Course Name : Master of Science
Discipline : Zoology
COURSE SCHEME:
(For those who joined in June 2024 and after)

I year M.Sc. ZOOLOGY

Semester	Part	Subject Name	Hours	Credit	Int + Ext =Total	Local	Regional	National	Global	Professional Ethics	Gender	Human Values	Environment & Sustainability	Employability	Entrepreneurship	Skill Development	Subject Code	Revised / New / No Change / Interchanged & Percentage of Revision
I	Core 1	**Cell and Molecular Biology**	6	4	25+75=100	✔				✔	✔	✔	✔	✔	-	✔	**P24ZYC11**	**New**
	Core 2	**Biochemistry**	6	4	25+75=100	✔				✔	✔	✔	✔	✔	-	✔	**P24ZYC12**	**New**
	Core 3	**Techniques in Biology**	6	4	25+75=100	✔				✔	✔		✔		✔	✔	**P24ZYC13**	**New**
	Core 4	**LAB: Cell and Molecular Biology**	3	3	40+60=100	✔				✔	✔		✔		✔	✔	**P24ZYCP11**	**New**
	Core 5	**LAB: Biochemistry**	3	3	40+60=100	✔				✔	✔			✔	✔	✔	**P24ZYCP12**	**New**
	Elective 1	**Aquaculture**	6	4	25+75=100		✔						✔	✔		✔	**P24ZYE11**	**New**
	Total		**30**	**22**														
II	Core 6	**Molecular Genetics**	7	4	25+75=100	✔						✔		✔		✔	**P24ZYC21**	**New**
	Core 7	**Ecology**	6	4	25+75=100	✔				✔	✔			✔	✔	✔	**P24ZYC22**	**New**
	Core 8	**Biostatistics and Bioinformatics**	7	5	25+75=100	✔						✔		✔		✔	**P24ZYC23**	**New**
	Core 9	**LAB: Molecular Genetics**	3	3	40+60=100	✔						✔		✔		✔	**P24ZYCP21**	**New**
	Core 10	**LAB: Ecology**	3	3	40+60=100	✔						✔		✔		✔	**P24ZYCP22**	**New**
	NME	**Economic Zoology**	4	4	25+75=100	✔						✔		✔		✔	**P24ZYN21**	**Revised 25%**
	Total		**30**	**23**														
	Internship Programme (Industrial training) during Vacation																	

TENTATIVE SYLLABUS STRUCTURE TABLE

III Semester			
Core 11	Developmental Biology	6	4
Core 12	Immunology	6	4
Core 13	Evolution	6	4
Core 14	Lab – Developmental Biology	3	3
Core 15	Lab – Immunology	3	3
Elective 2	Research Methodology	6	4
IV Semester			
Core 16	Animal Physiology	6	4
Core 17	Microbiology	6	4
Core 18	Animal Biotechnology	6	4
Core 19	Lab – Animal Physiology	3	3
Core 20	Lab – Microbiology	3	3
Elective 3	Project	6	5
	Total		90

SEMESTER: I

CORE: 1	**CELL AND MOLECULAR BIOLOGY**
Contact hours per Week – 6 hours	***Credits: 4***
Contact hours per Semester – 90 hours	***Subject Code:*** **P24ZYC11**
Course Outcomes: Upon successful completion, the students will be able to:	
CO1: Explain the ultrastructure and functions of subcellular organelles at molecular level in an animal cell.	
CO2: Illustrate that fundamental structural units define the function of all living things.	
CO3: Apply concepts from other sciences to interpret the cellular processes.	
CO4: Understand the nature of cancer and the processes underlying cancer formation and progression.	
CO5: Identify and explain the important checkpoints that a cell passes through during the cell cycle.	

Unit – I **(18 hours)**

Biomembranes: Molecular organization; transmembrane domains – transport across membrane: passive transport: diffusion and facilitated diffusion – active transport: ion channels; active transport driven by ATP hydrolysis; ion gradients – cell-cell adhesion:

selectins; immunoglobulin superfamily; cadherins – Basic elements of cell signalling: Cell surface receptors; second messenger system; signaling from plasma membrane to nucleus

Unit II **(18 hours)**

Organization and functions of mitochondria: oxidative metabolism in mitochondria; electron transport complexes. Structure and functions of peroxisomes: diseases associated with peroxisomal functions. Ultrastructure and functions of Endoplasmic Reticulum: synthesis of secretory proteins; membrane biosynthesis; glycosylation of proteins; destruction of misfolded proteins Organization and functions of Golgi complex: protein glycosylation; lipid and polysaccharide metabolism; protein sorting and export; mechanism of vesicular transport Organization and functions of Lysosomes: lysosomal storage disorders

Unit III **(18 hours)**

Ultrastructure of interphase nucleus; nuclear envelope and nuclear pore; transport of molecules through nuclear pores – Levels of organization of chromosome: structure of metaphase chromosome; Euchromatin and heterochromatin: constitutive and facultative heterochromatin; X Chromosome inactivation and histone modification – giant chromosome – nucleolus

Unit IV **(18 hours)**

Phases of Cell cycle: G_0, G_1, S, G_2 Phases and M Phase: formation of mitotic chromosome; molecular organization of mitotic spindle; spindle assembly and chromosome attachment; cytokinesis; cell cycle checkpoints; Regulators of cell cycle progression: protein kinases, cyclins and growth factors – stages of meiosis

Unit V **(18 hours)**

Cancer: Growth properties of cancer cells; tumour suppressor genes: RB and p53; Oncogenes: proteins encoded by oncogenes; viral oncogenes; strategies for combating cancer Apoptosis: events of apoptosis; role of caspases; regulation of apoptosis by Bcl-2 family proteins and signalling pathways of apoptosis

Text book:

1. Cell and Molecular Biology, 4th Edition, 2020, Rastogi, S.C., New Age International Pvt. Ltd., New Delhi
2. Cell and Molecular Biology, 5th Edition, 2017, Gupta, P.K., Rastogi Publications, Meerut

Reference books:

1. Karp's Cell and Molecular Biology: Concepts and Experiments, 9th Edition, 2020, Janet Iwasa and Wallace Marshall, John Wiley & Sons Inc
2. The Cell: A Molecular Approach, 8th Edition, 2019, Geoffrey M. Cooper, Oxford University Press

3. Becker's World of the Cell, 8th Edition, 2012, Jeff Hardin, Gregory Bertoni and Lewis J. Kleinsmith, Pearson Benjamin Cummings
4. Essential Cell Biology, 5th Edition, 2019, Bruce Alberts, Karen Hopkin, Alexander Johnson, David Morgan, Martin Raff, Keith Roberts, and Peter Walter, W. W. Norton & Company, Inc
5. Molecular Cell Biology, 8th Edition, 2016, Arnold Berk, Chris A. Kaiser, Harvey Lodish, Angelika Amon, Hidde Ploegh, Anthony Bretscher, Monty Krieger, and Kelsey C. Martin, Macmillan Learning

e-Resources:

1. http://www.cellsalive.com/
2. https://www.biointeractive.org/classroom-resources/electron-transport-chain
3. https://ugcmoocs.inflibnet.ac.in/assets/uploads/1/41/1083/et/L2020022006060202494 9.pdf
4. https://ugcmoocs.inflibnet.ac.in/assets/uploads/1/41/1086/et/L2320022006060202282 8.pdf
5. https://ugcmoocs.inflibnet.ac.in/index.php/courses/moocs
6. https://www.ncbi.nlm.nih.gov/books/NBK9839/?depth=10
7. https://learninglink.oup.com/access/content/cooper8e-student-resources/cooper8e-chapter-11-video-1
8. https://learninglink.oup.com/access/content/cooper8e-student-resources/cooper8e-chapter-15-video-1
9. https://learninglink.oup.com/access/content/cooper8e-student-resources/cooper8e-chapter-16-video-3
10. https://learninglink.oup.com/access/content/cooper8e-student-resources/cooper8e-chapter-18-animation-4
11. https://www.biointeractive.org/classroom-resources/role-p53-cell-cycle
12. https://www.biointeractive.org/classroom-resources/eukaryotic-cell-cycle-and-cancer
13. https://www.biointeractive.org/classroom-resources/ubiquitin-and-proteasome

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CORE: 2	**BIOCHEMISTRY**
Contact hours per Week – 6 hours	***Credits: 4***
Contact hours per Semester – 90 hours	***Subject Code:*** **P24ZYC12**
Course Outcomes: Upon successful completion, the students will have the knowledge and skills to:	
CO1: Define structure and types of chemical bonds in biomolecules.	
CO2: Identify the structural significance and metabolic process of biomolecules.	
CO3: List various biomolecules classification and their mechanism which enhance their bioactive reaction.	
CO4: Analyze biomolecule in biological system and relate deficiency disorders.	
CO5: Interpret lipid metabolism and their importance.	

Unit–I **(18 hours)**

Structure of atom and Chemical Bonds-Ionic bond, Covalent bond, Hydrogen bond, van der Waals force; Water-properties, Structure; pH and Buffer-acid and bases, Ionization of weak acid, Henderon-Hasselbalch equation, Bicarbonate and Phosphate buffers, acid-base balance of the body-buffer system of body fluids, respiratory mechanism, renal regulations, abnormalities of acid – base balance.

Unit –II **(18 hours)**

Bioenergetics – thermodynamics- First law of thermodynamics- Energy, Enthalpy; Second law of thermodynamics- Spontaneity and Disorder, Entropy, Measurement of Entropy; Free Energy-Gibbs Free energy, Free energy and work; Chemical Equilibria-Equilibrium constants, Standard free energy changes, coupled reactions; Biological Oxidation-Oxidation-Reduction, Electron transport chain; High Energy phosphate compounds.

Unit–III **(18 hours)**

Carbohydrates–classification, structure, properties and functions–glucose, fructose, galactose, lactose, maltose, sucrose, starch, glycogen and cellulose; Carbohydrates metabolism-Glycolysis, Citric acid cycle, Gluconeogenesis, Glycogenesis, Glycogenolysis, HMP shunt; Glycogen storage diseases; Hormonal regulation of blood sugar-glucose tolerance test.

Unit–IV **(18 hours)**

Aminoacid– Classification, Structure, properties of aminoacids, amphoteric nature, isoelectric point, isoelectric pH and zwitter ion; protein – classification and structural organization of proteins- Primary, Secondary, Tertiary and Quaternary; biochemistry and biosynthesis of insulin, haemoglobin, Purine and pyrimidine bases; Enzymes- Nomenclature, Classification, Mechanism of enzyme action – types of inhibition, Factors affecting enzyme activity; Coenzymes and Isoenzymes.

Unit–V **(18 hours)**

Lipids-Classification, Structure and properties of triglyceride, phospholipid, glycolipid, derived lipids- steroids and cholesterol, terpenes, prostaglandins, and carotenoids; Lipid metabolism- Beta Oxidation of fatty acids; Ketone bodies-structure, ketogenesis, utilization of ketone bodies, over production of ketone bodies, regulation of ketogenesis; Biosynthesis of cholesterol; Vitamins – Structure and functions of ascorbic acid, thiamine, riboflavin, niacin and cyanocobalamine.

Text books:

1. J.L. Jain, "Fundamentals of Biochemistry", S. Chand Company Ltd., 1997.
2. U.Satyanarayana and U.Chakrapani, "Biochemistry", Books and Allied (P) Ltd, Kolkata, India 2017.

3. Ambika Shanmugam, "Fundamentals of Biochemistry for Medical student, Seventh Edition, Nagaraj and Company Private Ltd., Chennai, 2008.
4. S.C. Rastogi, "Biochemistry", Third Edition, Tat McGraw Hill Education Private Ltd., New Delhi, 2010.

Reference books:

1. Glasstone, "Thermodynamic for Chemists", Litton Educational Publishing, Inc., New York, 1947.
2. Mukhtar Ahmad, "Text Book of Modern Biochemistry", Oxford and IBH publishing Co. Pvt Ltd., 1995.
3. M.M.Cox and D.L.Nelon, "Lehninger Principles of Biochemistry", Fifth Edition, W.H. Freeman and Company, New York, 2010.
4. R.K.Murray, D.K. Granner, P.A. Mayes and V.W. Rodwell, "Harper's Biochemistry", 25th Edition, McGraw Hill, 2000.
5. D.Voet and J.G. Voet, "Biochemistry", Second Edition, John Wiley and Sons, Inc., 1995.
6. T.M.Delvin, " Text Book of Biochemistry with Clinical Correlations", Fourth Edition, John Wiley and Sons, Inc., 1997.
7. D.T. Haynie, "Biological Thermodynamics", Second Edition, Cambridge University Press, 2008.
8. E.A. Newsholme and T.R. Leech, "Functional Biochemistry in Health and Disease", John Wiley and Sons Led., 2010.

e-Resources:

1. https://ugcmoocs.inflibnet.ac.in/index.php/courses/view_ug/353
2. https://ugcmoocs.inflibnet.ac.in/index.php/courses/view_ug/141
3. https://ugcmoocs.inflibnet.ac.in/index.php/courses/view_pg/671
4. https://youtu.be/haO3ChM2wUs
5. https://youtu.be/mdb4YBS-Bu0
6. https://youtu.be/6Hv72iFjTlo
7. https://youtu.be/wBJ5LrasEmw
8. https://youtu.be/QHfFuVoPYUs
9. https://youtu.be/lOVskNjOLKo
10. https://youtu.be/s_zFlHzd1Yo
11. https://youtu.be/NUKu3LEEcYc
12. https://youtu.be/9QrCwFm_Vf4
13. https://youtu.be/fFtUuh3DRhc

CORE: 3	**TECHNIQUES IN BIOLOGY**
Contact hours per Week – 6 hours	***Credits: 4***
Contact hours per Semester – 90 hours	***Subject Code:*** **P24ZYC13**

Course Outcomes:

Upon successful completion, the students will have the knowledge and skills to:

CO1:	Understanding the multiplication of desired genes using PCR techniques, DNA and protein sequencing, C – value paradox and various blotting techniques with their applications.
CO2:	Describing the principle and applications of various microscopic techniques.
CO3:	Understanding the separation techniques such as chromatography and centrifugation.
CO4:	Explaining various Spectroscopic Techniques.
CO5:	Applying radioisotope techniques in biology.

UNIT-I **(18 hours)**

Microscopic Techniques:

Principle and applications of Light and Phase contrast microscopes; Principle of Freeze Fracture and Freeze Etching Techniques; Basic theory and applications of Transmission Electron Microscope and Scanning Electron Microscope; Principle and applications of Fluorescence, Confocal and Atomic Force Microcopy.

UNIT-II **(18 hours)**

Separation Techniques: Basis and applications of thin layer chromatography, gel filtration, ion exchange, affinity, High Performance Liquid Chromatography (HPLC). Principle and applications of Polyacrylamide gel electrophoresis (PAGE) and AGE. Instrumentation of Centrifuges and their types: Differential and Density gradient centrifugation.

UNIT-III **(18 hours)**

Recombinant DNA Methods: Polymerase Chain Reactions (PCR): practical aspects of PCR- primers and other components of PCR; principles and applications of PCR. Types of PCR: Reverse Transcriptase PCR (RT-PCR) and Multiplex PCR. DNA Sequencing: Chemical cleavage method Sanger's method. Automated DNA Sequencing. Principle and steps of Protein Sequencing. Genes and C – value paradox: DNA denaturation and renaturation. Principle and applications of nucleic acid hybridizations; Blotting techniques: Principle and applications of Southern, Northern and Western blotting techniques.

UNIT-IV **(18 hours)**

Spectroscopic Techniques: Principle and applications of ultraviolet, visible, electron spin resonance (ESR) and nuclear magnetic resonance (NMR) spectroscopy; Molecular

structure determination by X-ray diffraction; Principle and applications of mass spectroscopy (MS); Biological applications of Atomic absorption and plasma emission spectroscopy.

UNIT-V **(18 hours)**

Radioisotope Techniques: Nature of radioactivity; radioactive isotopes; detection and measurement of radioactivity: Biological applications of radioisotope techniques. Flow Cytometry: Instrumentation, Fluorescence-Activated Cell Sorting (FACS), Fluorescence Labels, Fluorescent Dyes and Applications.

Text books:

1. Dr. P. K. Bajpai, "Biological Instrumentation and Methodology (Tools & Techniques of Biology), S. Chand and Company, Second Edition, 2010.

UNIT	PAGE NO
UNIT I	126 – 133 203 - 240
UNIT II	21 - 49
UNIT III	159 - 190
UNIT IV	---------
UNIT V	134 - 145

2. Andreas Hofmann and Samuel Clokie, "Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology", Cambridge University Press, Eighth Edition, 2018.

UNIT	PAGE NO
UNIT I	73 – 176
UNIT II	381 – 420
UNIT III	196 – 209 424 – 452
UNIT IV	454 – 498 535 – 557
UNIT V	287 - 312 313 – 344

Reference books:

1. Michael Wink, "An Introduction to Molecular Biotechnology", Wiley Blackwell, Second Edition, 2011.
2. Wilson K and Walker J, "Principles and Techniques of Practical Biochemistry", Cambridge University Press, Fourth Edition, 1994.

3. Braithwaite A and Smith F J, "Chromatographic Methods", Chapman Hall, London, Fourth Edition, 1985.
4. Plummer D T, "Practical Biochemistry", Tata McGraw Hill Publications, Third Edition, 1987.
5. Brown T A, "Gene Cloning and DNA Analysis: An Introduction'', Wiley Blackwell, Seventh Edition, 2016.

e-Resources:

1. https://youtu.be/JmveVAYKylk
2. NPTEL - Module 3 PCR :https://nptel.ac.in/courses/102/103/102103013/
3. https://biocyclopedia.com/index/cell_biology_methods/freeze_fracture_and_freeze_etching.php
4. https://youtu.be/BbBK4T5Yr3M
5. https://my.eng.utah.edu/~lzang/images/Lecture_10_AFM.pdf
6. https://youtu.be/ZN7euA1fS4Y?t=105
7. https://youtu.be/i_6y6Z5UvwE
8. https://youtu.be/RqBAW-uFHK0
9. https://youtu.be/SQucmCTpdgg
10. https://youtu.be/ieEeFKrFBIg
11. https://youtu.be/rjuFrk0-AOw

CORE: 4	**LAB: CELL AND MOLECULAR BIOLOGY**
Contact hours per Week – 3 hours	***Credits: 3***
Contact hours per Semester – 45 hours	***Subject Code:* P24ZYCP11**
Course Outcomes: At the end of the semester, students will be able to	
CO1: construct a compound microscope.	
CO2: measure the size of cells using micrometer.	
CO3: identify the stages of mitotic and meiotic cell divisions.	
CO4: distinguish the cellular constituents in the blood of different organisms.	
CO5: localize the macromolecules in histological sections.	

1. Bright field and Phase contrast microscopes – Principle, operation, and applications
2. Measurement of cell size using micrometer
3. Isolation of mitochondria from goat liver by differential centrifugation
4. Observation of mitosis using the preparation of chromosomes from onion root tip
5. Observation of meiosis using the preparation of chromosomes from grasshopper testis – Demonstration only
6. Observation of giant chromosome in the salivary gland of *Chironomous* larvae
7. Preparation of cellular constituents in the blood smear of human, fish and haemolymph of insect

8. Isolation of DNA from animal cell – Determination of tm value
9. Microtechnique: Fixation, Dehydration, Infiltration, Embedding, Sectioning and Staining.
10. Histochemical localization of Carbohydrates, Proteins, Lipids and Nucleic acids

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CORE: 5	**LAB: BIOCHEMISTRY**
Contact hours per Week – 3 hours	***Credits: 3***
Contact hours per Semester – 45 hours	***Subject Code:*** **P24ZYCP12**
Course Outcomes: At the end of the semester, students will be able to	
CO1: Student knows how to prepare Buffer.	
CO2: Can estimate the Enzyme activity.	
CO3: Expertise in handling the Colorimeter instrument.	
CO4: Acquires the knowledge of separating pigments and proteins	

1. Preparation of Buffer
2. Titration curve – Estimation of pKa value of a Weak acid by pH meter
3. Effect of temperature on Salivary amylase activity
4. Determination of Km and Vmax value of Salivary amylase
5. Verification of Beer – Lambert law using $CuSO_4$
6. Estimation of Carbohydrate – Anthrone method
7. Estimation of Proteins –Lowry method
8. Estimation of vitamin C in lemon fruit
9. Separation of Pigments by Thin Layer Chromatography
10. Separation of protein by SDS-PAGE
11. Spotters - pH Meter, Titration curve, Centrifuge, spectrophotometer and paper chromatography, SDS Phage, HPLC.

ELECTIVE: 1	**AQUACULTURE**
Contact hours per Week – 6 hours	***Credits: 4***
Contact hours per Semester – 90 hours	***Subject Code:*** **P24ZYE11**
Course Outcomes: Upon successful completion, the students will have the knowledge and skills to:	
CO1: To gain knowledge on site selection and construction of fishpond and various types of fishponds.	
CO2: To learn induced breeding technique of commercially important cultivable fishes	
CO3: To understand the nutritional requirements of live and artificial fish feed.	
CO4: To know the common fish diseases, treatment, and control measures.	

CO5: To study the types of fishing Crafts and gears and methods of fish preservation.

UNIT– I **(15 Hours)**

Scope of aquaculture - Status of aquaculture in India –- Types of culture - milk fishes –Site selection and Construction of ponds– types of ponds - soil and water quality– preparation and fertilization of fishpond- management – predator and weed control.
Shrimp farming: shrimp hatchery, processing and export

UNIT– II **(20 Hours)**

Cultivable freshwater fishes (Common carp,Catla, Rohu, and Mrigal) and marine species. Barracuda (Sheela fish) - Whiteleg shrimp (*Litopenaeusvannamei)* Fish Breeding– bundh breeding– Hyphophysation; Principle, procedure and advantages- types of synthetic hormones – seed transport. Fish feed - Types: live feed culture– phytoplankton (diatoms) Zooplanktons (Rotifers) Artemia, Chironomous larvae Formulations and preparation of formulated fish feed

UNIT– III **(20 Hours)**

Ornamental fish culture – Introduction– Common ornamental fishes (sword tail, angel fish, zebra fish, black molly, guppy, common goldfish, clown fish)- construction of fish tank (base covering and stocking of fish), aquatic ornamental plants
Breeding methods of Goldfish, Guppy, Molly.

UNIT– IV **(20 Hours)**

Types of fish culture – monoculture, composite fish culture, integrated fish culture - Animal husbandry and Agriculture. Fish parasites and diseases - Ectoparasite (Argulus and Lernea), Endoparasite (Ligulosis), Bacterial (Gill rot, Erthroderma), fungal (Gill rot, Saprolegniasis), Viral (EUS, Viral Haemorrhagic Septicaemia) and protozoan diseases.

UNIT– V **(15 Hours)**

Fishing crafts (Coracle, Kattumaram, Trawler, Dredgers) and gears (Trawl nets, Cast nets, Gill nets) and hook and line– fish preservation– principles and methods– marketing– Economics of aquaculture.

Text books:

1. N. Arumugam, "Aquaculture", Saras Publication, Nagercoil. 2010.
2. G. Santhanakumar and A.M. Selvaraj, "Concepts of Aquaculture", Meenam Publications, Nagercoil. 2005.

Reference books:

1. V.G. Jingaran, "Fish and Fisheries of India", Hindustan publishing Co., New Delhi, 1997.
2. S.C. Agarwal, "A hand book of fish farming", Narandendra publishing house, Delhi, 1994.

3. S.B. Zade, C. Khune, S.R. Site and R.V. Jigare, "Principles of Aquaculture", Himalaya Publishing House, Mumbai, 2011.
4. S.K. Gupta and P.C. Gupta, "Principles of Aquaculture", S. Chand publications – New Delhi, 1990.

SEMESTER - II

CORE: 6	**MOLECULAR GENETICS**
Contact hours per Week – 7 hours	***Credits: 4***
Contact hours per Semester – 105 hours	***Subject Code:*** **P24ZYC21**
Course Outcomes:	
CO1: Predict the genotypic and phenotypic ratios in the meiotic products.	
CO2: Perform a quantitative analysis of the progeny of a dihybrid testcross to assess whether the two genes are linked on the same chromosome.	
CO3: Illustrate the features of DNA replication and the machineries that contribute to its speed and accuracy.	
CO4: Compare and contrast the critical roles played by different kinds of RNA in protein synthesis.	
CO5: Differentiate the molecular mechanisms of gene regulation in eukaryotes and bacteria.	
CO6: Describe human genetic diseases that are caused by genetic changes.	

Unit – I **(18 hours)**

Mendel's postulates: Law of segregation and law of independent assortment; Molecular basis of Mendelian inheritance pattern: alleles at the molecular level – Chromosome theory of heredity: Gene mapping by linkage analysis; Three-point test cross; Linkage and Crossing over; Sex linked genes in human; Sex chromosomes and Sex determination; Dosage compensation of X linked genes – Genetic transfer in bacteria – Evolutionary significance of recombination

Unit – II **(18 hours)**

Changes in chromosome structure: deletion and duplication; rearrangements of chromosome structure: inversions, translocations, compound chromosomes and Robertsonian translocations.Variation in chromosome number: Aneuploidy, Polyploidy; types of polyploidy; evolutionary significance of polyploidy; meiotic nondisjunction: Monosomy and Trisomy in human. Types and causes of mutation – molecular basis of mutation. DNA repair mechanisms: photo reactivation; excision repair; recombination repair; SOS repair.

Unit III **(18 hours)**

Experimental evidences for DNA as genetic material; Physical properties of DNA; Chargaff's rule; alternate forms of DNA; DNA Replication in Prokaryotes and Eukaryotes;

models of replication; Enzymology of DNA replication; Proof reading activity of Replication apparatus; Role of DNA polymerase, helicases, ligase, and topoisomerases in Replication.

Unit – IV **(18 hours)**

Transcription in Prokaryotes and Eukaryotes; types of RNA. Post transcriptional modifications in eukaryotes: Capping, poly adenylation, splicing of introns and RNA editing; Role of snRNPs in pre-mRNA splicing. Genetic code: Properties of genetic code; deciphering the code. Translation: functional role of tRNA and ribosomes in protein synthesis.

Unit – V **(18 hours)**

Gene regulation in prokaryotes: Induction and suppression of *lac* operon in *E. coli*; Attenuation of *trp* operon; Positive and Negative control of *ara* operon; post translational regulatory mechanisms. Gene regulation in eukaryotes; alternate splicing of RNA; histone modification; heat shock genes; cytoplasmic control of mRNA stability; enhancers and silencers; transcription factors; RNA interference by miRNA and siRNA; activation and inactivation of whole chromosomes.

Text book:

1. William S. Klug, Michael R. Cummings, Charlotte A. Spencer, Michael A. Palladino, Darrell Killian, Concepts of Genetics, Pearson Education, 11th Edition, 2019
2. Veer Bala Rastogi, Genetics, Medtech Publishers, 4th Edition, 2019

Reference books:

1. D. Peter Snustad and Michael J. Simmons, Principles of Genetics, John Wiley & Sons Inc, 7th Edition, 2016
2. Anthony J.F. Griffiths, Susan R. Wessler, Sean B. Carroll and John Doebley, Introduction to Genetic Analysis, W.H. Freeman & Company, 11th Edition, 2015,
3. Robert J. Brooker, Genetics: Analysis and Principles, McGraw-Hill Education, 6th Edition, 2018
4. Jocelyn Krebs, Stephen Kilpatrick, and Elliott Goldstein, Lewin's Genes XI, Jones & Bartlett Learning, 2014
5. James D. Watson, Tania A. Baker, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Losick, Molecular Biology of the Gene, Pearson Education Inc, 7th Edition, 2013

e-Resources:

1. http://opengenetics.net/open_genetics.html
2. https://www2.le.ac.uk/projects/oer/oers/genetics/oers/Patterns%20of%20inheritance/Patterns%20of%20inheritance-TRF.pdf
3. https://www2.le.ac.uk/projects/oer/oers/genetics/oers/ger/ger.pdf
4. https://www2.le.ac.uk/projects/oer/oers/genetics/oers/DNA%20Genes%20and%20chromosomes/DNA%20Genes%20and%20chromosomes-TRF.pdf
5. https://www.youtube.com/watch?v=iJGY1boNOdg (Recombination in Bacteria)

6. https://www.youtube.com/watch?v=IJQv1H-2IoI (Splicing mechanism and its importance)
7. https://www.youtube.com/watch?v=CaCq4gglw0g (Lac Operon concept)
8. https://www.youtube.com/watch?v=Wv9csJGYLmU (Heat shock protein)
9. https://www.youtube.com/watch?v=-AhKTeekXYg (Trp attenuation)
10. https://www.youtube.com/watch?v=TAZgW6222fs (Gene regulation in Prokaryotes vs Eukaryotes).

CORE: 7	**ECOLOGY**
Contact hours per Week – 6 hours	***Credits: 4***
Contact hours per Semester – 90 hours	***Subject Code:* P24ZYC22**
Course Outcomes: Upon successful completion, the students will be able to:	
CO1: study the concept and components of ecosystem.	
CO2: understand the characteristics of population and to learn its interaction with environment.	
CO3: sensitize the students on the careful utilization of environmental resources.	
CO4: analyse the problems associated with mismanagement of resources.	
CO5: create environment awareness among students.	

Unit – I **18 hours**

Ecosystem: concept and components; Light and temperature as limiting factors; trophic structure of ecosystem Functions of ecosystem: productivity, energy flow: food chain, food web, trophic levels, and ecological pyramids. Homeostasis - cybernetic nature; stability Biogeochemical cycles; Carbon, Nitrogen, Sulphur, Phosphorus and water.

Unit – II **18 hours**

Population: characteristics, density, natality, mortality, survivorship curve, life tables; Biotic potential, growth curves, growth models, fluctuations, structure, concept of r and k selection; Life history traits and tactics; population regulation: density dependent and density independent factors; Inter and Intraspecific interactions: parasitism, predation, competition, commensalism, mutualism.

Unit – III **18 hours**

Community: Characteristics and structure

Physical structure: growth forms; stratification: vertical, horizontal and temporal stratification, seasonality, periodicity

Biological structure: species abundance, species diversity, species dominance, diversity indices; factors regulating species diversity

Ecological niche: types, guild, ecotone and edge effect; concept of climax; ecological succession; ecological indicators

Unit- IV **18 hours**

Resource ecology- concept and classification; Renewable resources: solar energy, hydropower, wind, biomass, biofuels, wave and tidal energy, geothermal energy

Non-renewable resources: fossil fuels: coal, oil, natural gas, nuclear fuels

Biodiversity: types; importance and threats to biodiversity; Endangered species; biodiversity conservation - *in situ, ex situ* and *in vitro* – impact of alien/ invasive/ non-indigenous species on biodiversity

Unit -V **18 hours**

Climate change: Problems of climate change: global warming; melting of glaciers and polar icecaps; sea level rise

Hazards of climate change: forest fire; heat waves; drought; floods; cyclones, hurricanes and typhoons; loss of biodiversity and impact on flora and fauna; health effects; food security; climate refugees

Role of bioindicators and bioaccumulators in environmental monitoring, GIS, environmental organizations in India, remote sensing and its applications; Role of government, media in environmental education.

Text books:

1. T.K Saha," Ecology and Environmental Biology", Books and Allied (P) Ltd, Kolkata, India. 2013.
2. N.S Subrahmanyam, and Sambamurty, "Ecology", NarosaPublshing house, New Delhi, India, 2000.

Reference books:

1. H.D Kumar," Modern Concepts of Ecology", 8th Edition, Vikas Publishing House Pvt. Ltd, 1997.
2. E.P. Odum, "Basic Ecology", Saunders College Publishing,1983.
3. Richard T. Wright, Dorothy F. Boorse, Environmental Science Toward a Sustainable Future, 11th Edition, Pearson Education Inc., 2011
4. E.J. Koramandy, "Concepts of Ecology", 3rd Edition, Prentice Hall of India Pvt. Ltd,1986.
5. K.C. Agarwal, Biodiversity, Agro Botanical Publishers (India), 1996
6. M.C Dash and S.P Dash, "Fundamentals of Ecology",Tata McGraw Hill Education Private Ltd., New Delhi, 2010.
7. MN William, Biodiversity, CBS Publishers & Distributors, 2019
8. Suruchi Singh, Pradeep Singh, S. Rangabashiyam, K.K. Srivastava, Global Climate Change, Elsevier Inc., 2021

e-Resources:

1. https://nptel.ac.in/content/storage2/courses/122103039/pdf/mod6.pdf
2. https://nptel.ac.in/content/storage2/courses/122106030/Pdfs/1_1.pdf

3. https://nptel.ac.in/content/storage2/courses/120108004/module1/lecture1.pdf
4. https://nptel.ac.in/content/storage2/courses/103107084/module1/lecture1/lecture1.pdf
5. https://nptel.ac.in/courses/105/108/105108077/
6. https://www.ugc.ac.in/oldpdf/modelcurriculum/chapter4.pdf
7. https://youtu.be/zQi3C_eZkLs

CORE: 8	**BIOSTATISTICS AND BIOINFORMATICS**
Contact hours per Week – 7 hours	***Credits: 5***
Contact hours per Semester – 105 hours	***Subject Code:* P24ZYC23**
Course Outcomes: Upon successful completion, the students will be able to:	
CO1: Learners can recognize the definition of statistics, its subject and its relationship with the biological sciences.	
CO2: Learners can identify distribution form relating to the variable/variables. recognize normal distribution and interpret data via normal distribution.	
CO3: Learners can calculate and interpret measures of central tendency and variability in statistical data and compare different population sample using ANOVA.	
CO4: Learners can familiarise the basics of bioinformatic databases and the types of Bioinformatic data.	
CO5: Learners can understand the nucleotide and protein sequence databases.	

Unit – I **(18 hours)**

Biostatistics: Definition, Terms, Applications, Role of biostatistics in modern research, Limitations of Statistical Methods. Types of data: Primary, secondary, qualitative, quantitative, Scales of measurement of statistical data. – Collection of data: Methods of Collection: census and sampling techniques- Classification and Tabulation of data: Data Summarisation and Class intervals, Preparation of Class intervals and Tally marks - Frequency; Frequency distribution, types and preparation of frequency table - Representation of data: Bar diagram, Pie diagram, Histograms, Frequency polygon, Frequency curve: Skewness, Kurtosis, Ogive

Unit – II **(18 hours)**

Measures of Central tendency: Mean, Median, Mode, Quartiles and Percentiles – problems. Measures of variability or dispersion: Types of Variability and Measures of dispersion, Range, Mean Deviation, Standard Deviation, Standard Error, Quartile deviation, Variance and Coefficient of variance – problems Probability: Types and rules of probability; conditional probability Probability Distribution: Normal, Binomial and Poisson distributions - simple problems.

Unit – III **(18 hours)**

Inferential statistics - Statistical estimation; Types, methods and Applications - Testing of statistical hypothesis Correlation analysis: Types and measure of correlation - Karl Pearson's coefficient of correlation (simple problems) and Spearman's rank correlation. Regression analysis: Methods for Regression: Simple and multiple regression; Difference between regression and correlation analysis. Students t-test, chi square test and one way ANOVA - simple problems.

Unit – IV **(18 hours)**

Bioinformatics - Introduction - applications and research, bioinformatics in India, bioinformatics Databases in biology: Characteristics of Bioinformatics databases, Classification of databases (based on the types of data, maintainer status, technical design, data source and data access) Primary nucleotide sequence databases: GenBank, EMBL, and DDBJ, searching and retrieving from primary sequence data bases.
Sequence alignment – pairwise and multiple sequence

Unit – V **(18 hours)**

Secondary nucleotide sequence databases: UniGene, STACK, Ribosomal database project, HIV sequence database, Eukaryotic promoter database and REBASE. Protein sequence databases: UniProt, PIR, Swiss-Prot and TrEMBL – Structure databases: PDB, secondary and specialized protein sequence databases. Other databases; Enzyme databases, Pathways databases and Diseases databases.

Text books:

1. Unit I - Veer Bala Rastogi, "Biostatistics", MedTech, New Delhi. 3rd Edition/ 2015. Page No. 6– 82.
2. Unit II - Veer Bala Rastogi, "Biostatistics", MedTech, New Delhi. 3rd Edition/ 2015. Page No. 91– 161, 205– 234.
3. Unit III - Veer Bala Rastogi, "Biostatistics", MedTech, New Delhi. 3rd Edition/ 2015. Page No. 239– 242, 308-320, 337– 368.
4. Unit IV - Orpita Bosu, Simminder Kaur Thukral, "Bioinformatics Databases, Tools and Algorithms", Oxford University Press, New Delhi. 2010. Page No. 8 – 11, 21- 37.
5. Unit V - Orpita Bosu, Simminder Kaur Thukral, "Bioinformatics Databases, Tools and Algorithms", Oxford University Press, New Delhi. 2010. Page No. 44 – 81, 106 - 139.

Reference books:

1. Bailey, N.T.J, "Statistical methods in Biology", Hodder and Stongtton, London. 1979.
2. Campell, R.C, "Statistics for biologists", Blacker and Sons Publishers, Bombay. 1981.
3. Gupta, C.B. and Gupta, V, "Statistical methods", Ikas Publishing House, New Delhi. 1992.
4. Zar, J.H, "Biostatistical Analysis", Pearson Education, Delhi. 1999.5. Ignacimuthu S, "Basic Bioinformatics", Narosa Publishing House, 2013.

5. Rajadurai M, "Bioinformatics – A Practical Approach", PBS Book enterprises, Chennai. 2010.
6. Dan E. Krane and Michael L. Raymer, "Fundamental Concepts of Bioinformatics", Pearson Education Pte Ltd, New Delhi, 2003.
7. Arthur M. Lesk, "Introduction to Bioinformatics", Oxford University Press, New Delhi 2014.

e – Resources:

1. https://www.youtube.com/watch?v=cKQaKy6fjAQ&feature=emb_imp_woyt
2. https://youtu.be/p7EN4NcTjnM
3. https://youtu.be/GqPCE6hKbUw
4. https://youtu.be/6MEdP4zMLuQ
5. https://youtu.be/IaBQBiOID1c
6. https://youtu.be/PETpnhcm3-Y
7. https://youtu.be/quRYt4d4rDA
8. https://youtu.be/qQw0MJ7L3tI

CORE: 9	**LAB: MOLECULAR GENETICS**
Contact hours per Week – 3 hours	***Credits: 3***
Contact hours per Semester – 45 hours	***Subject Code:*** **P24ZYCP21**
Course Outcomes: At the end of the semester, students will be able to	
CO1: Understand the practical implications of Mendel's Laws.	
CO2: Can estimate the Enzyme activity.	
CO3: Chart out the Pedigree analysis of any family.	
CO4: Acquires the knowledge of statistical applications of genetics experiments.	

1. Study on Law of segregation using beads.
2. Study on Law of independent assortment using coins/ beads.
3. Study on Probability by coin tossing.
4. Pedigree analysis for any two of the simple Mendelian traits.
5. Chromosomal disorders in human – Down's, Turner's and Klinefelter's syndrome. (Book Plates)
6. Microscopic observation of mutant phenotypes of *Drosophila.*
7. Study of bacterial survival against UV irradiation and mutagenesis.
8. Correlation analysis– Height and Weight of students- length and width of Polyalthia leaves.

CORE: 10	**LAB: ECOLOGY**
Contact hours per Week – 3 hours	***Credits: 3***
Contact hours per Semester – 45 hours	***Subject Code:*** **P24ZYCP22**
Course Outcomes: At the end of the semester, students will be able to	
CO1: Student able to estimate the Primary productivity.	
CO2: Critically analyze the Industrial effluents.	
CO3: Expertise in estimating the soil organic matter.	
CO4: Transforms the practical laboratory experience to the field through study tour.	

1. Estimation of primary productivity of aquatic macrophytes– Light and Dark bottle method
2. Estimation of primary productivity of terrestrial plants – Harvest method
3. Estimation of primary productivity of terrestrial plants – Chlorophyll content method
4. Estimation of CO_2 in the sewage water sample.
5. Analysis of industrial effluents – Total and dissolved solids
6. Analysis of industrial effluents – Biological Oxygen Demand (BOD)
7. Analysis of industrial effluents – Chemical Oxygen Demand (COD)
8. Estimation of soil organic matter
9. Estimation of dust pollution in urban locality – Time course kinetics of deposition of dust
10. A study tour of minimum 3 days is compulsory visit to wildlife sanctuaries, zoological parks, biosphere reserves etc. during the tenure of the programme. A detailed report of the study tour specifying the places and institutions visited, date and time of visit, details of observations made etc. must be submitted by each student in "handwritten" mode for external evaluation during the day of practical examination. The study tour report is compulsory for each student appearing for practical examination.

NME	**ECONOMIC ZOOLOGY**
Contact hours per Week – 4 hours	***Credits: 4***
Contact hours per Semester – 60 hours	***Subject Code:*** P24ZYN21
Course Outcomes: Upon successful completion, the students will be able to:	
CO1: Applying studied information to have knowledge on common cattle breeds and their management, milk and milk products.	
CO2: Understanding the knowledge of fowl breeds and their management, nutritive and economic value of chick and egg.	

	CO3: To inculcate knowledge on common ornamental fishes, aquarium setup, breeding, diseases and their treatment.
	CO4: To satisfy the learners with modern techniques of silkworm and honeybee rearing with economic values.
	CO5: To study the morphology of earthworm, production method of vermicompost with applications.

Unit – I **(18 hours)**

Dairy farming: Common cattle breeds- Cow (Jersey), Buffalo (Murrah) and Goat (Jamunabhari), Management of a model dairy farm- Livestock diseases- Foot and mouth disease, udder disease-Nutritive value of milk-milk products- Economics.

Unit – II **(18 hours)**

Poultry: Breeds of fowl- Sexing of one-day old chick- Rearing and management of Broilers and Layers- Nutritive value of chick and egg– disease control (Ranikhet, Coryza, fowl pox)– Economics.

Unit – III **(18 hours)**

Ornamental fish culture– Introduction – General characters of black molly, Guppy, common gold fish– construction of fish tank (base covering, plant and fresh water set up)– water quality management– types of feed and feeding methods– Breeding of ornamental fishes (Guppy, Gold fish)– fish disease (White spot, gill rot) and treatment– Economics.

Unit – IV **(18 hours)**

Sericulture – Mulberry plant - Morphology of silkworm *Bombyx mori*– Silkworm rearing– Marketing of cocoons– Economics. Apiculture– types of honeybees - Methods of honeybee rearing – Nutritive and medicinal values of honey- Economics.

Unit – V **(18 hours)**

Vermiculture–Introduction– General morphology of earthworm– Cultivable species – *Eisenia foetida*and *Eudriluseugeniae*- Steps involved in Vermicomposting (bedding, layering, and watering)– Method of harvesting– Application of vermicompost and vermi wash- Economics.

- **Field visit- Dairy farm, Poultry farm, Ornamental fish farm, Silkworm rearing stations, Vermicompost production unit.**

Textbooks:

1. N. Arumugam, Applied Zoology, Saras Publications, Nagercoil. 2017.

Reference Books:

1. G.C. Banerjee, Animal husbandry, Oxford and IBH Publishing Co. 1998.

2. M.R. Gnanamani, Modern aspects of commercial poultry keeping, 9th edition, Giri Publications, 2003.
3. David Kingston *et al.*, Guidelines of ornamental fish culture, Veterinary University Training and Research Centre (Fisheries). 2006
4. G. Ganga and J. Sulochana Chetty, An introduction to sericulture, Oxford IBH Publishers, New Delhi. 1991.
5. S.A. Ismail, Vermicology, Orient Longman Ltd. 1997.

e-Resources:

1. http://www.iaszoology.com/insect/
2. https://www.studyandscore.com/study-material/economic-zoology
3. https://www.slideshare.net/atulthakur007/economic-zoology
4. https://onlinecourses.swayam2.ac.in/cec20_ge23/preview
5. https://www.assignmentpoint.com/science/zoology/assignment-on-economic-zoology.html

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