VIJAYANAGARA SRI KRISHNADEVARAYA UNIVERSITY

JNANASAGARA CAMPUS, BALLARI – 583 105

Department of Studies in Zoology

SYLLABUS

Master of Science
(I-IV Semester)

With effect from
2021-22

VIJAYANAGARA SRI KRISHNADEVARAYA UNIVERSITY

JNANASAGARA CAMPUS, BALLARI-583105

Department of Studies in Zoology

Programme: Master of Science (M.Sc.) in Zoology

Duration: 2 Years (4 semesters)

Programme Overview:

Master of Science (M.Sc.) in Zoology aims to equip students with recent advances in Zoology from organismic to reductionist biology. It also aims to empower students to understand the challenges of society and the country that falls into the realms of Zoology, such as Aquaculture, Molecular cell biology, stem cell biology, Molecular endocrinology, developmental biology, Reproductive biology, Cancer Biology, Physiology, ethology, chronobiology, wild life conservation, toxicology, biodiversity etc. It also offers students to a series of elective courses so that they can choose to specialize in the specific area of their interests in Zoology.

Programme Educational Objectives (PEOs):

After 3-4 years of completion of the programme the graduates will be able to:

5. To provide basic knowledge of animal structure, function and behavior.
6. To provide practical skills and knowledge in the field of applied zoology, this can make a path for self employment opportunities in Aquaculture, Apiculture, Lac culture and Sericulture.
7. To enhance practical skill in current advances in Zoology.
8. To inculcate critical thinking and analytical skills to enable students to pursue higher studies and research in Lie Sciences or related fields of Zoology.
9. Occupy positions in academic/research institutions / industry.
10. Demonstrate leadership qualities to achieve professional and organizational goals with commitment to ethical standards and team spirit.

Programme Outcomes (POs):

At the end of the programme the students will be able to:

8. The student would sufficiently be skilled and empowered to solve the problems in the realms of Zoology and its allied areas.

9. Understand the unity of life with the rich diversity of organisms and their ecological and evolutionary significance.
10. Opportunities of continuing education and professional development.
11. Acquire basic skills in the observation and study of nature, biological techniques, experimental skills and scientific investigation.
12. Demonstrate the ability to propose and execute a research project, and ethically report the results with concern for society and environment.
13. Enable the students to avail career opportunities in teaching, industry and research.
14. Work in a group to execute a project and contribute as an individual.
15. Use tools of information technology for all activities related to Zoology.
16. Develop lifelong learning habits by continuously updating advances in Zoology.

VIJAYANAGARA SRI KRISHNADEVARAYA UNIVERSITY

Distribution of Courses/Papers in Postgraduate Programme as per Choice Based Credit System (CBCS) in

Zoology

M. Sc. I - SEMESTER

Semester No.	Category	Subject code	Title of the Paper	Marks			Teaching hours/week			Credit	Duration of exams (Hrs)
				IA	Sem. Exam	Total	L	T	P		
FIRST	DSC1	21ZOO1C1L	Systematics and Biology of Non-Chordates	30	70	100	4	-	-	4	3
	DSC2	21ZOO1C2L	Aquaculture and Fishery Biology	30	70	100	4	-	-	4	3
	DSC3	21ZOO1C3L	Molecular Cell Biology and Genetics	30	70	100	4	-	-	4	3
	DSC4	21ZOO1C4L	Stem Cell Biology and Regenerative Medicine	30	70	100	4	-	-	4	3
	SEC1	21ZOO1S1LP	Vermiculture and Vermitechnology	20	30	50	1	-	2	2	2
	DSC1P1	21ZOO1C1P	Systematics and Biology of Non-Chordates Lab	20	30	50	-	-	4	2	4
	DSC2P2	21ZOO1C2P	Aquaculture and Fishery Biology Lab	20	30	50	-	-	4	2	4
	DSC3P3	21ZOO1C3P	Molecular Cell Biology and Genetics Lab	20	30	50	-	-	4	2	4
Total Marks for I Semester						**600**				**24**	

M.Sc. II-SEMESTER

Semester No.	Category	Subject code	Title of the Paper	Marks			Teaching hours/week			Credit	Duration of exams (Hrs)
				IA	Sem. Exam	Total	L	T	P		
SECOND	DSC5	21ZOO2C5L	Biology of Chordates	30	70	100	4	-	-	4	3
	DSC6	21ZOO2C6L	Developmental Biology and Molecular Endocrinology	30	70	100	4	-	-	4	3
	DSC7	21ZOO2C7L	Ethology and Chronobiology	30	70	100	4	-	-	4	3
	DSC8	21ZOO2C8L	Cancer and Radiation Biology	30	70	100	4	-	-	4	3
	SEC2	21ZOO2S2LP	Non-clinical Safety Evaluation of Drugs (with MathWorks)	20	30	50	1	-	2	2	2
	DSC5P4	21ZOO2C5P	Biology of Chordates Lab	20	30	50	-	-	4	2	4
	DSC6P5	21ZOO2C6P	Developmental Biology and Molecular Endocrinology Lab	20	30	50	-	-	4	2	4
	DSC7P6	21ZOO2C7P	Ethology and Chronobiology Lab	20	30	50	-	-	4	2	4
Total Marks for II Semester						**600**				**24**	

M.Sc. III-SEMESTER

Semester No.	Category	Subject code	Title of the Paper	Marks			Teaching hours/week			Credit	Duration of exams (Hrs)
				IA	Sem. Exam	Total	L	T	P		
THIRD	DSC9	21ZOO3C9L	Reproductive Biology and Artificial Organs	30	70	100	4	-	-	4	3
	DSC10	21ZOO3C10L	Environmental Biology	30	70	100	4	-	-	4	3
	DSE1	21ZOO3E1AL	A. Human Physiology	30	70	100	4	-	-	4	3
		21ZOO3E1BL	B. Biophysics and Biostatistics								
		21ZOO3E1CL	C. Parasitology, Evolutionary Biology and Paleozoology								
	DSE2	21ZOO3E2AL	A. Immunology, Proteomics and Genomics	30	70	100	4	-	-	4	3
		21ZOO3E2BL	B. Biochemistry and Enzymology								
		21ZOO3E2CL	C. Neurobiology and Aging								
	GEC1	21ZOO3G1AL	A. Wild life conservation and management	20	30	50	2	-	-	2	2
		21ZOO3G1BL	B. Entrepreneurial Zoology								
		21ZOO3G1CL	C. Hormones and Diseases								
	SEC3	21ZOO3S3LP	Research Methodology	20	30	50	1	-	2	2	2
	DSC9P7	21ZOO3C9P	Reproductive Biology and Artificial Organs Lab	20	30	50	-	-	4	2	4
	DSC10P8	21ZOO3C10P	Environmental Biology Lab	20	30	50	-	-	4	2	4
Total Marks for III Semester						**600**				**24**	

M.Sc. IV-SEMESTER

Semester No.	Category	Subject code	Title of the Paper	Marks			Teaching hours/week			Credit	Duration of exams (Hrs)
				IA	Sem. Exam	Total	L	T	P		
FOURTH	DSC11	21ZOO4C11L	Biodiversity and Conservation	30	70	100	4	-	-	4	3
	DSC12	21ZOO4C12L	Toxicology	30	70	100	4	-	-	4	3
	DSE3	21ZOO4E3AL	A. Agricultural Zoology and Entomology	30	70	100	4	-	-	4	3
		21ZOO4E3BL	B. Applied Zoology								
		21ZOO4E3CL	C.Animal Biotechnology								
	DSE4	21ZOO4E4AL	A. Genetic Engineering	30	70	100	4	-	-	4	3
		21ZOO4E4BL	B.Histology and Histotechniques								
		21ZOO4E4CL	C. Livestock Management and Animal Husbandry								
	GEC2	21ZOO4G2AL	A. Global Environmental Issues	20	30	50	2	-	-	2	2
		21ZOO4G2BL	B. Public Health, Hygiene and diseases								
		21ZOO4G2CL	C. Human reproductive health issues and Sex Education								
	DSC11P9	21ZOO4C11P	Biodiversity and Conservation Lab	20	30	50	-	-	4	2	4
	Project	21ZOO4C1R	Research Project	30	70	100		-	8	4	4
Total Marks for IV Semester						**600**				**24**	

(I-IV semester)- Total Marks: 2400 Total credits: 96

DSC – Department Specific Core, DSE – Discipline Specific Elective, SEC – Skill Enhancement Course, GEC – Generic Elective Course, IA – Internal Assessment, SEE – Semester End Examination, L – Lecture, T – Tutorial, P – Practical.

M.Sc. Zoology First Semester

Course: Systematics and Biology of Non-Chordates	**Course code:** 21ZOO1C1L
Teaching Hours/Week (L-T-P): 4 - 0 - 0	**No. of Credits:** 04
Internal Assessment: 30 marks	**Semester End Examination:** 70 marks

Course Objectives:
To understand the evidence that living species share descent from common ancestry and how this fact explain the traits of living species. Makes students to understand how life evolved from simple to complex organization by division of labour and enhancing efficiency in invertebrates.

Unit 1 **11 Hours**

Newer Aspects of Taxonomy
Levels of Taxonomy: Alpha, Beta & Gamma Taxonomy; Cytotaxonomy, Chemotaxonomy, Numerical taxonomy, Molecular taxonomy, Dendrogram, Cladistics.

Species Concept
Nominalistic Species Concept, Typological Species Concept, Phenetic Species Concept, Biological Species Concept, Evolutionary Species Concept, Ecological Species Concept, Recognition Species Concept, Aberrant Species Concept.

Other Species definitions
Monotypic and Polytypic Species, Allopatric and Sympatric Species, Peripatric and Parapatric Species, Cryptic Species and Sibling Species, Infraspecific Categories, Invasive species, Alien species, Indicator species, Keystone species, Umbrella species, Flagship species, Charismatic species.

Unit 2 **11 Hours**

General characters and classification of invertebrate phyla
From protozoa to Echinodermata (including minor phyla)

General characters and classification of Chordates
From Pisces to Mammals (including Protochordates)

Phylogenetic interrelationships
Between Protochordates and chordates.

Unit 3 **11 Hours**

Taxonomic Collection, Preservation, Curation and Identification Importance of Museum Collections, Methods for collecting non-chordates, Methods for Collecting Chordates, Preservation of non-chordates, Preservation of Chordates, Curation, Identification Method. Taxonomic keys-different types of Keys.

Zoological Nomenclature

Basic concept of ICZN, Binomial Nomenclature, Trinomial Nomenclature, Important rules, IUCN red list of threatened species.

Evaluation of Biodiversity Indices

Shannon Weiner Index, Dominance Index, Similarity and Dissimilarity Index, Association Index.

Unit 4 **11 Hours**

Locomotion and skeletal organization in invertebrates

Ultrastructure of protozoan locomotory organs (pseudopodia-cytoplasmicorganells, flagella, cilia and pellicularmyonemes) and mechanism of various modes of locomotion; skeletal organization in calcareous sponges, Hexactinilida and Demospongiae (Porifera).

Nutrition and Respiration

Filter feeding in Polychaeta, Mollusca and Echinodermata; Respiratory organs in Arthropoda; Mechanism of gaseous exchange in trachealrespiration in Insecta and gill respiration in Crustacea. Respiration in mollusca; Respiratory pigments,

Excretion

Mechanism of excretion (nitrogenous excretory products, transport of water and salts) in Polychaeta, Oligochaeta and Hirudinea of Annelida.

Unit 5 **11 Hours**

Reproduction

Structure and mechanism of reproduction in Dugesia, Fasciola, Taenia and Ascaris. Larval forms and their significance in Arthropoda and Echinodermata

Nervous System

Primitive nervous system: Coelenterata and Echinodermata, Advanced nervous system: Annelida, Arthropoda (Crustacea and Insecta) and Mollusca (Cephalopod).

General study

Polymorphism in cnidarians; parasitic adaptations in helminthes;Corals and coral reef formation;Vision in arthropods;Water vascular system of Echinoderms.

Reference Books:

1. B.K. Tikadar. Threatened Animals of India, ZSI Publication, Calcutta.
2. Barrington, E.J.W. (1979). Invertebrate Structure and Functions. II Edition, E.L.B.S.and Nelson
3. Ernst Mayer and Peter D. Ashlock: Principle Elements of Taxonomy.
4. G. G. Simpson. Principle of animal taxonomy; Oxford IBH Publishing Company.
5. Modern Text Book of Zoology: Invertebrates: R. L. KotpalRastogi Publications
6. Parker, T. S. and Haswell, W. A., TextBook of Zoology, Vol. II, ELBS, 1978.
7. Ruppert and Barnes, R.D. (2006). Invertebrate Zoology, VIII Edition. Holt Saunders InternationalEdition.
8. V.C Kapoor-Theory and practice of animal taxonomy, 6TH EDITION 1983(Reprint2011).

Course Outcomes (CO): After completion of this course student should able to

CO	Statement
1	General taxonomic rules on animal classification of chordates and evolutionary significance
2	Study Protochordata to Mammalia with taxonomic keys

3	To understand the animal diversity around us, principles of classification of animals and terminology needed in classification
4	Imparts conceptual knowledge of vertebrate adaptations in relation to their environment and Imparts conceptual knowledge of vertebrate adaptations in relation to their environment
5	Enhancement of research skills like critical thinking

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M.Sc. Zoology First Semester

Course: Aquaculture and Fish Biology	**Course code:** 21ZOO1C2L
Teaching Hours/Week (L-T-P): 4 - 0 - 0	**No. of Credits:** 04
Internal Assessment: 30 marks	**Semester End Examination:** 70 marks

Course Objectives:

This course will give the students an understanding of the principles of aquaculture, including production systems, water quality, nutrition, spawning, larval culture and culture methodologies with special reference to fish, and prawn. The course will include an opportunity to conduct hands-on activities related to culture and husbandry of animals.

Unit 1 **11 Hours**

Historical background and present status of aquaculture: purpose and importance of aquaculture.
Types of culture systems: Traditional, extensive, semi-intensive, intensive, super-intensive.
Characteristic features of cultivable species (Indian major carps, murrels, catfish and tilapia). Selection criteria of cultivable species.

Unit 2 **11 Hours**

Types of aquaculture: Freshwater aquaculture, brackish water aquaculture and mariculture,
Merits and demerits,
Design, construction and management of ponds, types of ponds.
Controlof aquatic weeds and predators.
Composite fish culture: Mono sex culture, culture of air-breathing fishes, sewage fed fish culture
Fish-cum duck culture: induced breeding of carps: Brood stock management.

Unit 3 **11 Hours**

Fish breeding: Synthetic hormones for induced breeding – GnRH analogue structure and function
Selective breeding for improving fish stocks - hybridization in Indian fishes. Gynogenesis, Androgenesis, triploidy, tetraploidy, hybridization, sex reversal and breeding, Production of transgenic fish,
Impact of GMOs on aquatic biodiversity

Unit 4 **11 Hours**

Impact of Aquaculture on Environment
Methods of Fishing: Crafts and gear technology
Nutrition in Aquaculture: Nutrient and non-nutrient diet components,
Preparation and processing of feed, feedformulae,
Natural and supplementary feed and their utilization

Fish diseases: Parasitic, protozoan, bacterial, fungal and viral diseases and their control measures.

Unit 5 **12 Hours**

Inland fisheries: Freshwater, riverine, reservoir, pond and cold-water fisheries.

Estuarine and brackish water fisheries and their economics.

Fish gears and crafts used in South Indian Fisheries.

Marine Fisheries: Sardine, Mackerel, Bombay duck, Sciaenids, Ribbonfish, Silver bellies, Pomfrets, Carangids, Sharks, Shrimps, Prawns, Crabs, Lobsters and Molluscs (Mussels, clams and scallops).

Reference Books:

1. R. Santhanam, N. Sukumaran and Natarajan, - A manual of fresh water aquaculture, Oxford and IBH Publishing Co Pvt. Ltd., Mumbai.
2. B.N. Yadav, - Fish and fisheries, Daya Publishing House, Delhi.
3. Mathew Landan, 1991. Introduction to aquaculture, John Wilay and Sons Inc..
4. V.R.P. Sinha, 1993. Acompendium of aquaculture Technologies for developing countries, Oxford and IBH Publishing Company PVT. Ltd.
5. V.G. Jhingran,1991. Fish and fisheries of India, Hindustan Publishing Corporation, Delhi.
6. T.V.R. Pillay – Aquaculture principles and practives, Fishing new Books, Blackwell Science Ltd., Oxford.
7. Shanmugam, K. 1990. Fishery Biology and Aquaculture, Hindustan Pub. Corporation, New Delhi.
8. C.V. Kurian and Sebastein – Prawn and Prawn fisheries of India, Hindustan Publishing House, New Delhi.
9. Elvire Balugal, A. 1984. Aquaculture systems and practices – A selected Review, Daya Publishing House, New Delhi.
10. B.N.Yadav, 1995. Fish Endocrinology, Daya Publishing House, New Delhi.
11. Handbook of Fisheries and Aquaculture. 2013. Indian Council of Agricultural Research, ICAR, DIPA, New Delhi, India.

Course Outcomes (CO): After completion of this course student should able to

CO	Statement
1	Understanding of design and construction of Fish hatchery and Shrimp hatchery. Feasibility of using sewage water for aquaculture.
2	Gain the knowledge of advance biological techniques used for improvement of fish culture and research.
3	Understand the culture techniques of various aquatic organisms helps in the production of healthy food for human consumption in a sustainable manner and also in employment generation.
4	Students can start their own business i.e., self employments.
5	Understand Criteria for the selection of species for culture and concepts of different types of culture.

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M.Sc. Zoology First Semester

Course: Molecular Cell Biology and Genetics	**Course code:** 21ZOO1C3L
Teaching Hours/Week (L-T-P): 4 - 0 - 0	**No. of Credits:** 04
Internal Assessment: 30 marks	**Semester End Examination:** 70 marks

Course Objectives: This course will provide knowledge about the complex organization in the eukaryotic cell and the molecular mechanisms of the cellular processes that exist in all cell types.

Unit 1 **11 Hours**

Introduction to molecular biology: Cell theory, Cellular organization, Central dogma of molecular biology; Evidences for DNA as a genetic material; Scope of molecular biology; Synthetic Biology.
Biochemistry of cell: Properties of water, Carbohydrate classification, Protein structures and bond formation,
Lipids and Nucleic acids: Types of DNA and RNA, Biological significance.

Unit 2 **12 Hours**

Structure of eukaryotic chromosome; Chromosomal condensation during mitosis; Structure of dsDNA, ssRNA, dsRNA,
Replication of DNA, DNA damage and repair mechanisms.
Genome organization: Structure of gene, Prokaryotic and eukaryotic transcription; post-transcriptional processing; Reverse transcription, RNA interference.
Genetic code, Gene translation, Regulation of gene expression,
DNA sequencing, Genetic engineering technology.

Unit 3 **11 Hours**

Molecular organisation and functions of cell organelles,
Cell cycle: Phases of cell cycle, molecular events during different stages of cell cycle,
Cyclins and Cyclin-Dependent Kinases, regulation of CDK-Cyclin activity, Senescence, Apoptosis, Significance of cell division.
Biomembranes: Davson-Danielli model, Fluid mosaic model,
Cell junctions; Signal transduction; Transport across cell membranes.

Unit 4 **11 Hours**

Elements of heredity and variation; Mendelian inheritance and extensions to Mendelian inheritance, Sex-linked; Sex-influenced and Sex-limited inheritance.
Multiple allelism: ABO blood group system and inheritance pattern; Rh incompatibility.

Unit 5 **11 Hours**

Eukaryotic model systems for genetic analysis: life cycle and importance of Drosophila and Zebra fish.

Genetic basis of human diseases: Numerical and structural anomalies of chromosomes.

Inherited biochemical diseases: Lipid metabolism disorder, Carbohydrate associated disorder, Defects in purine metabolism, Defects in membrane transport and collagen disorders.

Reference Books:

1. A.G. Motulsky and F. Vogel (1986) Human Genetics
2. Alberts,B., Bray Dennis, Lewis Julian, Raff Martin, Roberts.K and Watson, J.D. Molecular Biology of the Cell. Garland Publishing Inc. New York, 1994.
3. Bray, B. A. D, Lewis J, Raff M, Roberts K and Watson J.D (1995) Molecular biology of the cell, II edition, Garland Publishing Company Ltd. New York and London.
4. Brown, T. A. (1998) Genetics a molecular approach, 3rd edition, Chapman & Hall Publishers, London.
5. Burns, G. W. (1983) The science of genetics, V edition, McMillan Pub. Co., Inc., New York.
6. Connor, J. M. and Smith M. A. F. (1987) Essential Medical Genetics, 2nd edition, Black well scientific publications.
7. Cummings, M.R. (2009). Human Heredity: Principles and Issues. Pacific Grove, CA:Brooks/Cole.
8. Curt Stern (1960) Principles of Human Genetics 5. Robert et al., (2015)Thompson and Thompson Genetics in Medicine, Elsevier, Saunders, London
9. De Robertis, E. D. P, De Robertis E. M.F (1995) Cell and Molecular Biology, VIII edition, Indian edition
10. Fraser, C. F. and Nora J. J. (1986) Genetics of man, 2nd edition, Lea and Febiger publishers, Philadelphia.
11. Gardner, E. J., Simmins M. J. and Snusstad D. P. (1991) Principles of Genetics, 8th edition, John Wiley and Sons Inc.
12. Hartl, D. L. (2001) Genetics: Analysis of genes and genomes, 4th edition, Jones & Bartlett publishers, Boston.
13. Hassard, T.H. (1991) Understanding Biostatistics, Mosby year Book St. Louis.
14. Hutt, F. B. and Rasmusen B. A. (1982) Animal genetics, 2nd edition, John Wiley & sons, New York.
15. Lewis, R. (2008) Human Genetics: Concepts and Applications, McGraw-Hill Publishing, New York, 8th ed
16. R. F. Mueller and I.D Yound (2001) Emery's Elements of Medical Genetics
17. Robert F. Weaver (2012) Molecular Biology fifth edition, McGraw Hill companies Inc.
18. Stickberger, N.W. Genetics. MacMillan Publishing Co. New York, 1985.
19. Watson, J.D et al., Recombinant DNA. W.H.Freeman & Co, 1992.

Course Outcomes (CO): After completion of this course student should able to

CO	Statement
1	Understand how the cell functions as a unit of life
2	Gain knowledge about the techniques and experiments that contributed to the understanding of molecular mechanisms of the cellular processes
3	Formulate the tools and techniques used in rDNA technology
4	Solve Mendelian monohybrid, dihybrid experiment related problems and carry out blood grouping and derive to the conclusion of Rh compatibility
5	Write sources and cause of genetic disorders in human beings and Identify and name the genes responsible for anomalies in human chromosomes

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M.Sc. Zoology First Semester

Course: Stem Cell Biology and Regenerative Medicine	**Course code:** 21ZOO1C4L
L-T-P per week: 4-0-0	**No. of Credits:** 04
Internal Assessment: 30 marks	**Semester End Examination:** 70 marks

Course Objectives: The objective of this paper is to familiarize the students with stem cell technology and its applications for betterment of the society. The course is designed to give a broad view of mammalian stem cells, reviewing where they are found in the body, the different types and how they are cultured. The topics will cover the basic biology of these stem cells as well as bioengineering and application of these stem cells to potential treatments of human diseases.

Unit 1 **11 hours**

Overview of stem cells: Definition and criteria for stem cells; Types of stem cells; Stem cell markers; Stem cell niches; Trans-differentiation

Growth Factors and Paracrine mechanism and action of stem cells.

Unit 2 **11 hours**

Molecular concepts of stem cells: Molecular Basis of Pluripotency; Mechanisms of self renewal; Cell cycle regulators in Stem cells; Somatic cell nuclear transfer technology

Aging and stem cell renewal

Cancer stem cells: Stem cell origin of cancer, Cancer stem cells, Pathways involved in stem cells and cancer stem cells

Unit 3 **11 hours**

Stem cell therapy: Autologous and allogenic stem cell transplantation, HLA typing

Gene therapy using stem cells: Methods of gene therapy.

Applications of stem cells in gene therapy.

Tissue derivation from different germ layers

Significance of pluripotency

Induced pluripotency of stem cells.

Recent advances, applications and challenges in the production of pluripotent stem cells.

Unit 4 **11 hours**

Embryonic and adult stem cells: Embryonic stem cells: Isolation, properties, test for pluripotency, and differentiation.

Embryonic carcinoma cells: Teratomas and Teratocarcinoma.

Adult stem cells: Different types of adult stem cells based on source (cord blood, bone marrow, adipose, endometrium etc) and lineages (hematopoietic stem cells, mesenchymal stem cells side population, endothelial progenitor cells)

Unit 5 **12 Hours**

Stem cells and regenerative medicine: Neural stem cells in neurodegenerative diseases; Hematopoietic stem cell transplantation
Epithelial stem cells and burns
Stem cells and heart disease
Pancreatic stem cells and diabetes
Liver stem cells and cell therapy for liver disease
Embryonic stem cells in tissue engineering, stem cell banking,
Ethical concerns in stem cell research.

Reference Books:

1. Stem cell biology and Gene therapy, Peter J QuesenBerryr, Willey – Less.
2. Essentials of Stem Cell Biology by Robert Lanza and Anthony Atala, Elsevier
3. Stem Cells: From Basic Research to Therapy, Volume 1: Basic Stem Cell Biology, Tissue Formation during Development, and Model Organisms by Federico Calegari, Claudia Waskow, Taylor and Francis group.
4. Essentials of Stem Cell Biology, Third Edition – Edited by Robert Lanza and Anthony Atala. Academic Press, CA, USA (2013).
5. Stem Cell Biology - Edited by Daniel R Marshak, Richard L. Gardner and David Gottlieb. Cold Spring Harbor Press, NY, USA (2001).
6. "Hand book of Stem Cells" Edited by RoberLanza, Elsevier, Academic Press, 2011.
7. "Stem Cells Handbook", Edited by Stewart Sell, Human Press, 2010.

Course Outcomes (CO): After completion of this course student should able to

CO	Statement
1	Learn the various types of stem cells their identification and isolation.
2	Understand the concept of stem cell niche and its importance.
3	Learn about cancer stem cells and study the various cell signalling pathways up regulated in cancer stem cells.
4	Learn stem cell cycle regulation and explore various animal models used in stem cell research.
5	Understand about stem cell cycle regulation
6	Describe the applications of stem cells in diseases, injury and gene therapy

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M.Sc. Zoology First Semester

Course: Vermiculture and Vermitechnology	**Course code:** 21ZOO1S1LP
L-T-P per week: 1-0-2	**No. of Credits:** 02
Internal Assessment: 15 marks	**Semester End Examination:** 35 marks

Course Objectives:

1. To make wealth out of waste.
2. To assist the students in Vermitechnology for sustainable agriculture practices.
3. To develop the concept of scientific organic natural farming with a key component of making organic manure through earthworms.
4. To provide the knowledge of how to turn all kinds of waste garbage to a valuable compost.
5. To impart the knowledge of converting the weeds into food of earthworms and preparing vermicompost.
6. To provide the knowledge of commercial vermicomposting, including rearing of earthworms and production of earthworm cast.

Unit 1 **7 hours**

Introduction to vermiculture

Definition, scope of vermiculture, types of earthworms

Ecological grouping – Epigeic, Anecic and Endogeic species

Ecological role and economic importance of earthworms.

Role as four R's of recycling reduces, reuse, recycle, restore.

Role of earthworms In waste management

Vermifilter, Earthworm as farmer's friend, earthworms as bioreactors, organic farming

Unit 2 **7 hours**

Vermiculture techniques and applications of Vermicompost

Advantages of vermiculture,

Vermicomposting technology,

Methods of vermicomposting,

Large scale manufacture of vermicompost, worm casts, vermicompost, vermiwash, Role of earthworms in soil fertility, use of vermicompost for crop production, use of vermicompost in land improvement and reclamation.

Vermicompost application on soil and plant growth,

Vermicompost as a organic manure a good substitute of fertilizers.

Marketing of vermicomposting products and financial support by governments and NGOs for vermiculture.

Unit 3 **28 hours**

Experiments to be conducted

1. Key to identify different types of earthworms
2. Field trip- Collection of native earthworms & their identification
3. Study of Sytematic position, habits, habitat & External characters of Eisenia fetida/ Eudrilus eugeniae
4. Study of cocoon and vermicast
5. Study of Life stages & development of Eisenia fetida/ Eudrilus eugeniae
6. Study of Vermiculture, Vermiwash & Vermicompost equipments, devices
7. Preparation of vermibeds, maintenance of vermicompost & climatic conditions.
8. Establishment of vermicomposting unit Bed method/pit method
9. Establishment of vermiwash unit
10. Harvesting, packaging, transport and storage of Vermicompost and separation of life stages
11. Study of Pests and diseases of Earthworms
12. Study the effects of vermicompost & vermiwash on any two short duration cropplants
13. Budget and cost scenario of vermiculture (project)

Reference Books:

1. Bhatt J.V. & S.R. Khambata (1959) "Role of Earthworms in Agriculture" Indian Councilof Agricultural Research, New Delhi
2. Dash, M.C., B.K.Senapati, P.C. Mishra (1980) "Verms and Vermicomposting" Proceedings of the National Seminar on Organic Waste Utilization and Vermicomposting Dec. 5-8, 1984, (Part B), School of Life Sciences, Sambalpur University, JyotiVihar, Orissa.
3. Edwards, C.A. and J.R. Lofty (1977) "Biology of Earthworms" Chapman and Hall Ltd., London.
4. Lee, K.E. (1985) "Earthworms: Their ecology and Relationship with Soils and Land Use" Academic Press, Sydney.
5. Kevin, A and K.E.Lee (1989) " Earthworm for Gardeners and Fisherman" (CSIRO, Australia, Division of Soils)
6. Rahudakar V.B. (2004). GandulkhatashivayNaisargeekParyay, Atul Book Agency, Pune.
7. Satchel, J.E. (1983) "Earthworm Ecology" Chapman Hall, London.
8. Wallwork, J.A. (1983) "Earthworm Biology" Edward Arnold (Publishers) Ltd. London.

Course Outcomes (CO): After completion of this course student should able to

CO	Statement
1	Learn the various types of stem cells their identification and isolation.
2	Understand the concept of stem cell niche and its importance.
3	Learn about cancer stem cells and study the various cell signalling pathways up regulated in cancer stem cells.
4	Learn stem cell cycle regulation and explore various animal models used in stem cell research.
5	Understand about stem cell cycle regulation
6	Describe the applications of stem cells in diseases, injury and gene therapy

M.Sc. Zoology First Semester

Course: Lab on Systematics and Biology of Non-Chordates	**Course code:** 21ZOO1C1P
L-T-P per week: 0-0-4	**No. of Credits:** 02
Internal Assessment: 20 marks	**Semester End Examination:** 30 marks

Course Objectives:

1. To observe various non chordate specimens by using Microscope
2. To know the various systems (Digestive system, circulatory system and Reproductive system) of rat by using virtual laboratory
3. To inculcate the significance of various chordates/ non chordates.

List of Experiments

1. **Study of Available Museum Specimens of Non-Chordate animals**
   a. **Protozoa:** Amoeba, Noctiluca, Monocystis, Trypanosoma, Leishmania.
   b. **Porifera:**Leucosolenia, Grantia, Scypha, Hyalonema, Euplectella.
2. **Identification and classification of Invertebrate animals**
   a. **Coelentrata:**Porpita, Vellela, Pennatula, Alcyonium, Adamsia.
   b. **Platyhelminthes:**Dugesia, Fasciola and Taenia. Mature and gravid proglottids of Taenia.
   c. **Nematoda:**Dracunculus, Wuchereria, Trichinella, Schistosoma and Enterobius.
   d. **Annelida:** Aphrodite, Arenicola, Pheretima, Pontobdella, and Hirudinaria.
3. **Identification and classification of Invertebrate animals**
   a. **Arthropoda :** Limulus, Spider, Palamnaeus, Apus, Lepas, Sacculina, Odontotermes, Bombyx, Xenopsylla, Apis, Julus
   b. **Mollusca:** Chiton, Dentalium, Pila, Turbinella, Aplysia, Mytilus, Octopus.
   c. **Enchinodermata:**Pentaceros, Asterias, Ophiothrix, Echinus, Holothuria
4. **Study of the following Chordates through Specimens/Charts/ Models**
   a. **Protochordata:**Herdmania, Amphioxus, Amphioxus
   b. **Cyclostomata:**Petromyzon and Myxine.
   c. **Pisces:**Torpedo, Hippocoampus,Echeneis,Clarius,Channa, Anguilla.
5. **Identification and classification of vertebrate animals**
   b. **Amphibia:**Ichthyophis, Amblystoma, Axolotl larva, Hyla, Siren, Rhacophorus.
   c. **Reptilia:** Draco, Chamaeleon, Uromastix, Testudo, Trionyx, Russels viper, Hydrophis, Crocodile,Gavialis.
   d. **Aves:**Psittacula, Eudynamis, Bubo, Alcedo, Ostrich, Kiwi, Kite, and Duck
   e. **Mammalia:** Ornithorhynchus, Pteropus, Funambulus, Echidna, Kangaroo, Shrew, Loris, Seal/ Walrus, Dolphin, Sea Cow, Giant panda, Tapir,
6. Study of Morphometric measurements in fishes.
7. Study of external characters of Earthworm. Dissection of digestive and nervous system of Earthworm, Mounting of Setae, Nephridia & ovary of earth worm.

8. Dissection of digestive system and nervous system of Palaemon, Mounting of appendages of Palaemon
9. Dissection of digestive system and nervous system nervous system of cockroach. Mounting of salivary glands in cockroach.
10. **Study of larval forms:** Miracidium, Redia, Cercaria, Metacercaria, Trochophore, Nauplius, Bipinnaria, Ophiopluteus, Pluteus, Echinopluteus, Brachiolaria, Zoye, Mysis,
11. Examination of pond water collected/cultured from different places for identification of invertebrates.
12. Visit to any one National Park or Sanctuary OR Reserve forest area OR Skill based Educational programme/Lecture OR visit local education centres for specimen collection and preservation.

Note:

3. Experiments may be added/ modified as and when required with the approval of BoS.
4. Demonstration practical/ Dissection/Virtual dissection/Models/Chart of animal systems as per UGC guidelines.

References:

1. A Text Book of Zoology; T.J.Parkar and W.A.Haswell, McMillan.
2. Analysis of Vertebrate Structure: Milton Hildebrand, Wiley International
3. Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2002). The Invertebrates: A New Synthesis, III Edition, Blackwell Science
4. Biology of Invertebrates; J.A.Pechenik, 4th Ed, Tata McGraw Hill Publication.
5. Functional Anatomy of Vertebrates. An evolutionary perspective. K.F.Liem, W.E.Bemis, W, F.Walker, L.Grande, 3rd Ed. Harcourt College Publishers.
6. Invertebrate Zoology: Bares, R.D., Saunders Publication.
7. Life of Invertebrates; Russell, W.D. Hunter, McMillan
8. Ruppert and Barnes, R.D. (2006). Invertebrate Zoology, VIII Edition. Holt Saunders International Edition.
9. The Life of Vertebrates: J.Z.Young, ELBS• Oxford Univ. Press.
10. Vertebrate comparative anatomy, Function, Evolution, K.V. Kardong, 3rd Ed. Tata McGraw, Hill Publication.

Course Outcomes (CO): After completion of this course student should able to

CO	Statement
1	Understand basics of classification of non-chordates
2	Learn the diversity of habit and habitat of these species
3	Develop the skills to identify different classes and species of animals.
4	Know uniqueness of a particular animal and its importance
5	Enhancement of basic laboratory skill like keen observation and drawing

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M.Sc. Zoology First Semester

Course: Lab on Aquaculture and Fish Biology	**Course code:** 21ZOO1C2P
L-T-P per week: 0-0-4	**No. of Credits:** 02
Internal Assessment: 20 marks	**Semester End Examination:** 30 marks

Course Objectives: This course will give the students an understanding of the principles of aquaculture, including production systems, water quality, plankton analysis, spawning, larval culture and culture methodologies.

List of Experiments

1. Qualitative identification and estimation of ammonia and urea.
2. Estimation of glycogen.
3. Estimation of proteins.
4. Estimation of lipids.
5. Estimation of hemoglobin.
6. Estimation of tissue somatic index.
7. Determination of temperature, pH, salinity in the pond water sample.
8. Estimation of total alkalinity and total hardness.
9. Estimation of dissolved oxygen and free carbondioxide.
10. Estimation of phosphates and nitrites.
11. Estimation of COD and BOD.
12. Identification of important cultivable species of fin fish and shell fish.
13. Common unwanted (weed and predatory) fishes in culture ponds – identification and their impact in aquaculture.
14. Collection, preservation and identification of common phytoplanktonic organisms in ponds.
15. Collection, preservation and identification of common zooplanktonic organisms in ponds – Rotifers, Cladocerans and Copepods.
16. Identification of aquatic insects and molluscs in ponds.
17. Common floating, emergent and submerged aquatic vegetation in ponds.

Note:

3. Experiments may be added/modified as and when required with the approval of BoS.

Reference Books:

1. Bard. J (1986). Handbook of Tropical Aquaculture.
2. Santhanam, R. A. Manual of Aquaculture.
3. Fresh Water Fish Culture and Training, Neha Charan, Random Publications, 2012

Course Outcomes (CO): After completion of this course student should able to

CO	Statement
1	Study the breeding, rearing, and harvesting of aquatic animals.
2	Know the methodology for the construction of hatcheries and farms.
3	Study the recent techniques and application for the practical aquaculture
4	Know culture practice and economic importance aquaculture
5	Understand the environmental impacts of aquaculture and Learn the importance of aquaculture

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Zoology First Semester

Course: Lab on Molecular Cell Biology and Genetics	**Course code:** 21ZOO1C3P
L-T-P per week: 0-0-4	**No. of Credits:** 02
Internal Assessment: 20 marks	**Semester End Examination:** 30 marks

Course Objectives: This lab course will provide skills and firsthand practical knowledge about the biological molecules, biochemistry, chromosomal aberrations and tools and techniques in cellular mechanisms.

List of Experiments

1. Study of microscopes: compound, dark-field, phase contrast, fluorescent, TEM and SEM.
2. Temporal mitosis in onion roots.
3. Meiosis in maize/ onion bud/grasshopper testes.
4. Isolation of genomic DNA from plant / animal tissue
5. Casein extraction from milk.
6. Decoding the genetic codes using base sequences.
7. Anomalies in chromosomes.
8. Micrometry: calibration of microscope and measurement of cell diameters.
9. Carbohydrate, protein and lipid tests
10. Barr body identification using buccal smear
11. Demonstration of agarose gel electrophoresis
12. Study of life cycle of drosophila, zebra fish and maintenance of stock
13. Problems based on mendelian laws, sex linkage
14. Centrifugation technique, colorimetry, chromatography and spectrophotometry
15. Blood grouping and Rh compatibility

Note:

1. Experiments may be added/modified as and when required with the approval of BoS.

Reference Books:

1. Bray, B. A. D, Lewis J, Raff M, Roberts K and Watson J.D (1995) Molecular biology of the cell, II edition, Garland Publishing Company Ltd. New York and London.
2. Brown, T. A. (1998) Genetics a molecular approach, 3rd edition, Chapman & Hall Publishers, London.
3. Connor, J. M. and Smith M. A. F. (1987) Essential Medical Genetics, 2nd edition, Black well scientific publications.
4. De Robertis, E. D. P, De Robertis E. M.F (1995) Cell and Molecular Biology, VIII edition, Indian edition

5. Fraser, C. F. and Nora J. J. (1986) Genetics of man, 2nd edition, Lea and Febiger publishers, Philadelphia.
6. Gardner, E. J., Simmins M. J. and Snusstad D. P. (1991) Principles of Genetics, 8th edition, John Wiley and Sons Inc.
7. Hartl, D. L. (2001) Genetics: Analysis of genes and genomes, 4th edition, Jones & Bartlett publishers, Boston.
8. Lewis, R. (2008) Human Genetics: Concepts and Applications, McGraw-Hill Publishing, New York, 8th ed
9. Robert F. Weaver (2012) Molecular Biology fifth edition, McGraw Hill companies Inc.
10. Watson, J.D et al., Recombinant DNA. W.H.Freeman & Co, 1992.

Course Outcomes (CO): After completion of this course student should able to

CO	Statement
1	To use the different types of microscopes
2	Identify The chromosomal aberrations by preparing karyotypes
3	Develop the skills to identify Molecular Structure of biomolecules
4	Carry out blood grouping and derive to the conclusion of Rh compatibility
5	Enhancement of basic laboratory skill like keen observation and drawing

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