VIDYASAGAR UNIVERSITY

Midnapore, West Bengal

PROPOSED CURRICULUM & SYLLABUS (DRAFT) OF

BACHELOR OF SCIENCE (HONOURS)

MAJOR IN ZOOLOGY

4-YEAR UNDERGRADUATE PROGRAMME

(w.e.f. Academic Year 2023-2024)

Based on

Curriculum & Credit Framework for Undergraduate Programmes

(CCFUP), 2023 & NEP, 2020

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VIDYASAGAR UNIVERSITY
BACHELOR OF SCIENCE (HONOURS) MAJOR IN ZOOLOGY
(under CCFUP, 2023)

Level	YR.	SEM	Course Type	Course Code	Course Title	Credit	L-T-P	Marks		
								CA	ESE	TOTAL
B.Sc. (Hons.)	2nd	III	SEMESTER-III							
			Major-3	ZOOHMJ03	T: Genetics; P: Practical	4	3-0-1	15	60	75
			Major-4	ZOOHMJ04	T: Animal Physiology; P: Practical	4	3-0-1	15	60	75
			SEC	ZOOSEC03	P: : Insect Pest, Vector Biology and Management	3	0-0-3	10	40	50
			AEC	AEC03	Communicative English -2 (***common for all programmes***)	2	2-0-0	10	40	50
			MDC	MDC03	Multidisciplinary Course -3 (***to be chosen from the list***)	3	3-0-0	10	40	50
			Minor-3 (Disc.-I)	ZOOMIN03	T: Applied Zoology; P: Practical	4	3-0-1	15	60	75
					Semester-III Total	20				375
		IV	SEMESTER-IV							
			Major-5	ZOOHMJ05	T: Biochemistry; P: Practical	4	3-0-1	15	60	75
			Major-6	ZOOHMJ06	T: Comparative Anatomy of Vertebrates; P: Practical	4	3-0-1	15	60	75
			Major-7	ZOOHMJ07	T: Ecology; P: Practical	4	3-0-1	15	60	75
			AEC	AEC04	MIL-2 (***common for all programmes***)	2	2-0-0	10	40	50
			Minor-4 (Disc.-II)	ZOOMNI04	T: Genetics & Evolutionary Biology; P: Practical	4	3-0-1	15	60	75
			Summer Intern.	INT	Internship/ Apprenticeship - activities to be decided by the Colleges following the guidelines	4	0-0-4	-	-	50
					Semester-IV Total	22				400
					TOTAL of YEAR-2	42				775

MJ = Major, MI = Minor Course, SEC = Skill Enhancement Course, AEC = Ability Enhancement Course, MDC = Multidisciplinary Course, CA= Continuous Assessment, ESE= End Semester Examination, T = Theory, P= Practical, L-T-P = Lecture-Tutorial-Practical, MIL = Modern Indian Language

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Programme Outcome

A student having Zoology as a major subject will be able to understand the vastness of the diversity of animals. Although, it is not possible to know each and every species, they will understand the utility of classification through study of systematics. They will be able to understand the origin & evolution of life and can identify and classify different chordate and non-chordate animals. The different cell types of different animals with basic knowledge of physiology will enhance the understanding level of adaptation. They will be more concerned about the recent environmental problems, and can understand the importance of biotechnology as an applied field from the study of genetics and developmental biology. The scope of the subject through research and applied field will also open to them.

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MAJOR (MJ)

Major (MJ) - 3: Genetics **Credit 04 (Full Marks-75)**

About the Course

The course is framed to get the knowledge of Mendelian inheritance and non-Mendelian inheritance as well the concept of fine structure of gene. Students will also get knowledge about the phenomenon of linkage, crossing over, mutation, and transposable element. The learners will know the molecular mechanism of sex determination process and inheritance of sex-linked genes in humans.

Course Outcomes

After successfully completing this course, students will be able to:

1. Know the basis of heredity and fine structure of gene.
2. Understand the chromosomal basis of inheritance of genetic diseases.
3. Learn about the linkage groups, crossing over and linkage map.
4. Understand the molecular basis of sex determination of human and Drosophila
5. Know the molecular cause, detection and effect of gene mutation.
6. Describe the concept of jumping gene.

MJ-3T: Genetics (Theory) **Credits 03**

Course Contents	Lecture (hrs.)
Unit 1: Mendelian Genetics and its Extension Basic principles of heredity: Mendel's law- monohybrid cross and dihybrid cross; Chromosomal basis of inheritance and its applications; Exceptions to Mendelian Inheritance; Incomplete dominance and co-dominance; Epistasis; Multiple alleles; Isoallele; Pseudoallele; Lethal alleles; Pleiotropy; Penetrance & Expressivity; Polygenic inheritance- skin colour & eye colour.	7hrs
Unit 2: Crossing Over, Linkage & Linkage Mapping and Sex linkage Crossing over: Kinds of crossing over & molecular mechanism of crossing over. Linkage & Linkage Mapping: Complete & Incomplete linkage; Measuring recombination frequency and linkage map construction using three factor crosses; Interference and Coincidence. Sex linkage: Sex linked genes in human; Sex chromosome disorders in human; Sex-limited & sex-influenced inheritance in human.	7hrs
Unit 3: Fine structure of gene and One-gene: One-polypeptide concept Classical and Modern concept of Gene (Cistron, Recon, Muton); Complementation test in Bacteriophage (Benzer's experiment on rII locus); One –gene:one-enzyme hypothesis & One-gene:one-polypeptide hypothesis.	5 hrs
Unit 4: Sex Determination	

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XX/XO, XX/XY, ZZ/ZW and haploidy/diploidy types sex determination; Genic balance theory in *Drosophila melanogaster*; Role of alternate splicing of Sxl gene, tra gene and dsx gene in sex determination of Drosophila; Intersex; Gynandromorph; Mechanism of Sex Determination in Human; Role of SRY and *Tfm* gene; Dosage compensation in *Drosophila* & Human.	7 hrs
Unit 5: Mutations Types of gene mutations; Chromosomal aberrations (classification of structural and numerical alterations of chromosomes with one suitable example from *Drosophila* and Human of each); Nondisjunction of X chromosome in *Drosophila* & Human; Molecular basis of mutations in relation to UV radiation, ionizing radiation and chemical mutagens; Detection of mutation in *Drosophila* by attached X method & ClB method.	10 hrs
Unit 6: Extra-chromosomal Inheritance Organelle inheritance (mitochondrial & chloroplast); Kappa particle in *Paramoecium*; Maternal Inheritance (Shell coiling in snail).	5 hrs
Unit 7: Transposable Genetic Elements IS element in bacteria; Ac-Ds elements in maize; P elements in *Drosophila*; LINE and SINE; Alu elements in humans; Concept of transposon and retrotransposon.	4 hrs

MJ-3P: Genetics (Practical) **Credit 01**

i. Study of mode of inheritance in human by Pedigree charts - Autosomal (dominant & recessive), X-linked (recessive & dominant) and Y- linked trait.
ii. Identification of Chromosomal aberration in *Drosophila* and Human from photograph.
iii. Chi square analysis for Mendelian ratio test.
iv. Solve the problems related to sex-linked genes and their inheritance in humans (Haemophilia, Colour blind, Sickle cell anaemia and Thalassemia).
v. Solve the problems related to two factor crosses, three factor crosses and gene interactions.

Recommended Readings:

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). Principles of Genetics. (VIII edition) Wiley India.
2. Russel PJ. 2010. iGenetics: A Molecular Approach, Pearson Benjamin.
3. Fairbanks, D.J. & Anderson, W.R. Genetics. (2009) Wardsworth Publishing Company.
4. Snustad, D.P. and Simmons, M.J. (2009). Principles of Genetics. (V edition) John Wiley and Sons Inc.
5. Klug, W.S., Cummings, M.R. and Spencer, C.A. (2012). Concepts of Genetics. (X edition) Benjamin Cummings.
6. Carroll S.B.; Doebley J.; Griffiths, A.J.F. and Wessler, S.R. (2018) An Introduction to Genetic Analysis. W. H. Freeman and Co. Ltd.
7. Strickberger M. W – Genetics.
8. Macmillam Tamarin R. H. – Principles of Genetics; McGraw Hill.

Major (MJ) - 4: Animal Physiology **Credit 04 (Full Marks-75)**

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About the Course

This course is designed at graduation level to know the chemical and mechanical process of digestion, physiology of respiration and circulation, renal physiology and thermoregulation process. Students will also know the process of nerve impulse propagation along the nerve fibre and synaptic transmission.

Course Outcomes

The student at the completion of the course will be able to:

1. Learn the physiology of digestion, respiration, circulation, excretion, osmoregulation and thermoregulation.
2. Understand the physiology of muscles and its contraction mechanism.
3. Understand the process of nerve impulse propagation.
4. Learn the about process of osmoregulation and thermoregulation process of vertebrates.
5. Describe the process of vision and hearing in mammals.

MJ-4T: Animal Physiology (Theory) **Credits 03**

Course Contents	Lecture (hrs.)
Unit 1: Digestion Digestion and Absorption of proteins, carbohydrates and lipids and nucleic acid; Source and Function of digestive enzyme.	7 hrs
Unit 2: Respiration Respiratory volumes and capacities; Transport of O_2 and CO_2 in mammals; Dissociation curves and the factors influencing it; Respiratory pigments in animals; Structure & function of haemoglobin.	8 hrs
Unit 3: Circulation Cardiac cycle and Cardiac output; Blood pressure and its regulation; Blood clotting system; Fibrinolytic system; ABO Blood group and Rh factors; Coronary circulation.	8 hrs
Unit 4: Excretion & Osmoregulation Structure of Kidney and nephron; Mechanism of urine formation; Regulation of acid-base balance; Osmoregulation in vertebrates.	8 hrs
Unit 5: Neuro-Muscular System Origin and propagation of action potential across nerve fibers; Synaptic transmission and Neuromuscular junction; Muscle contraction.	8 hrs
Unit 6: Thermoregulation Thermoregulation in poikilotherms and homeotherms; Physiology of hibernation and aestivation with reference to amphibians and reptilians; Thermoregulation of large mammals in hot desert.	6 hrs

MJ-4P: Animal Physiology (Practical) **Credit 01**

1. Preparation of temporary mounts: Squamous epithelium.

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2. Preparation of stained blood film to study various types of blood cells. Enumeration of red blood cells and white blood cells using haemocytometer. Calculation of total count and differential count from blood.
3. Estimation of bleeding time and clotting time.
4. Estimation of haemoglobin using Sahli's haemoglobinometer
5. Preparation of haemin crystals.
6. Recording of blood pressure using a sphygmomanometer.

Suggested Reading:

1. Bamji M S, Rao N P, and Reddy V. Text Book of Human Nutrition; 2009; Oxford & IBH Publishing.
2. Fox S I. 2011. Human Physiology. 12th Edn. Mc Graw Hill.
3. Ganong's Review of Medical Physiology; McGraw Hill.
4. Gunstream SE. 2010. Anatomy and Physiology with integrated study guide. Mc Graw Hill.
5. Guyton AC, Hall JE. 2006. Textbook of Medical Physiology. Hercourt Asia P Ltd.
6. Hill RW, Wyse GA, Anderson M. 2012. Animal Physiology. 3rd Edn. Sineuer Asso
7. Hoar W. S. – General and Comparative Physiology; PHI.
8. Kesar, S. and Vashisht, N.; 2007. Experimental Physiology, Heritage Publishers.
9. Prosser C. L. and F. A. Brown – Comparative Animal Physiology; Saunders.
10. Randall D, Burggren W. 2001. Eckert Animal Physiology by. 4th edition. W. H. Freeman. Refinetti R. 2000. Circadian Physiology. CRC Press, Boca Raton.
11. Schmidt-Neilson K – Animal Physiology – Adaptation & Environment, Cambridge University Press.
12. Sembulingam K, Sembulingam P. 2012. Essentials of Medical Physiology. Jaypee Pub, New Delhi.
13. Sherwood L. 2013. Human Physiology from cells to systems. 8th Edn., Brooks & Cole Tortora, G.J. and Derrickson, B.H.; 2009. Principles of Anatomy and Physiology, XII Ed, Wiley and Sons, Inc.

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Major (MJ) - 5: Biochemistry **Credit 04 (Full Marks-75)**

About the Course

This course is designed at graduation level to know the basic principles of biochemistry and kinetics of enzyme catalyzed reactions. The students will get knowledge about structure and function of carbohydrates, proteins, and lipids and their metabolism. The students also get knowledge about process oxidative phosphorylation.

Course Outcomes

The student at the completion of the course will be able to:

1. Interpret structure-functional relationships of carbohydrates, proteins and lipids.
2. Describe the mechanism of action of enzymes, coenzymes, co-factors, ribozymes, isozymes, kinetics of enzyme catalyzed reactions and enzyme inhibitions and regulatory process.
3. Understand the metabolism of carbohydrates, proteins and lipids through various anabolic and catabolic pathways and their regulation.
4. Know the process of ATP production through oxidative phosphorylation.

MJ-5T: Biochemistry (Theory) **Credits 03**

Course Contents	Lecture (hrs.)
Unit 1: Biochemical Foundation Principle of bonds and bond energy, covalent and non-covalent bonds. Stereochemistry: Optical isomerism; Isomers and types; Configuration and conformation. Concept and calculations related to normality, molarity and molality.	5 hrs
Unit 2: Carbohydrate Structure and Biological importance: Monosaccharides, disaccharides & polysaccharides; Derivatives of Monosaccharides and Glycoconjugates. Carbohydrate metabolism: Glycolysis; Citric acid cycle; Pentose phosphate pathway; Gluconeogenesis. Oxidative phosphorylation- Review of mitochondrial respiratory chain; ATP synthesis; Inhibitors and un-couplers of Electron Transport System.	10hrs
Unit 3: Protein Amino acids: Structure, Classification, Properties of α-amino acids; Physiological importance of essential and non-essential amino acids. Proteins: Classification, Bonds stabilizing protein structure; Levels of organization- primary, secondary, tertiary and quaternary structure of protein. Protein metabolism: Transamination; Deamination; Urea cycle; Fate of C-skeleton of glucogenic and ketogenic amino acids.	10 hrs
Unit 4: Lipid Classification of Lipid; Structure and Significance: Physiologically important saturated and unsaturated fatty acids, omega fatty acids, tri-acyl glycerol, phospholipids, sphingolipid, glycolipids, steroids, wax & eicosanoids. Lipid metabolism: Definition of alpha and omega oxidation; β-oxidation of saturated and even carbon-chain fatty acids; Fatty acid biosynthesis.	10 hrs

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Unit 5: Enzyme Nomenclature and classification; Cofactors; Specificity of enzyme action; Isozymes. Mechanism of enzyme action; Lock and key model, Induced fit model. Enzyme kinetics; Concept of Km and Vmax; Steady state theory; Derivation of Michaelis-Menten equation; Lineweaver-Burk plot; Factors affecting rate of enzyme-catalysed reaction. Enzyme inhibition - Competitive, Noncompetitive & Uncompetitive inhibition; Basic idea of Allosteric enzymes.	10 hrs

MJ-5P: Biochemistry (Practical) **Credit 01**

1. Qualitative tests of functional groups in carbohydrates, proteins and lipids.
2. Quantitative estimation of water-soluble proteins following Lowry Method.
3. Thin Layer chromatography for the separation of molecules.
4. Qualitative test for urea, uric acid and ammonia.

Suggested Reading:

1. Berg J. & G. Tomaselli – A Clinical Companion to Accompany Biochemistry –; Freeman & Co.
2. Berg JM, Tymoczko JL, Stryer L.2007.Biochemistry, VI Edition, W.H.Freeman and Co., New York.
3. Campbell MK, Farrell SO. 2012. Biochemistry. 7th Edn. Brooks and Cole.
4. Conn E. E. & P. K. Stumpf – Outlines of Biochemistry –Wiley Eastern.
5. Cox MM, Nelson DL. 2008. Lehninger's Principles of Biochemistry, W.H. Freeman & Co.
6. Das D. 2000. Biochemistry. NCBA, Kolkata.
7. Deb A. C. – Fundamentals of Biochemistry, NCBA.
8. Hames BD, Hooper NM. 2000. Instant Notes in Biochemistry, II Edition, BIOS Scientific Harper's Illustrated Biochemistry, McGraw Hill.
9. Lehninger Principle of Biochemistry – D. L. Nelson & M. M. Cox.
10. Sathyanarayana U, Chakrapani. 2002. Biochemistry –Books & Allied Pvt. Ltd, Kolkata.
11. Voet D, Voet JG. 2004. Biochemistry –3rd edition, 2004, John Wiley & Sons, Inc. Zubay GL. 1998. Biochemistry, 4th edition, Mc Graw-Hill.

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Major (MJ) -6: Comparative Anatomy of Vertebrates Credit 04 (Full Marks-75)

About the Course

The vision of this course is to understand the physiology of chordates from their anatomical point of view. Thus, it emphasizes and reconnoiters vertebrate structure and function aiming understanding major events in the history of vertebrate evolution and integrating the morphology and anatomy of vertebrates with their ecology, behaviour and physiological adaptation in diverse habitats as well as gradual complexities from simpler vertebrates to higher forms.

Course Outcomes

1. Students will recall and describe the anatomy and functions of various vertebrate systems, explain comparative anatomical variations, and apply their knowledge to analyze functional adaptations across species.
2. Students will analyze evolutionary adaptations of organ systems, synthesize knowledge of vertebrate biology, and evaluate the significance of anatomical features in ecological and evolutionary contexts.
3. Students will develop skills in microscopic analysis, comparative anatomy, morphological understanding, skull identification, and dissection techniques, preparing them for advanced studies in zoology and anatomy.

MJ-6T: Comparative Anatomy of Vertebrates (Theory) Credits 03

Course Contents	Lecture (hrs.)
Unit 1: Structure & function of Integumentary system General structure of integument of Fish to Mammalia; Epidermal & dermal derivatives with special reference to scales in fishes and reptiles; Integumentary glands in amphibia and mammals; Feathers in birds; Hair, horn and antler in mammals.	8 hrs
Unit 2: Structure & function of Musculoskeletal system General idea of axial and appendicular skeleton; Visceral arch, jaw suspension & their evolutionary significance.	7 hrs
Unit 3: Structure & function of digestive system Comparative account of digestive system in vertebrates with special reference to ruminant stomach in mammals; Dentition in vertebrates.	6 hrs
Unit 4: Structure & function Circulatory system Comparative account of heart and aortic arch with their evolutionary significance in vertebrates.	6 hrs
Unit 5: Structure & function of Respiratory system Gill morphology in fishes; Air sac in birds.	7 hrs
Unit 6: Structure & function of Excretory system Types and development of kidneys and their ducts in anamniotes and amniotes.	6 hrs
Unit 7: Structure & function of Nervous system Comparative account of brain in vertebrates with structural detail in mammals.	5 hrs

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MJ-6P: Comparative Anatomy of Vertebrates (Practical) **Credit 01**

1. Demonstration (through dissection/video/chart/model) & identification of different parts of Brain in Tilapia (*Oreochromis*) /*Rohu* and Afferent and Efferent branchial system in Carp /*Ophiocephalus.*
2. Dissection and mounting of pituitary gland in Tilapia (*Oreochromis*) / *Rohu* and Pecten in fowl.
3. Mounting of cycloid, ctenoid and placoid scales in fish.
5. Identification of bones (through museum specimen/plastamount/chart/model): Skull & lower jaw in frog/toad, turtle/tortoise, poisonous snake, *Coulmba* & *Cavia*; Vertebrae, limb bones & girdles in *Columba* & *Cavia.*

Recommended Readings:

1. Weichert, C.K. (1970) Anatomy of Chordates (4th edition).
2. Jordan, E. L. and Verma, P. S. (2013) Chordate Zoology (14th edition).
3. Saxena, R. K. and Saxena, S. (2015) Comparative Anatomy of Vertebrates (2nd edition).
4. Randall, D. et al. (2002) Eckert Animal Physiology (5th edition) Freeman.
5. Hill, R.W. et al. (2008) Animal Physiology (3rd edition) Sinaur Associates.
6. Guyton, A.C. et al. (2008) Textbook of Medical Physiology (12th edition) Saunders Co.
7. Withers, P.C. et al. (1992) Comparative Animal Physiology (1st edition) Brooks Cole.
8. Ganong, Willilam F. (2003) Review of Medical physiology (21st edition) McGraw-Hill.
9. Kardong, K.V. (2009) Vertebrates: Comparative Anatomy, Function, Evolution (4th edition) Tata Mc Graw Hill.
10. Kent, G.C. and Carr, R.K. (2000) comparative anatomy of vertebrates (9th edition) Mc Graw-Hill.

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Major (MJ) -7: Ecology **Credit 04 (Full Marks-75)**

About the Course

The objective of this course is to take students on a journey through the physical workings of the Earth, the interactions between species and their environments. It highlights on some of the important aspects viz. concept of ecosystem, energy flow in the ecosystems, growth and survival of populations and communities in different habitats, interactions between the organisms at different levels, concept of niches and consequences of changing environment on the biodiversity.

Course Outcomes

1. Student will be able to understand levels of organization, limiting factors, population dynamics and interactions between communities along with wildlife conservation methods.
2. Student will know the evolutionary and functional basis of animal ecology.
3. Students can engage themselves to analyze a biological problem, derive testable hypotheses and then design experiments and put the tests into practice.
4. Students will develop practical skills in data analysis, field methods, aquatic ecosystem assessment, and report writing through hands-on activities and studies in ecology.
5. Student can solve the environmental problems involving interaction of humans and natural systems at local or global level.

MJ-7T: Ecology (Theory) **Credits 03**

Course Contents	Lecture (hrs.)
Unit 1: An Overview of Ecology, Ecosystems & Biomes Definition and scope of ecology. Structure and function of ecosystem: Components - Abiotic & Biotic; Concept of limiting factors & their (water, temperature, pH, light & salinity) role on living organisms; Concept of food chain, food web, ecological pyramids & energy flow – definition, types, example; Concept of productivity & biogeochemical cycles (Carbon & Nitrogen). Introduction to Biome: Ecological features of Tundra, Desert, Savannah and Tropical Rain Forest Biomes. Concept of Habitat & Niche: Definition, Type & example; niche overlap and segregation.	12 hrs
Unit 2: Population Ecology Definition of population; Unitary and Modular populations; Unique and group attributes of population: density, natality, mortality, life tables, fecundity schedule, survivorship curves, age distribution, sex ratio, population growth form - exponential and logistic growth, biotic potential, dispersal & dispersion. Population regulation: Density dependent and density independent factors; Life history strategies: Concept of iteroparous & semelparous; r and k strategies. Types of interactions: Neutral interaction; Positive interactions: commensalism, proto-cooperation and mutualism; Negative interactions: competition, predation, parasitism and allelopathy; Gause's Principle with examples; Dynamics of predation and predator-prey interaction & competition (only Lotka Voltera Model).	12 hrs

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Unit 3: Biotic Community Community characteristics: stratification, dominance, diversity, species richness, abundance, ecotone and edge effect. Ecological succession: Definition, process, types, theories of succession.	12 hrs
Unit 4: Environmental Degradation, Conservation & Biodiversity Pollution: Causes, Sources & Effects of air, water, noise pollution and their control. Conservation: Definition, Objectives & Types (in- situ & ex-situ with concept of zoological garden, gene bank, national park, sanctuary, reserve forest & biosphere reserve). Biodiversity: Definition, levels of biodiversity, benefits of biodiversity, megadiverse countries, biodiversity hotspots, threats to biodiversity, PBR.	9 hrs

MJ7P: Ecology (Practical) **Credits 01**

1. Estimation of free carbon dioxide, dissolved oxygen & transparency of any water body.
2. Estimation of any terrestrial ecosystem/biome/community through ecological methods like line transact & quadrat sampling; Determination of minimum size of quadrat; Calculation of density, abundance, frequency & Shannon index of any suitable population/community/ecosystem through field work or hypothetical community.
3. Study of life tables and plotting of survivorship curves of different types from the hypothetical/real data provided.
4. Submission of field report after studying any ecosystem/Zoological Garden/National Park/Sanctuary/Biosphere reserve.

Recommended Readings

1. Odum, E.P. (1983) Basic Ecology. Saunders College Publishing.
2. Krebs, C. J. (2001) Ecology (6th edition) Benjamin Cummings.
3. Odum, E.P., (2008) Fundamentals of Ecology. Indian Edition. Brooks/Cole.
5. Ricklefs, R.E. (2000) Ecology (5th edition) Chiron Press.
6. Southwood, T.R.E. and Henderson, P.A. (2000) Ecological Methods (3rd edition) Blackwell Sci.
7. Kendeigh, F C. (1984) Ecology with Special Reference to Animal and Man. Prentice Hall Inc.
8. Stiling, P. D. (2012) Ecology Companion Site: Global Insights and Investigations. McGraw Hill Education.
9. Beeby, A. and Brennan A. ((2004) First ecology ecological principle and environmental Issues (2nd edition). Oxford.
10. Kormondy, E.J. (2000) Concepts of Ecology (4th edition) Prentice Hallof india Pvt. Ltd.
11. Chapman, J.L. and Reiss, M. J. (2002) Ecology Principles & Applications (2nd edition) Cambridge University Press.
12. Bagon, M., Townsend, C.R. and Harper, J.L. (2005) Ecology: From Individuals to Ecosystems (4th edition). Wiley-Blackwell.
13. Sharma, P.D. (2011) Ecology and Environment. Rastogi Publication.
1. 13.Cain M L, Bowman W D and Hacker S D. 2013. Ecology. 3rd ed. Sinauer associates.
14. Smith TM, Smith R L. 2006. Elements of Ecology. 6th Ed. Pearson Education.
15. Odum E.P, Barret G.W. 2017. Fundamentals of Ecology. 15th Indian reprint. Cengage learning India Pvt. Ltd.
16. Van Dyke F. 2008. Conservation Biology: Foundations, Concepts, Application. 2nd Ed. Springer Science.

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MINOR (MI)

Minor (MI) -3: Applied Zoology **Credit 04 (Full Marks-75)**

About the Course

The study of Applied Zoology programme is focused to develop theoretical and practical knowledge on sericulture, lac culture, apiculture, fishery, dairy and poultry farming, vermiculture, pearl culture etc. Based on the acquired experience, students will be encouraged to take up small scale business as a carrier.

Course Outcomes

Applied Zoology deals with the application of Zoological knowledge for the welfare of mankind. At the end of the course the student will be able to:

1. Gain knowledge about silkworms rearing and their products
2. Understand the different breeds in poultry and dairy farming along with their management.
3. Gain knowledge in Bee keeping equipment and apiary management.
4. Acquaint knowledge about the culture techniques of oyster and prawn.
5. Acquaint the knowledge about basic procedure and methodology of vermiculture.
6. Learn various aspects of lac culture.
7. Know the concepts of induced breeding techniques and post harvesting techniques of fishes.

MI-3T: Applied Zoology (Theory) **Credits 03**

Course Contents	**Lecture (hrs.)**
Unit 1: Sericulture Types of silkworms and their host plants, Life cycle of *Bombyx mori*, Structure of silk gland, Silk: composition, characteristics and uses, Process of sericulture, Diseases and pest of silkworms and their control measures.	6hr
Unit 2: Apiculture Different species of Honey Bees, casts of honey bees and their role, life cycle of honey bee, Artificial Bee rearing, Bee Keeping Equipment, Bee Diseases and Enemies and their Preventive measures, Uses of Honey, Bees Wax, Propolis etc.	6 hrs
Unit 3: Lac Culture Strains of lac insects, life history of lac insect, cultivation of lac, processing of lac, Composition, properties and importance of lac, Lac enemies and their control measures.	5 hrs
Unit 4: Prawn Culture Process of culture of prawn in brackish water and fresh water and their advantages. Hazards of brackish water and fresh water prawn culture and their control.	5 hrs
Unit 5: Pearl Culture Pearl producing oysters, process of pearl formation, biology of pearl oyster, pearl oyster farming.	4 hrs

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Unit 6: Poultry & Dairy Farming Different breeds of fowl and cattle, Rearing process and importance of poultry& dairy farming, Diseases of poultry birds and cattles and their control.	5 hrs
Unit 7: Vermiculture Vermiculture process, advantage and disadvantages of vermicomposting.	4 hrs
Unit 8: Pisciculture Modern hatcheries for production of fish seed, Induced- breeding of carps, Management and culture of major carps, Integrated fish farming.	4 hrs
Unit 9: Insect Pest Biology, ecology, control and damage caused by *Trypoeyza incertulus*, *Leucinoides arbonalis*, *Pyrilla perpusilla* & *Sitophilus oryzae*.	6 hrs

MI-3P: Applied Zoology (Practical) **Credits 01**

1. Finding out of significance and systematic position of economically important animals such as *Antheraea* sp., *Bombyx mori*, *Penaeus* sp, *Macrobrachium* sp, *Apis* sp, *Pinctada* sp, *Eisenia* sp.
2. Identification and application of different rearing tools and equipment used in sericulture and lac culture.
3. Study of morphology of different stages of silk moth and lac insects (through photographs).
4. Identification and uses of the products of sericulture, apiculture, lac culture, poultry farm and dairy farm.
5. Identify the penaeid and non-penaeid groups from supplied prawn specimens.
6. Estimation of pH of vermi-compost.
7. Identifying feature and economic importance of *Trypoeyza incertulus, Leucinoides arbonalis, Pyrilla perpusilla, Sitophilus oryzae*.
8. Visit to poultry farm/ fish breeding center–/sericulture farm /Prawn processing farm/ Pearl culture center and submission of the visit report.

Suggested Readings:

1. Appropriate Sericultural Techniques; Ed. M. S. Jolly, Director, CSR & TI, Mysore.
2. Handbook of Silkworm Rearing: Agriculture and Technical Manual-1, Fuzi Pub. Co. Ltd., Tokyo, Japan.
3. Prost, P. J. Apiculture. Oxford and IBH, New Delhi.
4. Bisht D.S., Apiculture, ICAR Publication.
5. Singh S., Beekeeping in India, Indian council of Agricultural Research, New Delhi.
6. Dunham R.A. Aquaculture and Fisheries Biotechnology Genetic Approaches. CABI publications, U.K.
7. Khanna and H.R. Singh, A text book of Fish Biology and Fisheries, Narendra Publishing House.
8. Ghorai, N. Lac culture in India. International Books and Periodicals, New Delhi.
9. Pillay, T.V.R. Aquaculture Principle and Practices, Fishing New Books, Blackwell Science Ltd.
10. Banerjee, G.C. A Text Book of Animal Husbandry. Oxford and IBH Pub.Co.Pvt.Ltd, New Delhi.
11. Singh, H. and Moore, E.N. Life stock and Poultry Production. Prentice-Hall of India Pvt.Ltd.,New Delhi.

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Minor (MI) -4: Genetics & Evolutionary Biology **Credit 04 (Full Marks-75)**

About the Course

The course is framed to get the knowledge of basic principles of heredity as well the concept evolutionary biology. Students will also get knowledge about the phenomenon of linkage, crossing over, mutation, and mechanism of sex determination. It deals the theories of evolution and speciation and extinction of species on earth.

Course Outcomes

After successfully completing this course, students will be able to:

1. 1: Know the basis of Mendelian and non Mendelian inheritance.
2. Learn about the linkage groups, crossing over and linkage map.
3. 4: Understand the molecular basis of sex determination of human and Drosophila.
4. Know the molecular cause, detection and effect of gene mutation.
5. Understand the prebiotic environment and protobiogenesis.
6. Understand the evolutionary principles that can bring about evolution as well as processes of evolutionary change.
7. Learn about the process of formation of species and extinction of species on earth.

MI-4T: Genetics & Evolutionary Biology (Theory) **Credits 03**

Course Contents	**Lecture (hrs.)**
Unit 1: Mendelian Genetics and its Extension Basic principles of heredity: Mendel's law- monohybrid cross and dihybrid cross; Exceptions to Mendelian Inheritance; Incomplete dominance and co-dominance; Epistasis; Multiple alleles; Isoallele; Pseudo allele; Lethal alleles; Pleiotropy; Sex-linked inheritance; Extrachromosomal inheritance.	7 hrs
Unit 2: Linkage, Crossing Over and Chromosomal Mapping Kinds of Linkage and crossing over, Recombination frequency as a measure of linkage intensity, two factor and three factor crosses, Interference and coincidence.	5 hrs
Unit 3: Sex Determination Genic balance theory in Drosophila melanogaster; Role of Sxl gene, tra gene and dsx gene in sex determination of Drosophila; Mechanism of Sex Determination in Human; Role of SRY and *Tfm* gene; Dosage compensation in Drosophila & Human.	5 hrs
Unit 4: Mutations Types of gene mutations; Chromosomal aberrations; Nondisjunction of X chromosome in Drosophila & Human; Molecular basis of mutations in relation to UV radiation, ionizing radiation and chemical mutagens; ClB method.	6 hrs
Unit 5: **History of Life** Conditions of primitive earth & its environment; Origin of Life; RNA World Hypothesis.	3 hrs
Unit 6: Introduction to Evolutionary Theories Lamarckism; Darwinism; Neo-Darwinism.	3 hrs
Unit7: Processes of Evolutionary Change Heritable variations; Hardy-Weinberg Law: Statement and Evolutionary forces upsetting Hardy-Weinberg equilibrium: Mutation, Migration, Genetic drift & Natural selection in	7 hrs

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changing allele frequencies; Natural selection (Example: Industrial melanism); Types of natural selection (Directional, Stabilizing, Disruptive). **Unit 8: Speciation and Extinction** Reproductive isolation; Allopatric speciation, parapatric speciation & sympatric speciation; Mass extinction (Causes, names of five major extinctions, K-T extinction in detail); Role of extinction in evolution. **Unit 9: Phylogeny** Phylogenetic trees: Features, types and examples; Evolution of Human.	5 hrs 4 hrs

MI-4P: Genetics & Evolutionary Biology (Practical) **Credits 01**

i. Study of Mendelian Inheritance and gene interactions using suitable examples. Verify the results using Chi-square test.
ii. Study of Linkage, recombination, gene mapping using the data.
iii. Study of Human Karyotypes; normal and abnormal (Turner's, Down's and Klinefelter syndrome) from photographs.
iv. Study of homology and analogy from suitable specimens/ pictures.
v. Study of a) Phylogeny of horse with diagrams/ cut outs of limbs and teeth of horse ancestors and b) Darwin's Finches with diagrams/ cut outs of beaks of different species.

Suggested Readings

1. Barton, N. H., Briggs, D. E. G., Eisen, J. A., Goldstein, D. B. and Patel, N. H. (2007). Evolution. Cold Spring, Harbour Laboratory Press.
2. Brooker, R.J. (2012). GeneticsL Analysis and Principles. 4th Edn. McGraw Hill.
3. Chattopadhyay, S. (2012). Life: Evolution, Adaptation, Ethology. 3rd Edn. Books and Allied, Kolkata.
4. Futuyma, D. J. (1997). Evolutionary Biology. Sinauer Associates.
2. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). Principles of Genetics. VIII Ed. Wiley India.
3. Griffiths, A.J.F., Wessler, S.R., Lewontin,R.C.andCarroll,S.B. (2010). Introduction to Genetic Analysis WH Freeman.
8. Hall, B. K. and Hallgrimsson, B. (2008). Evolution. IV Edition. Jones and Bartlett Publishers
9. Hyde, D. (2009). Introduction to Genetic Principle. McGraw Hill.
10. Kardong, K. (2004). An Introduction to Biological Evolution. McGraw Hill.
11. Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). Concepts of Genetics. X Edition. Benjamin Cummings.
12. Pierce, B.A. (2013). Genetics Essentials: Concepts and Connections. 2 nd Edn. Freeman W.H.
13. Ridley, M. (2004). Evolution. III Edition. Blackwell Publishing
14. Russel, P. J. (2009). Genetics- A Molecular Approach. III Edition. Benjamin Cummings.
15. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc.

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SKILL ENHANCEMENT COURSE (SEC)

SEC-3P: Insect Pest, Vector Biology and Management (Practical) **Credit 03**
(Full Marks-50)

About the Course

The course provides an insight into the types of insect pests and vectors and the factors driving their spread. It also enlightens about the methods used to bring down their population below the threshold for a better management.

Learning Outcomes

After completion of the course students will acquire the practical knowledge on

1. Different types of insect pests and their natural enemies.
2. life history of important insect pests.
3. Insecticide formulations
4. Identification of common vectors of plant pathogens.
5. Different traps for insect management.

Course Outline

1. Study of orders of insects and their identification using taxonomic keys.
2. Identification of insect pest and their natural enemies from field.
3. Study the life history of important insect pests.
4. Calculation of insect pest diversity by Shannon' and Simpson's index and understanding their association.
5. Computation of life tables.
6. Insecticide formulations and mixtures.
7. Identification of common vectors of plant pathogens- aphids, leafhoppers, whiteflies, thrips and beetles.
8. Study of various equipment for application of pesticides.
9. Computation of EIL and ETL.
10. Study of different traps for insect management.

Suggested Reading:

1. Imms, A.D. (1977). A General Text Book of Entomology. Chapman & Hall, UK.
2. Pedigo L.P. (2002). Entomology and Pest Management. Prentice Hall Publication.
3. Mathews, G. (2011). Integrated Vector Management: Controlling Vectors of Malaria and Other Insect Vector Borne Diseases. Wiley-Blackwell.
4. Medical Entomology, Hati A. K Allied Book Agency, Kolkata.

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