



VIJAYANAGARA SRI KRISHNADEVARAYA UNIVERSITY
JNANASAGARA CAMPUS, BALLARI-583105

Department of Studies in Zoology

SYLLABUS

Master of Science
(I-IV Semester)

With effect from:
2021-22



VIJAYANAGARA SRI KRISHNADEVARAYA UNIVERSITY

Department of Zoology

Jnana Sagara, Ballari - 583105



Distribution of Courses/Papers in Postgraduate Programme I to IV Semester as per Choice Based Credit System (CBCS) Proposed for PG Programs

II-SEMESTER

Semester	Category	Subject code	Title of the Paper	Marks			Teaching hours/week			Credit	Duration of exams (Hrs)
				IA	SEE	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	20	30	50	1	-	2	2	1
	DSC5P	21ZOO2C5P	Biology of Chordates Lab	20	30	50	-	-	4	2	4
	DSC6P	21ZOO2C6P	Developmental Biology and Molecular Endocrinology Lab	20	30	50	-	-	4	2	4
	DSC7P	21ZOO2C7P	Ethology and Chronobiology Lab	20	30	50	-	-	4	2	4
Total Marks for II Semester						600				24	

Department Name: Zoology
Semester-II

DSC5: Biology of Chordates

Course Title: Biology of Chordates	Course code: 21ZOO2C5L
Total Contact Hours: 56	Course Credits: 04
Formative Assessment Marks: 30	Duration of ESA/Exam: 3 h
Summative Assessment Marks: 70	

Course Outcomes (CO's):

At the end of the course, students will be able to:

4. Impart teaching on chordates.
5. Draw a conclusion towards anatomical differences among vertebrates.
6. Design the tools for fishing and help in identifying the fishes.
7. Trace the migratory birds by morphological features.
8. Develop the aesthetic sense in protecting animal organisms.

Unit	Description	Hours
1	General characters of Chordata. Theories of origin of chordates, Protochordata: Outline classification of protochordates; General characters of Hemichordata, Urochordata and cephalochordata. Life cycle of Salpa, Doliolum and Branchiostoma. Significance of retrogressive metamorphosis.	12
2	Origin, evolution and general characters of Agnatha (Ostracoderms and Cyclostomes) and Gnathostomes (Placoderms). Pisces: Chondrichthyes and Osteichthyes, Deep sea adaptations, Adaptive radiation in Bony fishes, Migration in fish, Sensory, hydrostatic and lateral line system.	11
3	Amphibia: Origin and evolution, Adaptations in Amphibia, Neoteny, Breeding behaviour and parental care. Reptiles: Origin, adaptive radiation and evolution, Extinct reptiles, Poisonous and non-poisonous snakes in India. Snake venom, snake bite, associated bones and muscles, snake bite treatment.	11
4	Aves: Origin of birds and evidences, aerial adaptations and mechanism of flight, Courtship and breeding behaviour, Avian migration. Mammals: Origin and evolution of mammals, Structural peculiarities of Prototheria, Metatheria and Eutheria. Aquatic mammals.	11
5	Structure of cutaneous, branchial and pulmonary respiration. Comparative account of heart, kidney and brain of vertebrates. Integuments of tetrapods with emphasis on epidermal derivatives: glands, scales, horns, nails, hoofs, feathers, and hairs.	11

References:

1. Barrington, E.J.W. (1965): The biology of Hemichordata and Protochordata. Oliver and Boyd, Edinburgh, UK.
2. Colbert, E.H. (2011) Evolution of the Vertebrates. 5th Edn. John Wiley and Sons Inc., New York
3. Hobart M. Smith, 1960 Evolution of Chordate Structure, Holt, Rinehart & Winston Inc. New York
4. Holstead. 1969 The Pattern of Vertebrate Evolution. Freeman and Co. San Francisco. U.S.A.
5. Hyman, L.H. (1966): Comparative Vertebrate Anatomy. The University of Chicago Press, Chicago
6. Jolie, M. 1968. Chordate Morphology. East West Press. Pvt, Ltd
7. Milton Hildebrand and George Goslow (2002): Analysis of Vertebrate Structure, 5th Edn. John Wiley and Sons Inc., New York
8. Romer, A.S. and Parson, T.S. 1978 Vertebrate Body. W.B. Saunders Co. Philadelphia.
9. Romer, A.S. Vertebrate Paleontology. 3rd Edn. University of Chicago Press, Chicago
10. Walter, H.E. and Sayles, L.D. Biology of vertebrates, MacMillan & Co. New York.
11. Waterman. A.J. 1971. Chordate Structure and Function. McMillan Co. London.
12. Weichert, C.K., Anatomy of Chordates McGraw Hill Book Co. Inc. London.
13. Young, J.Z. 1969. Life of Vertebrates. Clarendon Press, Oxford.
14. Young, J.Z. (1976):, Life of mammals The Oxford University Press, London.
15. Young, J.Z. (1981): The Life of Vertebrates, 3rd Edn. Clarendon Press Oxford.

DSC6: Developmental Biology and Molecular Endocrinology

Course Title: Developmental Biology and Molecular Endocrinology	Course code: 21ZOO2C6L
Total Contact Hours: 56	Course Credits: 04
Formative Assessment Marks: 30	Duration of ESA/Exam: 3 h
Summative Assessment Marks: 70	

Course Outcomes (CO's):

At the end of the course, students will be able to:

6. Understand the patterns and process of embryonic development, body plan, fate map, induction, competence, regulative and mosaic development.
7. Understand molecular and genetic approach for the study of developing embryo which is not necessarily shared with any other disciplines in the biological sciences.
8. Understand relationship of central nervous system with peripehral endocrine system and controlled functions system in higher vertebrates.
9. Describe major signalling pathways in target cells for each hormone including feedback relationships.
10. Identify the organs involved in the endocrine function and an understanding of appropriate key human endocrine disorder will also be developed.
11. Understand the current developments in design and production of hormonal contraceptives.
12. Understand the mechanisms involved in production of recombinant protein hormones and their application in regulation of fertility in farm animals and humans.

Unit	Description	Hours
1	<p>1. Introduction: Overview of animal development. Questions of Developmental Biology. In Vitro Fertilization (IVF), Embryo transfer, Variations of Embryo transfer, Intra-cytoplasmic sperm injection (ICSI), Gamete intra-fallopian transfer (GIFT); Teratology and ageing.</p> <p>2. Early development: Fertilization - Structure of the gametes- sperm and egg; recognition of sperm, egg and sperm attraction; acrosome reaction, Species-specific recognition, gamete fusion and prevention of polyspermy; fusion of genetic material, activation of egg metabolism, rearrangement of egg cytoplasm.</p> <p>3. Morphogenetic movements: Types of cleavage, blastula and gastrula of fruit fly and Chick. Morphogenetic movements- Epiboly, Emboly, Invagination, Ingression, Delamination</p>	11
2	<p>1. Early development in Drosophila: Origin of anterior & posterior polarity, maternal effects of genes; Segmentation genes, homeotic selector genes. Generation of Dorso-ventral polarity.</p> <p>2. Early development in Amphibians: Axis formation in Amphibians: The progressive determination of amphibian axis, primary embryonic</p>	11

	<p>induction. Function of organizer Diffusible proteins of organizer.</p> <p>3.Organogenesis:Brain, limb, heart, haematopoiesis, kidney and formation of extra embryonic membranes (Chick).Vulva formation in C. elegans</p>	
3	<p>1. Introduction: Structure and functions of endocrine glands (Pituitary, pineal, pancreas, adrenal, thyroid etc.); Endocrine, Paracrine and autocrine secretions, Local hormones, Neuroendocrine secretions and Neurotransmitters.</p> <p>2. An over view of endocrine system: General classes of chemical messengers-Peptide, Amino acid derived and Steroid hormones, Neurotransmitters-Neuropeptides, v. Growth stimulating factors, Eicosanoids and Pheromones.</p> <p>3. Hormones and Homeostasis: Glucose, Calcium and Sodium Homeostasis, Neuro-endocrine integration: milk ejection reflex and water balance.</p>	11
4	<p>1. Endocrine Methodologies: Histological-Cytological, ii. Surgical and Hormone replacement Therapy, Bioassay, RIA, Radioreceptor Assay, ELISA, Autoradiography, Recombinant DNA techniques, Gene knockout animal models.</p> <p>2. Mechanism of hormone action: Membrane bound, cytoplasmic and nuclear hormone receptors. Signal transduction: secondary messengers - cyclic AMP, prostaglandins, DAG and calmodulin. Mechanism of hormone action-Steroid and thyroid hormone regulation of gene expression. Termination of hormone action and metabolism of hormones.</p> <p>3. Pineal, Thyroid and Parathyroid Glands: <u>Morphology and physiological actions of melatonin. Position and Morphology of thyroid and parathyroid glands. Bio-chemistry of synthesis, secretion and metabolism of thyroid hormones and Parathormone, Pathophysiology-Goiter, Grave's disease and Cretinism.</u></p>	11
5	<p>1. Hypothalamo-Hypophyseal system: Endocrine Hypothalamus: Structure and Function, Chemical structure and control of hypothalamic hormones-TRH, GHRH, GnRH, CRH, Somatostatin and dopamine, Control of release of these hormones and their action on target cells. Pituitary- Location, Development, structure and functional cell types, Hypothalamo-hypophysial portal system, Pituitary hormone and their physiological actions with emphasis on molecular mechanisms-GH and Prolactin, FSH, LH and FSH (Glycoprotein Hormones), Pituitary pathophysiology: Hyperprolactinaemia, Pituitary dwarfism, Gigantism and Acromegaly.</p> <p>2. Adrenal Gland and pancreas: Anatomy, and histology; Control of synthesis, secretion and physiological roles of cortical hormones with emphasis on molecular actions. Metabolism and action of catecholamine; Addison's disease and Cushing's syndrome. Structure and cell types of Islets of Langerhans, metabolism of Insulin, Glucagon and other pancreatic hormones, Insulin and Non-Insulin Dependent Diabetes Mellitus; Islet cell tumor.</p> <p>3.a. Hormones and Reproduction: Pregnancy, Parturition, Lactation, menstrual cycle Menarche, Menopause.</p>	12

	b. Gastro-Intestinal Hormones : Endocrine cells, Gastrin, CCK and Secretin	
<p>References:</p> <ol style="list-style-type: none"> 1. An Introduction to Neuroendocrinology, Brown R., (1994), Cambridge University Press, Cambridge, UK 2. Bolander .Jr F.F. (2004) Molecular Endocrinology Third Edition. Academic press. SanDiego. 3. Endocrinology (3 volumes set), DeGroot L. J. and Jameson J.L., Editors, (5th Ed., 2006), Saunders Elsevier Press, USA. 4. Fred H. Wilt and Sarah C. Hake, 2001. Principles of Developmental Biology, W.W. Norton & Comp. Inc. NY. 2004. 5. Goodman. H.M (2003). Basic Medical Endocrinology. Third Edition. Academic press. SanDiego. 6. Lewis Wolpert, 2012. Principles of Development, Oxford Univ. Press Slack J. M.W. Essential Developmental Biology, Blackwell. 7. Mary S. Tyler, 2000. Developmental Biology: A guide for experimental study, 2nd Edition, Sinauer Assoc. Inc. Sunderland, MA. 8. Negi. C.S. (2009). Introduction to Endocrinology. PHI learning Pvt Ltd. New Delhi. 9. Norris. D.O. (2006). Vertebrate Endocrinology. Third Edition. Academic press. SanDiego. 10. Richard M. Twyman, 2001. Instant notes on Developmental Biology, Springer Verlag, BIOS Scientific. 11. Scott F. Gilbert. 2014. Developmental Biology, 9th Edition, Sinauer Assoc. Inc. Sunderland, MA. 		

DSC7: Ethology and Chronobiology

Course Title: Ethology and Chronobiology	Course code: 21ZOO2C7L
Total Contact Hours: 56	Course Credits: 04
Formative Assessment Marks: 30	Duration of ESA/Exam: 3 h
Summative Assessment Marks: 70	

Course Outcomes (CO's):

At the end of the course, students will be able to:

4. Get knowledge about the different types of animal behaviour.
5. Enable the students to impart knowledge about the different types of behaviour.
6. Gain basic understanding about endocrinology.
7. Know how the animals, communicate.
8. Gain knowledge about the endocrine glands and the diseases.

Unit	Description	Hours
1	Introduction to animal behaviour- History of Animal behaviour- Karl Von Fritz, Tinbergen and Lorenz contribution- Methods for studying animal behaviour- Proximate and ultimate causation of behaviour- Behavioural patterns- Orientation, animal navigation and migration- Instinct Vs Learnt behaviour- Associative learning- Classical and Operant conditioning- Habituation, imprinting.	11
2	Social behaviour and animal signalling- Altruism- Honey bee, Vampire bats- Hamilton's rule, Kin Selection-Group foraging and its advantages- Dispersion- migration- territoriality- Animal Communication in birds, bees and wild mammals- Warning colouration, mimicry and deception.	11
3	Mating system- Sexual dimorphism- Male- Male competition- Female choice- Leks- Alternative mating tactics-satellite males- monogamy- Polyandry- Polygyny- Sperm competition- Parental care.	11
4	Chronobiology: Circannual rhythms <u>Introduction, History and Milestones, Clocks, Rhythm and Calendar, The biological timing system: Concepts and methods, Types: Ultradian, circadian and circannual rhythms. Proximate and Ultimate factors, Circannual control of seasonal processes, Photoperiodism: Concepts and photoperiodic time measurement models, Seasonal processes and photoperiodic control mechanisms. Human temporal structure: Biological clocks and human health and 8 diseases, Clock dysfunction and lifestyle related disorders, Chronopharmacology, chronomedicine, chronotherapy.</u>	13
5	Rhythm characteristics: Free running rhythms, Entrainment and masking in the natural and artificial environment, <i>Zeitgebers</i> : Photic and non-photic, Parametric and non-parametric entrainment, Phase shift, Phase response curves (PRC) and phase transition curves (PTC).	10

References:

15. An Introduction to Animal Behaviour (6th Edition). Aubrey Manning and Marian Stamp Dawkins, Cambridge University Press.
16. Animal Behaviour: An Evolutionary Approach, 9th Edition. John Alcock, Sinauer Associate Inc., USA, 2009.
17. Animal Behaviour (11th Edition). Dustin R. Rubenstein and John Alcock, Sinauer Associate Inc., USA, 2018.
18. Neuroscience of Emotion: A New Synthesis. Ralph Adolphs and David J. Anderson, Princeton University Press, 2018.
19. The Honey Bee. James L. Gould and Carol Grant Gould, Times Books, 2002.

20. The Wisdom of the Hive. Thomas D. Seeley, Harvard University Press, 1995
21. Honeybee Democracy. Thomas D. Seeley, Princeton University Press, 2010.
22. The Selfish Gene. Richard Dawkins, Oxford University Press, 2016.
23. Insect Clocks (3rd edition): D.S. Saunders, C.G.H. Steel, X. Afopoulou (ed.)
R.D.Lewis. 2002 Barends and Noble Inc. New York, USA
24. Chronobiology Biological Timekeeping: Jay. C. Dunlap, Jennifer. J. Loros, Patricia
J.DeCoursey (ed). 2004, Sinauer Associates, Inc. Publishers, Sunderland, MA, USA
25. Circadian Medicine: Christopher Colwell (ed.) Wiley-Blackwell (2015).
26. Circadian Physiology: Roberto Refinetti, CRC Press (3rded) 2016.
27. Biological Timekeeping: Clock, Rhythms and Behaviour, Vinod Kumar (ed.
2017) Springer India Pvt Limited.

DSC8: Cancer and Radiation Biology

Course Title: Cancer and Radiation Biology	Course code: 21ZOO2C8L
Total Contact Hours: 56	Course Credits: 04
Formative Assessment Marks: 30	Duration of ESA/Exam: 3 h
Summative Assessment Marks: 70	

Course Outcomes (CO's):**At the end of the course, students will be able to:**

1. Understand terms in cancer biology.
2. Gain knowledge about basics of cancer biology.
3. Gain knowledge on various causes of cancer, signalling, immune response and treatment regimen.
4. Understanding of the molecular and cellular mechanisms that lead to cancer.
5. Understand various types of cancer, tumor invasion, markers in cancer research and diagnosis.
6. Demonstrate antigen-antibody relationships and their detection methods.
7. Knowledge of the fundamentals of radiation transport, interactions and detection and with the principles required for the analysis, design and safe operation of radiation producing and using equipment and systems.

Unit	Description	Hours
1	Cancer: Definition, causes, properties, classification, prevalence, clonal nature. Cancer risk factors: Theory of carcinogenesis, Chemical carcinogenesis, Physical carcinogenesis: x-ray radiation – mechanisms of radiation carcinogenesis. Etiology of cancer: Stages of cancer: initiation, promotion, progression. Carcinogenesis. Prevalence of cancer in India and World.	11
2	Tumor immunology: Adaptive and Innate immune response, immune-surveillance, immune recognition of tumors, tumor-specific transplantation antigens, tumor associated transplantation antigens, NK cell and tumor, role of T-regulatory cells in immune invasion.	8
3	Oncogenes and their role in Cancer: Introduction to oncogenes, Mechanisms of oncogene activation (gene amplification), Mechanisms of oncogene activation (chromosomal translocations), Chromosomal translocations with dominant negative effects, Introduction to tumor suppressor genes. Cancer therapy – at cellular level- at gene level- at protein level. Principles of cancer biomarker and their applications – chemotherapeutics for cancer, Phytotherapy for cancer. Development of anti cancer drugs.	12
4	Current treatment regimen: Development and clinical use of effective therapies, anti-cancer drugs and attractive targets for drug development, Screening of new drugs, various clinical trial phases (Phase I, Phase II, Phase III), drug resistance and effective therapy.	12

5	<p>Radiation Biology 1: Introduction: Definition, scope and significance of radiation biology; General classification of radiation. Ionizing radiation: Linear energy transfer; radiation dose and units; principles of radiation dosimetry; direct and indirect effects; Radiation lesions in DNA; major types of DNA repair; damage recognition and signaling; consequence of unrepaired DNA damage (chromosome damage). Cellular radiobiology: Radiobiological definitions of cell death; survival curves and models; cell cycle effects; relative biological effectiveness (RBE); cellular repair exemplified in survival curves; cellular hyper-radiosensitivity (HRS) and induced repair (IRR); Other molecular targets – bystander (epigenetic) effects; radiation sensitizers and protectors.</p>	12
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References:

1. Cancer Biology (Authors: Raymond W. Ruddon)
2. The Biological Basics of Cancer (Author: *Robert Gilmore McKinnell et al*)
3. Principles of Cancer Biology (Author: Lewis J. Kleinsmith)
4. Biology of Cancer (Authors: Lobo D)
5. Weinberg R.A. Biology of Cancer. Taylor and Francis Inc.
6. The biology of cancer, Robert A. Weinberg, Garland Sciences, Taylor and Francis Group.
7. The molecular biology of cancer, Stella Pelengaris and Michael Khan, Wiley-Blackwell
8. Tannock IF and Hill RP (1998) The Basic Science of Oncology, Third edition, McGraw-Hill, New York.
9. The Molecular Biology of Cancer: S. Pelengaris, M. Khan. Blackwell Publication. 2002
10. The Cancer Handbook: Malcolm R. Alison. Nature Publishing Group.
11. The Biology of Cancer, Robert Allan Weinberg · 2014, Garland Science
12. Anonymous, Radiation Biology: A handbook for teachers and students; International Atomic Energy Agency (IAEA), Training Course Series 42, Vienna.
13. Steel GG, Basic Clinical Radiobiology, Amazon, UK.

SEC 2: Non-clinical Safety Evaluation of Drugs

Course Title: Non-clinical Safety Evaluation of Drugs	Course code: 21ZOO2S2LP
Total Contact Hours: 28 (01 L-0-2P)	Course Credits: 02
Formative Assessment Marks: 20	Duration of ESA/Exam: 1 h
Summative Assessment Marks: 30	

Course Outcomes (COs):

At the end of the course, students will be able to:

1. Studied the practical skills required to conduct the preclinical toxicity studies.
2. Know the pre-clinical and clinical development.
3. Study the various types of toxicity studies and their procedure.
4. Determine the various pharmacokinetic parameters from either plasma concentration or urinary excretion data for drug.
5. Use of experimental animals for the different toxicological studies.
6. Learn the importance of the role of computer aided drug design in drug discovery.

Unit	Description	Hours
1	<u>Laboratory Animals and Regulatory Guidelines:</u> Common laboratory animals: Description, handling and applications of different species and strains of animals. Environmental conditions. Maintenance and breeding of laboratory animals. Anaesthesia and euthanasia of experimental animals. CPCSEA guidelines to conduct experiments on animals. Regulatory guidelines for conducting toxicity studies OECD, ICH, EPA and Schedule-Y. OECD principles of Good laboratory practice (GLP) History, concept and its importance in drug development.	8
2	<u>Evaluation of Toxicity;</u> LD50, LC50, IC50, EC50; Route of administration; Dose response relationship and its evaluation. Acute, sub-acute and chronic- oral, dermal and inhalational studies as per OECD guidelines. Skin sensitization, dermal irritation & dermal toxicity studies. Test item characterization- importance and methods in regulatory toxicology studies. Reproductive toxicology studies, Male reproductive toxicity studies, female reproductive studies, teratogenicity studies and generation studies. Genotoxicity studies (Ames Test, in vitro and in vivo Micronucleus and Chromosomal aberrations studies). In vivo carcinogenicity studies. Principle of ecotoxicology; Terrestrial model and ecotoxicity testing: Earthworm, Honey bee, Birds, Plants; Aquatic	12

	models and ecotoxicity testing: Algae, Lemna, Daphnia, Brin shrim, Fish.	
3	Toxicokinetics and Biostatistics in Drug Development: Toxicokinetic evaluation in preclinical studies; Absorption, Digestion, Metabolism, Excretion. Saturation kinetics Importance and applications of toxicokinetic studies. Alternative methods to animal toxicity testing. Blinding, Randomization, and Stratification. Dose response curves. Levene's test, ANOVA, Dunnett's test, non- parametric test (wilcoxon rank tests, analysis of variance, correlation, chi square test, Kruskal Wallis followed by Mann Whitney U test). Sample size, Experimental designing, control v/s treatment results, robustness and significance.	8
References (indicative)		
<p>5. David C. Young. Computational Drug Design. A guide for Computational and Medicinal Chemists. Wiley. 2009.</p> <p>6. Casarett and Dull's toxicology: the basic science of poisons by Curties D. Klaassen; Ed. 7 th; McGraw Hill; New York; 2007.</p> <p>7. <u>Introduction to statistical methods with MATLAB (MATLAB and Simulink Training (mathworks.com))</u></p>		

DSC5 P4: Biology of Chordates

Course Title: Biology of Chordates	Course code: 21ZOO2C5P
Total Contact Hours: 56 (0-0-4P/week)	Course Credits: 02
Formative Assessment Marks: 20	Duration of ESA/Exam: 4 h

Summative Assessment Marks: 30	
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Course Outcomes (CO's):

At the end of the course, students will be able to:

4. Dissect small fishes and show different parts.
5. Distinguish bones of different animal organisms.
6. Recognize migratory birds.
7. Outline the causes of extinction of animals.
8. To handle small animal organism without affecting their internal organs
9. Draw a conclusion towards anatomical differences among vertebrates.
10. Differentiate and discuss the organ systems in different vertebrates.
11. Perform preliminary survey on migratory birds.
12. Design the net for collecting fishes and identify different fishes.
13. Develop the aesthetic sense in protecting animal organisms.

SL No	List of experiments	Hours
1	Study of digestive system, respiratory system, arterial system, venous system and reproductive systems in different vertebrates (using charts/ videos / computer simulations).	
2	Study of museum specimens.	
3	Protochordata: Salpa, Doliolum, Herdmania, Amphioxus, Petromyzon	
4	<u>Fishes: Catla, Rohu, Mrigal, Calbasu, Silver carp, Grass carp, Mackerel, Sardine, Eel, Shark. Study of different scales of various fishes.</u>	
5	Study of fish anatomy of fry and fingerlings.	
6	Amphibians: Study of Ambystoma, Axolotl larva, Ichthyophis. Parental care in Amphibia.	
7	Reptiles: Outline differences between poisonous and non-poisonous snakes. Camouflage.	
8	Birds: Study of Structure, mechanism, adaptation and development of feathers in different birds.	
9	Osteology: Skull and lower jaws, types of vertebrae of procoelus, ophisthocoelus, amphicoelus, heterocoelus, axis and atlas vertebrae.	
10	Comparative anatomy (models): Hearts and brains of vertebrates.	

References:

8. A manual of practical zoology, Chordates, Dr. P.S Verma, S. Chand Publications.
9. Advanced practical chordate zoology by G.S Sandhu and Harshavardhan.
10. Biology of chordates by B.N Pandey and Vartika Mathur, PHI Learning publishers.
11. Modern text book of zoology, by Dr. R.L Kotpal
12. Waterman. A.J. 1971. Chordate Structure and Function. McMillan Co. London.
13. Hyman, L.H. (1966): Comparative Vertebrate Anatomy. The University of Chicago Press. Jolie, M. 1968. Chordate Morphology. East West Press. Pvt, Ltd

DSC6 P5: Developmental Biology and Molecular Endocrinology

Course Title: Developmental Biology and Molecular Endocrinology	Course code: 21ZOO2C6P
Total Contact Hours: 56 (0-0-4P/week)	Course Credits: 02
Formative Assessment Marks: 20	Duration of ESA/Exam: 4 h
Summative Assessment Marks: 30	

Course Outcomes (CO's):**At the end of the course, students will be able to:**

4. Learn basic principles of important techniques applied to neuroendocrine research.
5. Describe how androgens and estrogens are involved in cancers, as in the prostate and breast respectively.
6. Explain how the actions of peptide hormones (e.g. insulin) are involved in diseases (e.g. diabetes).
7. Understand the basic organization of the vertebrate brain, and the interaction of hypothalamus with the pituitary and pineal gland.
8. Understand neuroendocrine regulation of physiological processes.
9. Develop the ability of critical thinking of regulatory biology in animals.
10. Explain the molecular mechanisms by which peptide hormones activate cell surface receptors to provoke their biological effects.

SL No	List of experiments	Hours
1	Mounting of developmental stages of chick embryo	
2	Study of the developmental stages and life cycle of Drosophila from stockculture.	
3	Study of whole mounts and sections of developmental stages of frog through permanent slides: Cleavage stages, blastula, gastrula, neurula, tail-bud stage, tadpole (external and internal gill stages)	
4	Study of whole mounts of developmental stages of chick through permanent slides: Primitive streak (13 and 18 hours), 21, 24, 28, 33, 36, 48, 72, and 96 hours of incubation (Hamilton and Hamburger stages)	
5	Project report on Drosophila culture/chick embryo development	
6	Histological study of endocrine glands.	
7	Paper chromatographic separation of corticoids	
8	Case study relating to particular clinical conditions of hormone.	
9	Study of the estrous cycle in mouse or rat by the vagina smear technique.	
10	Study of models pertaining to ART (Assisted reproductive techniques), Transgenic techniques, STDs and Contraception	
11	Diagnosis of pregnancy by the presence of HCG in Urine by using suitable method	

12	Dissect and display the endocrine glands in a fish	
13	Dissect and display of Endocrine glands in laboratory bred rat*	
14	Demonstration of Castration/ ovariectomy in laboratory bred rat*	
15	Designing of primers of any hormone	
16	Visit to research institutions and laboratories.	

***Demonstration practical/ Dissection/Virtual dissection/Models/Chart of animal systems as per UGC guidelines.**

References:

7. Analysis of Biological Development, Kalthoff, (2nd Ed., 2000), McGrawHill Science, New Delhi, INDIA.
8. Balinsky B. I. and Fabian B. C. (1981). An Introduction to Embryology, V Edition, International Thompson Computer Press.
9. Biochemical actions of hormones, ed. Litwack, G. (1985), Academic press, New York, USA.
10. Carlson, R. F. Patten's Foundations of Embryology.
11. Gilbert, S. F. (2010). Developmental Biology, IX Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA
12. Kalthoff (2008). Analysis of Biological Development, II Edition, McGraw-Hill Publishers.
13. Lewis Wolpert (2002). Principles of Development. II Edition, Oxford University Press
14. Molecular Biology of Steroid and Nuclear Hormone receptors, ed. Freedman L. P., (1998), Birkhauser, Boston, USA.
15. Principles of Development, Wolpert, Beddington, Brockes, Jessell, Lawrence, Meyerowitz, (3rd Ed., 2006), Oxford University Press, New Delhi, INDIA.

DSC7 P6: Ethology and Chronobiology

Course Title: Ethology and Chronobiology	Course code: 21ZOO2C7P
Total Contact Hours: 56 (0-0-4P/week)	Course Credits: 02

Formative Assessment Marks: 20	Duration of ESA/Exam: 4 h
Summative Assessment Marks: 30	

Course Outcomes (CO's):

At the end of the course, students will be able to:

1. Conceptualize how species profitably inhabit in the temporal environment and space out their activities at different times of the day and seasons.
2. Understand the historical foundations of the field, as well as current theories and evidence for a broad range of behavioral topics.
3. Develop a critical viewpoint and to interpret observations from experiments on biological rhythms regulating daily and seasonal biology.
4. Plan studies on biological rhythms in both human and non-human species.
5. Understand the consequence of the disruption of internal rhythms on work performance and health in the modern world.

SL No	List of experiments	Hours
	Ethology	
1	To study the geotaxis, phototaxis, chemotaxis and hydrotaxi of earthworm.	
2	To study the response of woodlice to hygrostimuli.	
3	Fixed action pattern in spider.	
4	Habituation in snail.	
5	Behaviour observations in a primitive eusocial wasp.	
6	Courtship and mating behaviour in <i>Drosophila</i> .	
7	Foraging behaviour in a (Myna bird).	
8	Behavioural profiling of a primate <i>Macacamuletta</i> .	
9	Territorial behaviour in stray dogs.	
	Chronobiology	
10	Assay of circadian rhythms using animal model systems.	
11	Assay of circadian activity rhythms in human.	
12	Ambulatory blood pressure monitoring and circadian analysis.	
13	Quantifying oscillations: phase, period and amplitude.	
14	Dry lab exercises on the previously recorded data.	
15	Recording of body temperature (Tb) of human.	
16	Experiments demonstrating the photoperiodic clock.	

References:

7. Animal Behaviour: An Evolutionary Approach, 9th Edition. John Alcock, Sinauer Associate Inc., USA, 2009.
8. Animal Behaviour (11th Edition). Dustin R. Rubenstein and John Alcock, Sinauer Associate Inc., USA, 2018.
9. The Honey Bee. James L. Gould and Carol Grant Gould, Times Books, 2002.
10. Chronobiology Biological Timekeeping: Jay. C. Dunlap, Jennifer. J. Loros, Patricia J. DeCoursey (ed). 2004, Sinauer Associates, Inc. Publishers, Sunderland, MA, USA.

11. Biological Timekeeping: Clock, Rhythms and Behaviour, Vinod Kumar (ed. 2017) Springer India Pvt Limited.
12. Circadian Physiology: Roberto Refinetti, CRC Press (3rded) 2016.

CBCS Question Paper Pattern for M.Sc. Zoology Semester End Examination with Effect from the AY 2021-22

Disciplines Specific Core (DSC) and Discipline Specific Elective (DSE)

Paper Code:

Time: 3 Hours

Note: Answer any FIVE of the following questions with Question No. 1 (Q1) Compulsory, each question carries equal marks.

Paper Title:

Max. Marks: 70

Q1. 14 Marks

Q2. 14 Marks

Q3. 14 Marks

Q4. 14 Marks

Q5. 14 Marks

Note: Question No.1 to 5, one question from each unit i.e. (Unit I, Unit II,). The Questions may be a whole or it may consists of sub questions such as a,b, c etc...

Q6. 14 Marks

Note : Question No.6, shall be from Unit II and III, the Question may be a whole or it may consists of sub questions such as a,b, c etc...

Q7. 14 Marks

Note: Question No.7, shall be from Unit IV and V, the Question may be a whole or it may consists of sub questions such as a,b, c etc...

Q8. 14 Marks

Note: Question No-8 shall be from Unit II, Unit III , Unit IV and Unit V.

The question shall have the following sub questions and weightage. i.e a – 05 marks, b – 05 marks, c – 04 marks.

Skill Enhancement Courses (SECs)

Paper Code:
Time: 1 Hours

Paper Title:
Max. Marks: 30

There shall be Theory examination of Multiple Choice Based Questions [MCQs] with Question Paper set of A, B, C and D Series at the end of each semester for SECs for the duration of One hour (First Fifteen Minutes for the Preparation of OMR and remaining Forty-Five Minutes for Answering thirty Questions). The Answer Paper is of OMR (Optical Mark Reader) Sheet.

Question Paper Pattern for Subjects with Tutorial

For the subjects with Tutorial component, there is no Semester-End Examination (SEE) to the component C3. The liberty of assessment of C3 is with the concerned faculty. The faculty must present innovative method of evaluation of component C3 before the respective BoS for approval and the same must be submitted to the Registrar and Registrar(Evaluation) before the commencement of the academic year.
