recombinant vector vaccines.
DNA vaccines.
Synthetic peptide vaccines.
Multivalent vaccines.

13. Immunity and malnutrition and immune deficiency diseases. (6 hours)

Immunity and malnutrition.
Primary immune deficiency diseases. (a) Burton‟s disease (b) Di-George syndrome and SCID.
Secondary immune deficiency - AIDS.

Transmission of HIV.

Vaccines to prevent AIDS.

Autoimmunity (systemic and organ specific brief)

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THIRD SEMESTER THEORY ZOL3C08–

DEVELOPMENTAL BIOLOGY & ENDOCRINOLOGY (90 Hours)

Part- A - DEVELOPMENTAL BIOLOGY (54hrs)

1. Introduction: Basic concepts of development (6 hrs)

Cell fate, potency, determination and differentiation.

1.2 Commitment

Specification - autonomous, conditional, syncytial .

Genomic equivalence and cytoplasmic determinants

Morphogenetic gradients

Genomic Imprinting

The stem cell concept- Progenitor cells, Adult stem cells, Mesenchymal stem cells, Multipotent adult stem cells, Pluripotent Embryonic stem cells, Stem cell therapy.

2. Gametogenesis, fertilization and early development (10 hrs)

Production of gametes- Spermatogenesis and Oogenesis, Ultra structure of gamates

Cell surface molecules in sperm-egg recognition in animals (sea urchin and mammals)

Zygote formation-

Encounter of sperm and egg

Capacitation

Acrosome reaction

Activation of ovum

2.3.5 Amphimixis

2.3.6. Prevention of Polyspermy (Fast block and Slow block)

Cleavage and blastula formation

Gastrulation and formation of germ layers in amphibia

Embryonic fields

3. Embryogenesis and Organogenesis (10 hrs)

Axis formation in amphibians - The phenomenon of the Organizer- Nieuwkoop center, primary embryonic induction, mechanism of axis formation

Anterior posterior patterning in Amphibians - Hox code hypothesis

Anterior posterior patterning in *Drosophila* – anterior forming genes (bicoid, hunchback), posterior forming genes (nanos, caudal), terminal forming gene (torso), segmentation genes- gap genes, pair rule genes, segmentation polarity genes, homeotic selector genes, realistor genes

Dorso- ventral patterning in *Drosophila*- dorsal protein gradient

Limb development in chick- Formation of the Limb Bud, Generating the Proximal-Distal Axis of the Limb, Specification of the Anterior-Posterior Limb Axis, Generation of the Dorsal-Ventral Axis

Insect wings and legs formation

Vulva formation in *Caenorhabditis elegans.*

Eye lens induction.

4. Cellular and Molecular basis of development (7 hrs)

Induction and competence- cascade of induction- reciprocal and sequential inductive events, instructive and permissive interactions.

Epithelial- Mesenchymal interactions- paracrine factors - The Hedhog family, The Wnt family, Juxtacrine signaling and cell patterning, notch pathway.

Cellular interactions concerned in fertilization, blastulation, gastrulation and organogenesis.

4.5. Molecular basis of cellular differentiation – Cadherins.

5. Genetic basis of development (8 hrs)

Differential gene transcription –Promoters and Enhancers, DNA methylation, Transcription factors, Silencers and Insulators.

Differential RNA processing- X chromosome inactivation- dosage compensation.

Control of gene expression at the level of translation-Differential mRNA longevity, selective inhibition of mRNA translation, Selective activation of mRNA translation, micro RNAs, Control of RNA expression by cytoplasmic localization.

Post translational regulation of gene expression.

Models of cell differentiation- hematopoiesis, myogenesis, differentiation of neural crest cells.

Reversibility of patterns of gene activity-cell fusion, transdifferentiation.

6. Metamorphosis, Regeneration and Ageing (7 hrs)

Metamorphosis in Amphibians and Insects and their hormonal control

Types of regeneration - Super, Hetero, Epimorphic, Morphallactic and Compensatory regeneration, Histological process during regeneration

Ageing – The biology of senescence, cellular and extra cellular ageing, Genes and ageing, DNA repair enzymes, Ageing and the insulin signaling cascade, The mTOR pathway, Chromatin modification, Wear and tear, Oxidative damage, Mitochondrial genome damage, genetically programmed ageing .

7. Environmental regulation of animal development (4 hrs)

Environmental regulation of normal development - types of polyphenism

Environmental disruptions of normal development (Teratogenesis) Teratogenic agents - Alcohol, retinoic acid, Bisphenol A(BPA), heavy metals, pathogen, Testicular Dysgenesis Syndrome, DES as an endocrine disruptor, Endocrine disruptors as obesogens

Environmental oestrogens.

Impact of pesticide on development.

8. Developmental Mechanisms of Evolutionary change- (2hrs)

Heterotopy, Heterochrony, Heterometry, Heterotypy. (Brief)

Part B- ENDOCRINOLOGY (36 hrs)

1. Endocrine glands and their Hormones (Brief account) (5 hrs)

Hormone secreting organs and tissues -skin, liver, kidney, heart.

General classes of chemical messengers- Peptide, thyroid, steroid hormones, neurotransmitters and pheromones

Synthesis and delivery of hormones- storage, secretion and transportation

Control of hormone secretion.

Physical characteristics of hormones - latency, post-secretary modification and half- life

Physiological roles of hormones.

2. General mechanisms of Hormonal action (5 hrs)

Hormone Receptors and transducers;

Types of receptors- g protein coupled receptors, steroid receptors and nitric oxide receptors,

Regulation of receptor number, receptor activation

Second messengers of hormone action- cAMP, cGMP, inositol triphosphate, diacylglycerol ,

Receptor signal transduction

Eicosanoids and hormone action

3. Anatomy of endocrine glands; structure, physiological functions, and control of secretion of their hormones and pathophysiology (13 hrs)

Hypothalamus

Hypophysis

Thyroid

Parathyroid

Adrenal

Pancreas

4. Hormones and male reproductive physiology (7 hrs)

Synthesis, chemistry, and metabolism of androgens

Endocrine control of testicular function

Physiological roles of androgens and estrogens

Pathophysiology

5. Hormones and female reproductive physiology (3 hrs)

Synthesis, chemistry, and metabolism of Ovarian steroid hormones

Physiological roles of Ovarian steroid hormones

Hormonal regulation of female monthly rhythm

Hormonal factors in pregnancy, parturition and lactation

6. Neurohormones (3 hrs)

Gases as neural messengers

Endorphins- physiological roles, mechanism of action and pathophysiology

Brain hormones and behaviour

Neuroendocrine pathophysiology

References

Developmental biology

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THIRD SEMESTER THEORY

ELECTIVE COURSE - FISHERY SCIENCE - I

ZOL3E09 –TAXONOMY, BIOLOGY, PHYSIOLOGY & ECOLOGY (90 Hours)

1. Fish Taxonomy (10 hrs)

Fundamentals of fish taxonomy

Classification of fin fishes – mention the following families [referring to their orders] with common or economically important examples: Hemiscyllidae, Carcharhinidae, Sphyrnidae, Notopteridae, Anquillidae, Clupeidae, Chanidae, Cyprinidae, Bagridae, Siluridae, Claridae, Heteropnuestidae, Ariidae, Salmonidae, Harpodontidae, Hemiramphidae, Belonidae, Aplocheilidae, Poecilidae, Syngnathidae, Platycephalidae, Ambassidae, Carangidae, Teraponidae, Leiognathidae, Gerreidae, Nandidae, Cichlidae, Mugilidae, Trichiuridae, Channidae, Cyanoglossidae and Tetraodontidae.

2. Integument (7 hrs)

Exoskeleton
Skin and scales
Colouration
Chromatophores and pigments
Structure, function and modification of fins

3. Locomotion (5 hrs)

Body shape and musculature

4. Life history of fishes (5 hrs)

Reproduction, reproductive hormones, reproductive behaviour, oviparity, ovoviviparity
Age and growth
Migration

5. Digestive physiology (8 hrs)

Food and feeding
Feeding behaviour
Feeding mechanism
Digestive enzymes
Absorption

6. Circulatory physiology (6 hrs)

Heart
Blood, blood cells, blood pigments and functions of blood
Circulation

7. Respiratory physiology (6 hrs)

Gills and Accessory respiratory organs
Gas transport

8. Excretory and Osmoregulatory physiology (6 hrs)

Excretory organs

Osmoregulation in marine, brackish water and fresh water fishes

9. Endocrine physiology (6 hrs)

Endocrine glands – structure and function
Regulation of endocrine secretion
Crustacean neurosecretory system and its role in reproduction

10. Adaptive physiology (6 hrs)

Deep sea fishes
Cave dwelling fishes
Hill stream fishes

11. Oceanography (15 hrs)

Ecological subdivisions of the sea
Major topographic features of continental shelf, continental slope and ocean floor
Physico-chemical properties of sea water
Ocean currents
Ocean productivity
Coral reefs

12. Brackish water ecology (5 hrs)

Characteristics of brackish and estuarine waters
Estuarine productivity

13. Limnology

Classification of inland waters – ponds, lakes, rivers and reservoirs.
Physico-chemical properties of inland waters

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FOURTH SEMESTER THEORY

ZOL4C10- BIOTECHNOLOGY& MICROBIOLOGY (90 hours)

Part - A. BIOTECHNOLOGY (54 Hrs)

1. Introduction (1 hr)

Definition, branches, scope and importance

2. Vectors (5 hrs)

Cloning vectors –

Plasmids: pBR322 and pUC

Phages: λgt10 and M13 vector

Cosmids: general features

Phagemids: general features

Viruses: SV40 and CaMV

Transposones; Ac transposon and Ds transposon of Maize, P-element of *Drosophila*

Artificial chromosomes: BAC, YAC and MAC.

Shuttle vectors: applications and example

Expression vectors: mention commonly used promoters in expression vectors (Nopaline synthase (*nos*) promoter from T-DNA, 35 S RNA promoter of CaMV, Polyhedrin promoter from Baculovirus

3. Different steps involved in *in vivo* cloning (3hrs)

Construction of chimeric DNA (Blunt end ligation, cohesive end ligation, homopolymer tailing, use of linkers)

Selection of transformed cells –blue white selection method, colony hybridization, Plaque hybridization

Amplification – Multiplication, Expression, and integration of the DNA insert in host genome

4. Molecular probes (3 hrs)

Production

Labelling

Applications

FISH, McFISH and GISH

5. Genomic and cDNA library (4 hrs)

Construction

Screening –By DNA hybridization, Screening by immunological assay, and screening by protein activity.(Refer unit 4-Molecular Biotechnology by Glick and Pasternak-ASM press)

Blotting techniques- Southern blot, Northern blot, Western blot, Dot blot and Slot blot.

Chromosome walking

6. Polymerase Chain Reaction (3 hrs)

Basic PCR – raw materials and steps involved

Inverse PCR, Anchored PCR, Asymmetric PCR, PCR for mutagenesis and Real Time PCR

Applications of PCR in Biotechnology and genetic engineering

7. Molecular markers: detection and applications (3 hrs)

RFLP
AFLP
RAPD
Minisatellites (VNTR)
Microsatellites (SSR)
SNPs

8. Isolation, sequencing and synthesis of genes (3 hrs)

Isolation (for specific proteins and tissue specific proteins)
DNA sequencing – Maxam and Gilbert's chemical degradation method, Sanger's dideoxynucleotide synthetic method.
Synthesis of gene-Chemical synthesis of tRNA gene, Synthesis of gene from mRNA, Gene synthesis machines

9. Transfection methods and transgenic animals (3 hrs)

Definition, Methods - Electroporation, DNA micro injection, Calcium phosphate precipitation, Dextran mediated transfer, shot gun method, virus mediated, lipofection method, engineered embryonic stem cell method

Transgenic animals for human welfare

10. Biotechnology - Animal and human health care (4 hrs)

Vaccines
Disease diagnosis
Gene therapy
Transplantation of bone marrow, artificial skin,
Antenatal diagnosis
DNA finger printing
Forensic medicine

11. *In vitro* fertilization (3 hrs)

In vitro fertilization and embryo transfer in human
In vitro fertilization and embryo transfer in live stock

12. Animal cell and tissue culture (3 hrs)

Culture media – natural and artificial
Culture methods – primary explantation techniques, various methods of cell and tissue culture
Tissue and organ culture

13. Gene Silencing techniques (2 hrs)

Antisence RNA
RNAi
Gene knockouts and Knock out mouse

14. Cloning- (2 hrs)

Cloning procedures (adult DNA cloning, Therapeutic cloning, Embryo cloning) – Advantages and disadvantages of cloning

15. Environmental biotechnology (3 hrs)

Pollution control – cleaner technologies, toxic site reclamation, removal of oil spill, reducing of pesticides and fertilizers, biosensors, biomonitoring.

Restoration of degraded lands - reforestation using micro propagation, development of stress tolerant plants

16. Agricultural Biotechnology (3 hrs)

Biofertilizers

Insect pest control (Pheromones, hormone mimics & analogues)

Biopesticides (Baculovirus, *Bacillus thuringiensis*, NPV)

16. Intellectual property rights (3 hr)

Intellectual property protection,

Patents, copy right, trade secrets, trademarks

GATT and TRIPS, patenting of biological materials,

International co-operation, obligation with patent applications, implications of patenting- current issues

17. The ethical and social implications - (3 hrs)

Ethics of Genetic engineering - Social impacts - Human safety-Virus resistant plants- Animals and ethics-

Release of GEOs-Use of herbicide resistant plants-Human genome alterations by biotechnology

Social acceptance of biotechnology-Transgenic crops - Social acceptance of medical biotechnology- Acceptance of GM crops for food and pharmaceutical production, Social acceptance of Industrial biotechnology.

Part-B-MICROBIOLOGY (36 Hours)

1. Introduction- (1 hr)

History and scope of microbiology

Contributions of Louis Pasteur, Robert Koch, Alexander Flemming and Edward Jenner.

2. Microbial Taxonomy and Phylogeny (3 hrs)

Major characteristics (classic and molecular)

Numerical taxonomy

Taxonomic ranks

Phylogenetic studies

Phenetic classification

Bergey's Manuel (mention major groups)

3. Bacterial cell structure and function (5 hrs)

Plasma membrane and internal system - Cytometrix, inclusions, ribosomes, nucleoid

Bacterial cell wall Peptidoglycan - structure-

Gram positive and gram negative cell wall- Mechanism of gram staining

Components external to cell wall; pili and fimbriae, capsule and slime layers, Flagella and motility

4. Microbial nutrition (4 hrs)

Nutritional requirements,

Nutritional types (Auto, Hetero, Chemo, Phototrophs & Obligate parasites)
Culture media and types of media.
Mixed microbial population and pure cultures.

5. Microbial growth (4 hrs)

Growth curve -synchronous growth
Continuous culture
Influence of environmental factors on growth
Measurement of growth
Measurement of cell numbers- Petroff, Hassuer counting Chamber, Spread plate and pour plate techniques
Measurement of cell mass-Turbidity and microbial mass measurement

6. Utilization of energy (3hrs)

Biosynthetic process-peptidoglycan synthesis, amino acid synthesis,
Non synthetic processes -Bacterial motility and transport of nutrients.(biochemical reactions not required).

7. Viruses (3 hrs)

General structural properties
Types: DNA viruses, RNA viruses, and enveloped viruses

8. Microbial diseases (4 hrs)

Human diseases caused by bacteria- Typhoid, Cholera, Tetanus, Leprosy, Tuberculosis and Pneumonia.
Human diseases caused by viruses- AIDS, Rabies, Measles, Swine Flu, Bird flu, SARS
Fungal diseases- Candidiasis

9. Control of microorganisms (4 hrs)

Disinfectants; A - physical- Heat, filtration and radiation. B- Chemical agents - Phenol and Phenolic compounds, alcohols, halogens and aldehydes.
Antibiotics- Penicillin, Cephalosporins, Chloramphenicol, Tetracyclines
Microbial drug resistance.

10. Microbial fermentation (2 hrs)

Lactic acid fermentation - Homolactic and heterolactic fermenters, Mention dairy products
-cheese and yogurt
Alcoholic fermentation.

11. Environmental microbiology (3 hrs)

Microbiological analysis of drinking water.
Microbial Bioremediation
Biogas plant.

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Part- A- Biotechnology

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Part B- Microbiology

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FOURTH SEMESTER ELECTIVE COURSE- FISHERY SCIENCE- II

ZOL4E11 - CAPTURE AND CULTURE FISHERIES (90 Hours)

1. Introduction to Capture and Culture fisheries (10 hrs)

Marine fisheries - Crustaceans, Molluscans and fin fishes

Shrimps, Crabs and Lobsters Mussels, Oysters and Cephalopods, Sardine, Mackerel, Bombay duck, Pomfretes, Ribbon fishes and Tuna

2. Freshwater fisheries (5 hrs)

Major river systems and fisheries

Lakes and reservoir fishery

3. Estuarine fisheries (5 hrs)

Major estuaries and fisheries

4. Aquaculture (5 hrs)

History of aquaculture, scope and definition, importance of aquaculture, present state of aquaculture, future prospectus

Classification of aquaculture practices

5. Design and construction of aqua farms and hatcheries (5 hrs)

Pond design and construction

Farm design and layout

Pond preparation

Cage farms

Pens and enclosures

Design and construction of hatcheries

6. Transportation and acclimatization (3 hrs)

7. Nutrition and feeds (3 hrs)

Feeding habits and food utilization

Live feeds

Artificial feeds

8. Water quality management (3 hrs)

Water quality parameters

Techniques for monitoring

Strategies for monitoring

9. Fertilizers and chemicals in aquaculture (2 hrs)

10. Reproduction and genetic selection (10 hrs)

Reproductive cycles

Control of reproduction
Induced breeding
Use of hormone analogues
Cryo-preservation of gametes
Sex reversal
Genetic selection and hybridization

11. Control of weeds, pests and predators in aquaculture (2 hrs)

12. Aquaculture practices (25 hrs)

Integrated fish farming - paddy cum fish culture, duck cum fish culture, pig cum fish culture
Polyculture
Culture of shrimps
Culture of prawns
Culture of crabs
Culture of edible oysters, pearl oysters and mussels
Culture of sea weeds
Culture of fresh water fishes - Indian major carps and exotic carps
Culture of cold water fishes - trout and mahaseer
Culture of brackish water fishes - mullets, milk fish and *Etroplus*

13. Preparation and maintenance of aquarium (5 hrs)

Types of aquaria
Preparation and maintenance
Equipments
Water chemistry
Aquarium fishes and plants

14. Pathology (7 hrs)

Major fish diseases - viral, bacterial, fungal
Protozoan infections
14.3 Control and treatment.

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FOURTH SEMESTER THEORY

ELECTIVE COURSE - FISHERY SCIENCE – III

ZOL4E12 – HARVESTING, POST HARVESTING TECHNOLOGY AND MARKETING (90 hrs)

PART- I. HARVESTING

1. Commercial fishing method (1 hr)

Brief history of commercial fishing
Introduction to materials for construction of nets and ropes

2. Crafts and gears for harvesting (21 hrs)

Towed or dragged gear
Bottom trawling
Beam trawl
Otter trawl
Side trawling
Stern trawling
Bottom pair trawling
Mid water (pelagic) trawling
Targeted and selective trawling
Turtle excluder device (TED)
Dredging
Encircling gear
Beach seining
Purse seining
Seine nesting
Static gear
Gill nets
Trap nets
Long lines
Pots and traps
Other gears
Squid jigging
Net fishing
Harpooning
Fish aggregating devices (FAD)
Echo-sounder and sonar
Catch per unit effort and economic consideration of vessel operations.
2.8 Onboard handling and processing

Part-II- POST HARVEST TECHNOLOGY

3. Chemical composition of fish (2 hrs)

Chemical composition of fish muscle
Significance of proteins and lipids
Nutritive value of fish muscle over red meat

4. Post-mortem changes in fish muscle (4 hrs)

Pre-rigor mortis and post mortem changes
Physical and biochemical changes associated with the post mortem changes
Importance of post mortem changes in fish processing
Problems associated with post mortem changes and solutions

5. Fish spoilage mechanisms (4 hrs)

Microbial spoilage
Enzymatic spoilage
Biochemical spoilage

6. Handling of fresh fish (3 hrs)

Icing and icing methods
Different types of ice - block ice, flake ice and dry ice
Handling - on board chilling and use of refrigerated sea water (RSW)
Fish landing platforms
Hygienic handling of fish on board and on shore

7. Methods (Techniques) of processing/preservation and their products (10 hrs)

Drying
Salting
Smoking
Freezing - plate freezers, blast freezers and individual quick freezing (IQF)
Battered and breaded products
Accelerated freeze drying (AFD)
Immersion freezing and cryogenic freezing
Canning
Irradiation
Assessment of capacity of plate, blast and IQF freezers

8. Processing of shrimps (3 hrs)

Commercially important prawns and shrimps of India
Pre-processing of prawns and shrimps into different varieties - peeled and devined (PD), peeled and undevined (PUD), head-less shrimps (HI), head on shrimps (HON)
Grades of shrimps
Cooked shrimps
IQF shrimp

9. Processing of lobsters (3 hrs)

Commercially important lobsters of India
Pre and processing lobsters into different varieties of products
Grades of packing

10. Processing of cephalopods (3 hrs)

Commercially important cephalopods (squids and cuttlefish) of India
Pre-processing of cephalopods into different varieties
Grades of packing

11. Processing of fish (4 hrs)

Commercially important fishes of India
Fish filleting
Surimi
IWP products, grades for fish products

12. Fishery by-products (9 hrs)

Body oil, liver oil and sauces
Shark fins, fin rays, fish maws/isinglass
Fish silage, chitin and chitosan
Fermented fishery products

13. Fish processing plant and cold storage (2 hr)

The pre-processing and processing plant, cold storage – general conditions relating to premises ,building, equipment, general conditions of hygienic of plant and workers, conditions of storage of frozen products Requirements for registration with MPEDA, approval of processing plant by FIA allotment code

14. Quality control (7 hrs)

Fundamental aspects of quality
Major quality problems in sea foods
Quality of water and ice-chlorination and use of UV rays
Microbiology
Microbial hazards of sea foods - *E. coli, Salmonella, V. cholerae, Staphylococcus*
Inspection systems
Brief introduction to the quality control concepts of HACCP, ISO and IQM (total quality management)

15. Packing and export of seafood (4 hrs)

Methods of packing of various sea food products for export
Identification marks
In house stuffing and transport in refrigerated containers

16. Fishery education, research, development and export promotion agencies (3 hrs)

Objectives and activities of the following institutions (very brief) – CIFT, CMFRI, CIRNET, NIO, FSI, CIBA, FIA, MPEDA

Objectives of fishery extension

Qualities for fishery extension workers

Organizations of extension programs

Part- III- FISHERY MANAGEMENT AND INTERNATIONAL MARKETING

17. Fishery management (2 hrs)

Marketing of fish in India

Fisherman and fisherman co-operatives

18. International marketing (4 hrs)

Scope and importance.

Major sea food products and markets of India.

Documents required for export - letter of credit, invoice, bill of landing etc.

Buyers and buyers agents

Trade promotion

Role of trade promotion offices and embassies

Seafood trade fairs

Trade promotion visits

Value added products and its marketing.

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