Scheme A2: Semester 3rd

Course Code	Course Title	Course ID	L (Hrs)	T (Hrs)	P (Hrs)	L Credits	T Credits	P Credits	Total Credits	MARKS TI	MARKS TE	MARKS PI	MARKS PE	MARKS Total
Core Course(s)														
CC-A07	Animal Physiology	241/ZOO/CC307	03	00	02	03	00	01	04	25	50	05	20	**100**
CC-A08	Developmental Biology	241/ZOO/CC308	03	00	02	03	00	01	04	25	50	05	20	**100**
CC-A09	Immunology	241/ZOO/CC309	03	00	02	03	00	01	04	25	50	05	20	**100**
Discipline Specific Elective Courses (Select any one course from the following)														
DSE-03	Animal Behaviour and Wild-Life Conservation OR Fish, Fisheries and Aquaculture	241/ZOO/DS303	02	00	02	02	00	01	03	15	35	05	20	**75**
Multidisciplinary Course(s)														
MDC-03	One from the Pool	241/ZOO/MD303	02	00	02	02	00	01	03	15	35	05	20	**75**
Skill Enhancement Course(s)														
SEC-02	One from the Pool	241/ZOO/SE302	01	00	02	01	00	01	02	05	20	05	20	**50**
Value added Course(s)														
VAC-02	One from the Pool	241/ZOO/VA302	02	00	00	02	00	00	02	00	50	00	00	**50**
Seminars														
Seminar	Seminar	241/ZOO/SEMINAR301	02	00	00	02	00	00	02	00	50	00	00	**50**
Internship/Field Activity#														
INTRSP	Industrial Visit/ Field Work and Report Writing	241/ZOO/INTRSP301	02	00	00	02	00	00	04	00	50	00	00	**50**
Total Credits									**28**					**600**

 # Four credits of internship earned by a student during summer internship after 2nd semester will be counted in 3rd semester of a student who pursue 2 year PG Programme without taking exit option.

Scheme A2: Semester 4th

Course Code	Course Title	Course ID	L	T	P	L	T	P	Total Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
Ability Enhancement Course(s)														
AEC-03	Manuscript Writing**/ Pool	241/ZOO/AE401	02	00	00	02	00	00	02	00	50	00	00	**50**
Dissertation/Project Work														
Dissertation	Industrial Training/Research Project/ Dissertation	241/ZOO/DISSERTATION401	0	0	40	0	0	20	20	00	00	100	400	**500**
Total Credits									**22**					**550**

ZOOLOGY: SEMESTER-III								
Course Code	**Course ID**	**Course Title**	**Credit**	**Contact Hours/Week**	**Internal Assessment marks**	**End Term Marks**	**Max. Marks**	**Exam Duration**
CC-A08	241/ZOO/CC308	**Developmental Biology**	3	3	25	50	75	2 hrs.
		Practical	1	2	5	20	25	2 hrs.

Course Learning Outcomes (CLO)

1. Students will learn how different processes interact to shape an organism's size, shape, and features as it develops from an embryo to an adult or throughout its life cycle.
2. They will systematically acquire knowledge about the growth and development of organisms and the biological processes occurring within and between cells and organisms in nature.
3. Developmental biology uses a variety of methods and practices that help us understand scientific reasoning in experimental life sciences.
4. This understanding will enable students to describe and explain biological processes and their significance for living organisms.

Instructions for Paper-Setter

1. Nine questions will be set in all. All questions will carry equal marks.
2. Question No. 1, which will be short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit wise selecting two questions from each Unit I to IV. The candidate will be required to attempt question No. 1 and four more questions selecting one question from each unit.

UNIT	TOPICS	CONTACT HOURS
I	• Introduction to animal development: Problems of developmental biology; Developmental patterns in metazoans; Development in unicellular eukaryotes; Development in Dictyostelium • Creating multicellularity: Cleavage types and significance, Blastula, Fate maps, cell lineages; Comparative account of gastrulation • Early vertebrate development: Neurulation and ectoderm; Mesoderm and endoderm	11
II	• Cytoplasmic determinants and autonomous cell specification: Cell commitment and differentiation; Germ cell determinants; Germ cell migration; Progressive cell - Cell interaction and cell specification fate; Cell specification in nematodes • Body pattern formation: Establishment of Body axis in mammals and birds; Proximate tissue interactions; Genetics of axis specification in Drosophila	11
III	• Hormones as mediators of development: Amphibian metamorphosis; Insect metamorphosis • Biology of sex determination: Chromosomal sex determination – Mammals, Drosophila and Nematodes; Testis determining genes; Secondary sex determination in mammals; Environmental sex determination. • Cell death and cell renewal: Programmed cell death; Stem cells and the maintenance of adult tissues; Embryonic stem cells and therapeutic cloning	11
IV	• Environmental evolution and animal development: Environmental cues and effects; Malformations and disruptions; Changing evolution through development modularity; Developmental constraints • Homeobox concept in different phylogenetic groups: Cell diversification in early animal embryo; Tetrapod limb development; Skeletal muscle regeneration; Connective tissue cell family; Blood cells formation	11
V Practical	1. To study the various developmental stages of life cycle of Caenorhabditis elegans with the help of Charts 2. To study the various developmental stages of embryogenesis and life cycle of Drosophila. 3. To study the various developmental stages of life cycle of Frog. 4. Preparation of whole mount of chick embryo 5. To study various developmental stages of chick embryo with the help of the permanent slides. 6. To dissect out Drosophila larvae and to take out the imaginal discs. 7. To study Influence of mutagens on insect development 8. To study Development and Preservation of chick Embryo. 9. To study primary and secondary sexual characteristics 10. To solve numerical problems related with the inheritance biology	30

	11. Studies on vaginal smears during different stages of estrous cycle.	

Learning Resources

1. An Introduction to Embryology by B.I. Balinsky, Saunders, Philadelphia (1981).
2. Development Biology (Vol.II) by Browder, L.W, Saunders (1984).
3. Essentials of Developmental Biology: JMW Slack [Latest edition] .
4. Gene activity in Early Development by Davdson, E.H. Academic Press, London (1977).
5. Major Problems in Developmental Biology by H. Urspaung, Academic Press, New York, (1972).
6. Principles of Development: Louis Wolpert [Latest edition].
7. S.F. Gilbert. Developmental Biology. Sinauer Associates Inc., Massachusetts. Ethan Bier. 'The Cold Spring'. Cold Spring Harbor Laboratory Press, New York.
8. The Control of Gene Expression in Animal Development by J.B. Gurdon, Harvard University, Press, Oxford (1974).

ZOOLOGY: SEMESTER-III								
Course Code	**Course ID**	**Course Title**	**Credit**	**Contact Hours/Week**	**Internal Assessment marks**	**End Term Marks**	**Max. Marks**	**Exam Duration**
CC-A09	241/ZOO/CC309	**Immunology**	**3**	**3**	**25**	**50**	**75**	**2 hrs.**
		Practical	**1**	**2**	**5**	**20**	**25**	**2 hrs.**

Course Learning Outcomes (CLO)

1. Understand the fundamental concepts of immunology, including how the immune system fights infections and diseases, and the immunological basis of treatments for common diseases.
2. Learn strategies to enhance existing vaccines and understand the cellular and molecular mechanisms involved in fighting pathogens.
3. Gain knowledge of the cellular and molecular basis of the inflammatory response.
4. Understand the mechanisms that regulate the immune response and learn about autoimmune disorders and their prevention.

Instructions for Paper-Setter

1. Nine questions will be set in all. All questions will carry equal marks.
2. Question No. 1, which will be short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit wise selecting two questions from each Unit I to IV. The candidate will be required to attempt question No. 1 and four more questions selecting one question from each unit.

UNIT	TOPICS	CONTACT HOURS
I	• Phylogeny and Ontogeny of immune system: Innate and Acquired Immunity: Organization and structure of lymphoid organs: Cells of the immune system and their differentiation • Nature of antigens and superantigens: Antigenicity and immunogenicity; Factors influencing immunogenicity; Epitopes and haptens • Structure and Functions of Antibodies: Classes and subclasses; Gross and Fine structure; Antibody mediated effector functions • Antigen-Ab interactions: Principles and Applications: Cross Reactivity, Precipitation reactions, Agglutination reactions; Radioimmunoassay, ELISA, Immunoprecipitation, Immunofluorescence	12
II	• Nature of immune response: Humoral Immune Response; Cellular Immune Response • Cytokines: Cytokine Properties; Cytokine receptors; Cytokines and Immune response; Cytokine Antagonists; Cytokine Related Diseases • Cell-mediated effector functions: Cell adhesion molecules; Effector cells and molecules; CTLs – Mechanism of action; NK cells-mechanisms of action • Hypersensitivity-Types and Mechanism.	11
III	• Complement System: Components and functions of Complement system; Pathways of complement system; Regulation and biological consequences. • Major Histocompatibility Complex in mouse and HLA system in human: Class I and class II molecules; Expression and diversity; Disease susceptibility and MHC/HLA • Organization and expression of Ig genes: Multigene organization of Ig genes; DNA rearrangements and mechanisms; Generation of antibody diversity; Differential expression of Ig genes.	11
IV	• T-Cell Maturation, Activation and Differentiation: T-Cell Receptors- Organization and rearrangement of TCR genes, TCR-CD3 complex; T-cell maturation and thymus; T -cell activation and differentiation; Cell death and T-cell population • B-cell generation, activation and differentiation: B-cell receptors; B-cell maturation, activation and proliferation; T H-B-Cell interactions • Auto-immunity and Vaccines- Types – subunit, conjugate and recombinant vector vaccines.	11
V Practical	1. The determine the antibody concentration by using Quantitative Precipitin Assay 2. To Detect of presence of Rheumatoid factors (RF) in given sample. 3. To detect presence of Treponemes which cause veneral disease (syphilis) by VDRL test 4. To learn the technique of latex agglutination. 5. To perform the RPR test for the detection of syphilis 6. Antigen-antibody interaction in vitro. 7. Immunological diagnosis of pregnancy/infection/cancer.	30

	8. To study permanent slides of Lymphoid and endocrine glands 9. Observation of sex chromatin (Barr bodies) in buccal epithelium of Human female 10. Study of chromosomes slides (autosomes and sex chromosomes)	

Learning Resources

1. Cellular and Molecular Immunology by Abul K. Abbas, Andrew H. Lichtman, Shiv Pillai, Elsevier Publishing [Latest edition].
2. Fundamentals of Immunology by William E. Paul, Lippincott Williams & Wilkins Publishing [Latest edition].
3. I.M. Roitt. Essential Immunology, ELBS Edition.
4. Immuno Biology- The immune system in health and disease, Janeway, Travers, Walport and Shlomchik, Garland Science Publishing [Latest edition].
5. Kuby. Immunology, W.H. Freeman, USA.
6. Pelczar. A text book of microbiology
7. Totora et al. Microbiology
8. W. Paul. Fundamentals of Immunology.

ZOOLOGY: SEMESTER-III								
Course Code	**Course ID**	**Course Title**	**Credit**	**Contact Hours/Week**	**Internal Assessment marks**	**End Term Marks**	**Max. Marks**	**Exam Duration**
DSE-03	241/ZOO/DS303	**Animal Behaviour and Wild-Life Conservation**	**2**	**2**	**15**	**35**	**50**	**2 hrs.**
		Practical	**1**	**2**	**5**	**20**	**25**	**2 hrs.**

Course Learning Outcomes (CLO)

1. Understand the key concepts of animal behavior, including social behavior patterns and the factors influencing them.
2. Gain in-depth knowledge of wildlife conservation theory, practices, and approaches.
3. Learn wildlife census techniques and develop insights into effective conservation strategies.
4. Enhance the ability to conserve diverse resources and life forms through a deeper understanding of animal behavior and innovative approaches.

Instructions for Paper-Setter

1. Nine questions will be set in all. All questions will carry equal marks.
2. Question No. 1, which will be short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit wise selecting two questions from each Unit I to IV. The candidate will be required to attempt question No. 1 and four more questions selecting one question from each unit.

UNIT	TOPICS	CONTACT HOURS
I	• Social behaviour: Aggregations and society; Advantages of group living; Types of social organization in animals; Group selection, kin selection, altruism, reciprocal altruism; Territoriality and parental care; Behaviour Ecology: Habitat selection • Social behaviour of termites, ants and primates. • Various means of communication in animals: Chemical, Visual, auditory, touch etc.	8
II	• Hormones and animal Behaviour: Hormones important to behavioural regulation; Genetic basis of behavior • Aggressive behaviour; sexual attraction and sexual behaviour. • Pheromones and animal behaviour: types of pheromones, role of pheromones in animal behaviour; pheromones of social insects, Human Ethology	7
III	• Wildlife Census: Planning a wildlife census, understanding sample counts, Block counts, Road side counts, Dung counts, Pugmark census, Water-hole census. • Study of signs and symptoms: A practice of recording field observations, Bio-telemetry, Ageing and Sexing techniques. • Wildlife Tourism: Definition scope and range; Popular Wildlife Tourist Sports of the world, Popular Wildlife spots in India, Sustainable use of wildlife spots	7
IV	• Wildlife Damage, its nature and definition, electric fences for wildlife damage control, Basic electric fence design, Trench design, live trapping, Mist netting, Rocket netting Chemical capture: Equipment, Drugs, Plan of operation. • Poaching: Its definition and implications, conducting anti-poaching operations, evidence in poaching cases. • National Projects: Project Tiger, Project elephant, Project Rhinoceros, Project Crocodiles, Project Hangul, Manipur Brow Antlered Deer.	8
V Practical	1. To study the effect of temperature on gill movement in fishes. 2. To study nesting behaviour of squirrels in different habitats vis., urban environment, grain-market-area, roadside plantations, orchards gardens etc. 3. Field study of burrowing behaviour of common available rodent fauna of the region. 4. Study of morphological changes in common avian species during breeding season. 5. Preparation of charts of endangered amphibians, reptiles and mammals with ecological remarks. 6. Animal behaviour patterns using Photostat sheets/ repertoire sheets 7. Analysis of standard pug marks of large sized wild mammals. 8. Study of Migratory Birds 9. Study of Diversity indices: use of software in calculating diversity indices 10. Study of beaks and claws of different bird species. 11. Field visit to a zoo or wildlife part/sanctuary and preparation of field report 12. Preparation of field diary on the basis of observations regarding habitat, habits of common available avian and rodent fauna of the region.	30

Learning Resources
1. Ali, S. Ripley S.D. Handbook of Birds of India, Pakistan 10-Vols. Oxford University Press, Bombay.
2. E.P. Gee, The Wildlife of India.
3. Techniques for wildlife Census in India by W.A. Rogers (A field manual); Wildlife Institute of India, Dehradun.
4. The Book of Indian Animals by S.H. Prater, BNHS-Publication, Bombay.
5. Wildlife in India by V.B. Saharia Natraj Publishers, Dehradun.
6. Wildlife Wealth of India by T.C. Majupuria; Tecpress Services, L.P., 487/42-SOL-Wattenslip, Pratunam Bangkok, 10400, Thailand

ZOOLOGY: SEMESTER-III								
Course Code	**Course ID**	**Course Title**	**Credit**	**Contact Hours/Week**	**Internal Assessment marks**	**End Term Marks**	**Max. Marks**	**Exam Duration**
DSE-03	241/ZOO/DS303	**Fish, Fisheries and Aquaculture**	**2**	**2**	**15**	**35**	**50**	**2 hrs.**
		Practical	**1**	**2**	**5**	**20**	**25**	**2 hrs.**

Course Learning Outcomes (CLO)

1. Gain knowledge of modern methods for improving fish stocks and intensive culture techniques for key fin-fish and shellfish species.
2. Develop skills for various aquaculture practices.

Instructions for Paper-Setter

1. Nine questions will be set in all. All questions will carry equal marks.
2. Question No. 1, which will be short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit wise selecting two questions from each Unit I to IV. The candidate will be required to attempt question No. 1 and four more questions selecting one question from each unit.

UNIT	TOPICS	CONTACT HOURS
I	• Introduction to fish biotechnology • Selection and hybridization • Androgenesis and Gynogenesis – natural and induced • Polyploidy techniques • Sex reversal and sterility	7
II	• Transgenesis, transgenes and application • Cryopreservation of gametes and embryo • Fish-by products • Fish preservation process • Nutritive aspect of fish meat and oil.	7
III	• Different systems for aquaculture: pond culture, cage culture, raceway culture. • Culture of important fish species (Major carps, common carps, Chinese carps, cat fish culture and Tilapia culture). • Integrated Aquaculture and waste water aquaculture • Pearl Culture • Frog culture	8
IV	• Prawn culture-Fresh and brackish water • Impact of Aquaculture on Environment • Methods of Fishing: Crafts and gear technology • Fish diseases and their control • Nutrition in Aquaculture: Nutrient and non-nutrient diet components; Preparation and processing of feed, feed formulae; Natural and supplementary feed and their utilization	8
V Practical	1. Fish Feed formulation and processing. 2. Proximate analysis of fish feed (Determination of moisture, protein, fat, ash carbohydrate, fiber and energy). 3. Taking out of pituitary gland, preservation and preparation of extract. 4. Estimation of primary productivity 5. Study of benthic macroinvertebrates in natural water bodies. 6. Identification of eggs, spawn, fry and fingerlings of cultivable fishes of India. 7. Determination of length weight relationship. 8. Determination of age of fish using hard parts 9. Analysis of fecundity, Gonado somatic index (GSI), Hepatosomatic index (HIS) in some fishes. 10. Study of crafts and gear and method of operation (Models can also be used) 11. Visit to fish farm and fish market and preparation of report 12. A small experimental project	30

Learning Resources

1. Bardach, JE, Ryther, JH & Mclarnely, OW (1972) Aquaculture. Wiley Interscience
2. Boyd, CE (1988) Water quality management for pond fish culture. Developments in Aquaculture and Fisheries Sciences. I. Elsevier Scientific Publishing Company, Amsterdam.
3. Delince, G (1992) The Ecology of the fish pond system. Kluwer Academic Publishers, Netherlands, 230 pp.
4. Handbook of Fisheries and Aquaculture, Indian Council of Agricultural Research, New Delhi. 755 pp.
5. Hepher, B (1975) Supplementary feeding in fish culture. In: Nutrition and Production of Fishes. Vol. 3 S. Karger, Basel : 183-198
6. Hoar, WS, Randall, DJ & Donaldson, ME (1983) Fish Physiology. Vol. IXA & IXB. Reproduction. Academic Press, London.

7. Jhingran, VG (1983) Fish and Fisheries of India. Hindustan Publishing Corporation (India) 954 pp
8. Ponniah, AG, Das, P & Verma SR (Ed.) (1998) Fish Genetics and Biodiversity Conservation. Nature Conservators, Muzaffarnagar, India 474pp.
9. Tandon, KK & Johal, MS (2006) Age and Growth in Indian Freshwater Fishes.Narendra Publishing House Delhi, 232 pp.

Zoology: SEMESTER-IV							
Course Type	**Course Code**	**Name of the Course**	**Credit**	**Contact Hours/ Week**	**Internal Assessment marks**	**End Term Marks**	**Max. Marks**
Dissertation	241/ZOO/DISSERTATION401	**Dissertation**	**20**	**40**	**100**	**400**	**500**

Course Learning Outcomes (CLO)

1. **Demonstrate advanced knowledge and understanding** of a specialized area within the field of botany, integrating current research and scientific literature.
2. **Formulate a clear research question or hypothesis** and design a methodologically sound investigation to address it.
3. **Apply appropriate experimental, analytical, or field techniques** to collect, analyse, and interpret botanical data.
4. **Critically evaluate scientific data** and discuss its implications in the context of existing botanical theories and research.
5. **Present research findings clearly and effectively** in a well-structured scientific dissertation, adhering to academic standards of writing and referencing.
6. **Defend research outcomes** and methodology in an oral or written format, demonstrating a thorough understanding of the research topic and its broader scientific context.
7. **Work independently and manage time effectively** over an extended research project, showing initiative, problem-solving ability, and scientific integrity.

COURSE DESCRIPTION:

***Industrial Training/Research Project/ Dissertation*:** Every student will be required to undertakeIndustrial Training or a research project based on related areas of Botany. The training/research project report will be submitted in the form of dissertation and will be presented forevaluation at the end of semester by an external expert. The internal and external assessment of training and project work will be carried out as following.

Internal Assessment:

- Synopsis
- One Mid-semester progress report/presentation

External Assessment:

- Final project report and viva-voce presentation.

Dissertation Report Submission Guidelines:

The dissertation report should be contained followings:

1. Dissertation report will contain a cover page, certificate signed by student and supervisor, table of contents, introduction, Objective, Literature review, methodology, results and discussions conclusion, and references.
   - The paper size to be used should be A-4 size.
   - The font size should be 12 with Times New Roman.
   - The text of the dissertation may be typed in 1.5 (one and a half) space.
   - The print out of the dissertation shall be done on both sides of the paper (instead of singleside printing)
   - The total no. of written pages in dissertation report should be 40 to 60.
2. The candidate shall be required to submit three hard bound copies of dissertation along with aCD in the department as per the date announced.
3. Plagiarism should be below 20% (with filter of 5 words in a line from the same source) andstudents are required to produce letter of undertaking regarding plagiarism.
4. The candidate will defend her/his dissertation/project work through presentation before theExternal examiner at the end of semester and will be awarded marks.

(5)

Multidisciplinary Course from the department for pool of the Courses in the University

(These courses are to be offered to students of different discipline/Subject)

Semester 1

Course Code	Course Title	Course ID	L	T	P	L	T	P	Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
MDC-01	Population Genetics & Evolution-I	241/ZOO/MD101	02	00	02	02	00	01	03	15	35	05	20	75

Semester 2

Course Code	Course Title	Course ID	L	T	P	L	T	P	Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
MDC-02	Population Genetics & Evolution-II	241/ZOO/MD202	02	00	02	02	00	01	03	15	35	05	20	75

Semester 3

Course Code	Course Title	Course ID	L	T	P	L	T	P	Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
MDC-03	Aquaculture-I	241/ZOO/MD303	02	00	02	02	00	01	03	15	35	05	20	75

Course Code	Course Title	Course ID	L	T	P	L	T	P	Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
MDC-04	Aquaculture-II	241/ZOO/MD404	02	00	02	02	00	01	03	15	35	05	20	75

Multidisciplinary Course

ZOOLOGY: SEMESTER-I								
Course Code	**Course ID**	**Course Title**	**Credit**	**Contact Hours/Week**	**Internal Assessment marks**	**End Term Marks**	**Max. Marks**	**Exam Duration**
MDC-01	241/ZOO/MD101	Population Genetics & Evolution-I & Practical	2	2	15	35	50	2 Hrs
			1	2	5	20	25	

Course Learning Outcomes (CLO)

1. Imparts knowledge regarding the various theories of evolution, evolutionary process such as variation, speciation, natural selection.
2. Students will be able to understand the use of inheritance pattern underlying geneticdiseases.
3. Student gets familiar with types of genetic variations used to assess genetictraits/diseases.
4. Students will form concepts about mode of speciation, evolution, system, origination, extinction, and causes of differential rates of diversification.
5. Students will study the origin and diversification of eukaryotes, evolution of eukaryotic cell from prokaryotes, evolution of eukaryotic genomes; gene duplication and divergence.

Instructions for Paper-Setter

1. Nine questions will be set in all. All questions will carry equal marks.
2. Question No. 1, which will be short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit wise selecting two questions from each Unit I to IV. The candidate will be required to attempt question No. 1 and four more questions selecting one question from each unit.

UNIT	TOPICS	CONTACT HOURS
I	Concept of evolution: Darwinism and Neo-Darwinism, Hardy-Weinberg law of genetic equilibrium. A detailed account of destabilizing forces: (i) Natural selection, (ii) Mutation, (iii) Genetic drift, (iv)Migration (v) Meiotic drive.	8
II	Evolutionary time scale: eras, periods and epoch. Major events in evolutionary time scale: origins of unicellular and multicellular organisms.	7
III	Quantifying genetic variability: Genetic structure of natural populations, phenotypic variations, Models explaining changes in genetic structure of populations. Factors affecting human disease frequency Mendelian basis of transmission of disease	8
IV	Molecular population genetics: Patterns of change in nucleotide and amino acid sequences Ecological significance of molecular variations Emergence of Non-Darwinism-Neutral Hypothesis	7
Practical	1. Study of salivary gland chromosomes of larvae of chironomus/Drosophila from permanent slides. 2. Study of metaphase karyotypes from photographs/permanent slides of Drosophila, grasshopper and man/rat. 3. Study the normal human karyotype 4. Study of sex-chromatin Bars body from human buccal mucosa, drum stic in human blood	30
Learning Resources		

1. *Genetics and the origin of species* by **T. Dobzhansky**, Columbia University Press;1951.
2. *Organic Evolution* by **Lull**, MacMillan Co., New York; 1947.
3. *Time, life and Man* by **R.A. Stirton**, John Wiley and Sons, New York; 1959.
4. *Evolution of the Vertebrates* by **E.H. Colbert**, Willy Eastern Ltd., New Delhi;1969.
5. Dobzhansky, Th., F.J. Ayala, G.L. Stebbines and J.M. Valentine. Evolution. Surjeet Publication, Delhi.
6. Futuyama, D.J. Evolutinary Biology, Suinuaer Associates, INC Publishers, Dunderland.
7. Haiti, D.L. A Primer of Population Genetics. Sinauer Associates, Inc, Massachusetts.
8. Jha, A.P. Genes and Evolution. John Publication, New Delhi.
9. King, M. Species Evolution-The role of chromosomal change. The Cambridge University Press, Cambridge.

ZOOLOGY: SEMESTER-II								
Course Code	**Course ID**	**Course Title**	**Credit**	**Contact Hours/Week**	**Internal Assessment marks**	**End Term Marks**	**Max. Marks**	**Exam Duration**
MDC-02	241/ZOO/MD202	**Population Genetics & Evolution-II**	2	2	15	35	50	2 Hrs
			1	2	05	20	25	

Course Learning Outcomes (CLO)

1. Students will be able to understand the use of inheritance pattern underlying genetic diseases.
2. Student gets familiar with types of genetic variations used to assess genetic traits/diseases.
3. Provides description of molecular divergence, molecular clocks, molecular drive and their complication in inferring phylogenetic trees.
4. Students will form concepts about mode of speciation, evolution, system, origination, extinction, and causes of differential rates of diversification.
5. Students will study the origin and diversification of eukaryotes, evolution of eukaryotic cell from prokaryotes, evolution of eukaryotic genomes

Instructions for Paper-Setter

1. Nine questions will be set in all. All questions will carry equal marks.
2. Question No. 1, which will be short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit wise selecting two questions from each Unit I to IV. The candidate will be required to attempt question No. 1 and four more questions selecting one question from each unit.

UNIT	TOPICS	CONTACT HOURS
I	Molecular evolution: molecular divergence and molecular clock. Patterns and mechanism of reproductive isolation, modes of speciation	8
II	Interrelationship among different phyla of Invertebrates and their evolutionary significance. Origin of Vertebrates: Pisces, Amphibia, Reptilia, Aves and Mammalia. Stages of primate evolution. Evolution of human behavior and its consequences.	8
III	Genetics of quantitative traits in populations: Analysis of quantitative traits Quantitative traits and natural estimation of heritability	7
IV	Genotype-environment interactions Inbreeding depression and heterosis Molecular analysis of quantitative traits, phenotypic plasticity	7
Practical	1. Demonstration of monohybrid and dihybrid cross, Co-dominance, Incomplete dominance and Epistasis with the help of beads and photographs. 2. Study of genetic disorders with the help of photographs. 3. Study of structural and numerical alteration of chromosomes: deletion, substitution, duplication etc.	30

Learning Resources

1. *Genetics and the origin of species* by **T. Dobzhansky**, Columbia University Press;1951.
2. *Organic Evolution* by **Lull**, MacMillan Co., New York; 1947.
3. *Time, life and Man* by **R.A. Stirton**, John Wiley and Sons, New York; 1959.
4. *Evolution of the Vertebrates* by **E.H. Colbert**, Willy Eastern Ltd., New Delhi;1969.
5. Dobzhansky, Th., F.J. Ayala, G.L. Stebbines and J.M. Valentine. Evolution. Surjeet Publication, Delhi.
6. Futuyama, D.J. Evolutinary Biology, Suinuaer Associates, INC Publishers, Dunderland.
7. Haiti, D.L. A Primer of Population Genetics. Sinauer Associates, Inc, Massachusetts.
8. Jha, A.P. Genes and Evolution. John Publication, New Delhi.
9. King, M. Species Evolution-The role of chromosomal change. The Cambridge University Press, Cambridge.

ZOOLOGY: SEMESTER-III								
Course Code	**Course ID**	**Course Title**	**Credit**	**Contact Hours/Week**	**Internal Assessment marks**	**End Term Marks**	**Max. Marks**	**Exam Duration**
MDC-03	**241/ZOO/MD303**	**Aquaculture-I**	**2**	**2**	**15**	**35**	**50**	**2 Hrs**
		Practical	**1**	**2**	**05**	**20**	**25**	

Course Learning Outcomes (CLO)

1. Students will be able to understand the aquaculture system
2. Student gets familiar with impact of aquaculture on Environment
3. Gain knowledge abou conditioning factors and how they can be manipulated
4. Students will form concepts about Integrated farming

Instructions for Paper-Setter

1. Nine questions will be set in all. All questions will carry equal marks.
2. Question No. 1, which will be short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit wise selecting two questions from each Unit I to IV. The candidate will be required to attempt question No. 1 and four more questions selecting one question from each unit.

UNIT	TOPICS	CONTACT HOURS
I	Theory Culture technology– freshwater (carps, catfishes, murrels, prawns), brackish water (asian sea-bass, milk fish, mullets, crabs, shrimps), mariculture (mussels, oysters, sea weeds), fish food organisms (algae; Artemia; zooplankton).	8
II	Water Quality Requirements for Aquaculture- Role of temperature, pH, salinity, dissolved oxygen, ammonia, nitrite, nitrate, phosphate, biological oxygen demand, Chemical oxygen demand.	8
III	Integrated farming and its economic importance - fish-cum-livestock farming, paddy-cum-fish farming, aquaculture engineering aqua house, hatchery, ponds, race ways, recirculating system, cage, pen.	7
IV	Fish seed technology - natural collection, bundh breeding, induced breeding, cryopreservation of gametes. Transport of finfish and shellfish- transport of eggs, fry, fingerlings and adults. Fish farming	7
Practical	1. Estimation of hydrobiological parameters- temperature, pH, conductivity, salinity, dissolved oxygen, primary productivity, ammonia, nitrite, nitrate, phosphate, biological oxygen demand, chemical oxygen demand of nursery, rearing, stocking and breeding ponds. 2. Estimation of ovarian egg counts. 3. Culture of live food organisms and assay of nutritional quality of live food; estimation of population density of live food organisms. 4. Decapsulation and hatching of Artemia cysts for use in hatcheries. 5. Demonstration of breeding pools and hatcheries. 6. Induced breeding of Indian major carps and catfishes. 7. Identification of eggs, spawn, fry and fingerlings of cultivable fishes of India.	30

Learning Resources

1. Fishponds in Farming Systems, Zijpp, V. D., Verreth, J. A. J., Tri, L. Q., van Mensvoort, M. E. F., Bosma, R. H., and Beveridge, M. C. M., Wageningen Academic Publishers,Netherlands
2. Aquaculture Principles and Practices, Pillay, T. V. R., Blackwell Publishing, USA
3. Aquaculture and Fisheries Biotechnology Genetic Approaches, Dunham, R. A., CABI Publishing, USA

ZOOLOGY: SEMESTER-IV								
Course Code	**Course ID**	**Course Title**	**Credit**	**Contact Hours/Week**	**Internal Assessment marks**	**End Term Marks**	**Max. Marks**	**Exam Duration**
MDC-04	241/ZOO/MD404	Aquaculture-II	2	2	15	35	50	2 hrs
		Practical	1	2	05	20	25	

Course Learning Outcomes (CLO)
Student will gain:

1. **Comprehensive knowledge of aquaculture disciplines.**
2. **Knowledge to identify and manage common fish and shellfish diseases**
3. **Skills towards Sustainable aquaculture practices**
4. **Practical skills in aquaculture techniques:**

Instructions for Paper-Setter

1. Nine questions will be set in all. All questions will carry equal marks.
2. Question No. 1, which will be short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit wise selecting two questions from each Unit I to IV. The candidate will be required to attempt question No. 1 and four more questions selecting one question from each unit.

UNIT	TOPICS	CONTACT HOURS
I	Introduction to fish biotechnology. Selection and hybridization. Androgenesis and Gynogenesis – natural and induced. Polyploidy techniques. Sex reversal and sterility	8
II	Transgenesis, transgenes and application. Fish-by products. Fish preservation process. Nutritive aspect of fish meat and oil. Impact of Aquaculture on Environment, Methods of Fishing: Crafts and gear technology, Fish diseases and their control	8
III	Different systems for aquaculture: pond culture, cage culture, raceway culture. Culture of important fish species (Major carps, common carps, Chinese carps, cat fish culture and Tilapia culture). Integrated Aquaculture and waste water aquaculture. Pearl Culture, Frog culture.	7
IV	Nutrition in Aquaculture: Nutrient and non-nutrient diet components, Preparation and processing of feed, feed formulae, Natural and supplementary feed and their utilization	7
Practical	1. Fish Feed formulation and processing. 2. Proximate analysis of fish feed (Determination of moisture, protein, fat, ash carbohydrate, 3. fiber and energy). 4. Taking out of pituitary gland, preservation and preparation of extract. 5. Estimation of primary productivity 6. Study of benthic macroinvertebrates in natural water bodies. 7. Identification of eggs, spawn, fry and fingerlings of cultivable fishes of India. 8. Determination of length weight relationship. 9. Determination of age of fish using hard parts 10. Analysis of fecundity, Gonado somatic index (GSI), Hepatosomatic index (HIS) in some 11. fishes. 12. Study of crafts and gear and method of operation (Models can also be used) 13. Visit to fish farm and fish market and preparation of report 14. A small experimental project	30

Learning Resources

1. Ponniah, AG, Das, P & Verma SR (Ed.) (1998) Fish Genetics and Biodiversity Conservation. Nature Conservators, Muzaffarnagar, India 474pp.
2. Bardach, JE, Ryther, JH & Mclarnely, OW (1972) Aquaculture. Wiley Inter science
3. Boyd, CE (1988) Water quality management for pond fish culture. Developments in Aquaculture and Fisheries Sciences. I. Elsevier Scientific Publishing Company, Amsterdam.
4. Delince, G (1992) The Ecology of the fish pond system. Kluwer Academic Publishers, Netherlands, 230 pp.
5. Hepher, B (1975) Supplementary feeding in fish culture. In: Nutrition and Production of Fishes. Vol. 3 S. Karger, Basel: 183-198 Hoar, WS, Randall, DJ & Donaldson, ME (1983) Fish Physiology. Vol. IXA & IXB. Reproduction. Academic Press, London.

Skill Enhancement Course from the department for pool of the Courses in the University

(These courses are offered by each department for students of other departments/same department and is designed to provide value-based and/or skill-based knowledge and should contain both theory and lab/hands-on/training/field work.)

Semester 2

Course Code	Course Title	Course ID	L	T	P	L	T	P	Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
SEC-1	Economic Zoology	241/ZOO/SE201	01	00	02	01	00	01	02	05	20	05	20	50

Semester 3

Course Code	Course Title	Course ID	L	T	P	L	T	P	Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
SEC-2	Medical Physiology	241/ZOO/SE302	01	00	02	01	00	01	02	05	20	05	20	50

Skill Enhancement Course

ZOOLOGY: SEMESTER-II								
Course Code	**Course ID**	**Course Title**	**Credit**	**Contact Hours/Week**	**Internal Assessment marks**	**End Term Marks**	**Max. Marks**	**Exam Duration**
SEC-1	241/ZOO/SE201	**Economic Zoology**	1	1	5	20	25	3 hr
			1	2	5	20	25	

Course Learning Outcomes (CLO)

1. Students will understand the economic importance of various animals and their roles in agriculture, medicine, and industry.
2. Students will gain knowledge about the management and sustainable utilization of economically significant animal resources.
3. Students will be able to identify and address the challenges related to pest control, animal husbandry, and aquaculture practices.
4. Students will develop skills in the conservation of economically valuable species and the assessment of their ecological impacts.

Instructions for Paper-Setter

1. Five questions will be set in all. All questions will carry equal marks.
2. Question No. 1, which will be short answer type covering the entire syllabus, will be compulsory. The remaining four questions will be set unitwise selecting two questions from each Unit . The candidate will be required to attempt question No. 1 and two more questions selecting one question from each unit.

UNIT	TOPICS	CONTACT HOURS
I	Definition and scope of economic zoology, importance of animals in agriculture, medicine, and industry, Historical developments and contributions of eminent zoologists, Impact of zoological research on economic development. Economic status and products of poultry keeping and dairy industry in Haryana	8
II	Role of insects in pollination and pest control, impact of parasitic invertebrates on human and animal health, utilization of mollusks, crustaceans, and other invertebrates in industries, apiculture, sericulture, and lac culture	7
Practical	1. Techniques for breeding and managing livestocks 2. Rearing insects for food, feed or other products 3. Identification and management of economically important insects 4. Testing and quality control of animal products 5. Analysis of nutritional value and safety 6. Market analysis and product development	30

Learning Resources

1. Jordan, E.L. & Verma, P.S. (2018). Invertebrate Zoology. S. Chand Publishing (New Delhi), pp. 1200.
2. Shukla, G.S. & Upadhyay, V.B. (2010). Economic Zoology. Rastogi Publications (Meerut), pp. 600.
3. Srivastava, R.P. & Singh, R.P. (2002). An Introduction to Economic Zoology. Anmol Publications (New Delhi), pp. 500.
4. Kotpal, R.L. (2019). Modern Textbook of Zoology: Invertebrates. Rastogi Publications (Meerut), pp. 900.
5. Atwal, A.S. & Dhaliwal, G.S. (2005). Agricultural Pests of South Asia and Their Management. Kalyani Publishers (Ludhiana), pp. 487.

ZOOLOGY: SEMESTER-III								
Course Code	**Course ID**	**Course Title**	**Credit**	**Contact Hours/Week**	**Internal Assessment marks**	**End Term Marks**	**Max. Marks**	**Exam Duration**
SEC-1	241/ZOO/SE302	**Medical Physiology**	1	1	5	20	25	3 hr
			1	2	5	20	25	

Course Learning Outcomes (CLO)

1. Students will understand the concept of medical physiology
2. Students will gain knowledge about the composition and function of blood.
3. Students will be able to learn nervous system and special sense
4. Students will develop knowledge about homeostasis and feedback mechanisms

Instructions for Paper-Setter

1. Five questions will be set in all. All questions will carry equal marks.
2. Question No. 1, which will be short answer type covering the entire syllabus, will be compulsory. The remaining four questions will be set unitwise selecting two questions from each Unit . The candidate will be required to attempt question No. 1 and two more questions selecting one question from each unit.

UNIT	TOPICS	CONTACT HOURS
I	Introduction to physiology, Nerve muscle physiology, Composition and function of blood, physiology of gastrointestinal tract, Respiratory system	8
II	Physiology of cardiovascular system, Endocrine system, Reproductive system, Excretory system, Nervous system and special sense	7
Practical	**I) Haematology:** a) Compound microscope. b) Preparation of blood film. c) StainingwithLeishman's stain. d) Identification of blood cell. e) Differential count of WBC. f) Total count of WBC. g) Total count of RBC. h) Haemoglobin estimation. i) Total count of platelets. j) Blood grouping. k) Bleeding time and clotting time. I). Haemin crystal. m) Demonstration of: PCV, ESR, Osmotic fragility, Prothrombin time.	30

Learning Resources

1. Medical physiology → A. C. Guyton
2. Review of medical physiology → W. F. Ganong
3. Human physiology → Vander, Sherman & Luciano

Value Added Course from the department for pool of the Courses in the University

(All the departments will offer value added course for the students of same or different departments)

Semester 1

Course Code	Course Title	Course ID	L	T	P	L	T	P	Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
VAC-1	Animal Diversity & Conservation	241/ZOO/VA 101	02	00	00	02	00	00	02	00	50	00	00	50

Semester 3

Course Code	Course Title	Course ID	L	T	P	L	T	P	Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
VAC-2	Human Genetic Syndromes	241/ZOO/VA 302	02	00	00	02	00	00	02	00	50	00	00	50

ZOOLOGY: SEMESTER-I								
Course Code	**Course ID**	**Course Title**	**Credit**	**Contact Hours/Week**	**Internal Assessment marks**	**End Term Marks**	**Max. Marks**	**Exam Duration**
VAC-01 **2 credit**	**241/ZOO/VA 101**	**Animal Diversity & Conservation**	**2**	**2**	**15**	**35**	**50**	**3 hrs.**

Course Learning Outcomes (CLO)

1. Biological diversity provides immediate benefits to society such as recreation and tourism
2. It will generate initiative among students for conservation of our rich natural resources and diversified life forms.
3. It gives jobs opportunities for people by establish training research programmes that have been launched for conservation and sustainable use of bio diversity.
4. Expand the knowledge of researchers to explore diversity of animal, its protection from extinction and their habitat from destruction

Instructions for Paper-Setter

1. Five questions will be set in all. All questions will carry equal marks.
2. Question No. 1, which will be short answer type covering the entire syllabus, will be compulsory. The remaining four questions will be set unitwise selecting two questions from each Unit . The candidate will be required to attempt question No. 1 and two more questions selecting one question from each unit.

UNIT	TOPICS	CONTACT HOURS
I	Wildlife: Definition, significance. Techniques of animal counts (Examples of Tiger count), Wildlife zones of the India, Wildlife Tourism, Biodiversity: Concept, threats to biodiversity, its Conservation (objectives and strategies), biodiversity indices	15
II	Concept and objectives of Protected areas: Important Protected Areas of India (Biosphere reserve, National Park & Wildlife sanctuaries) Red Data Book, IUCN Categories of wildlife species	15

Learning Resources

1. Techniques for wildlife Census in India by W.A. Rogers (A field manual); Wildlife Institute of India, Dehradun.
2. Wildlife Wealth of India by T.C. Majupuria; Tecpress Services, L.P., 487/42-SOL-Wattenslip, Pratunam Bangkok, 10400, Thailand
3. The Book of Indian Animals by S.H. Prater, BNHS-Publication, Bombay.
4. Wildlife in India by V.B. Saharia. Natraj Publishers, Dehradun.
5. E.P. Gee, The Wildlife of India.

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ZOOLOGY: SEMESTER-III

Course Code	Course ID	Course Title	Credit	Contact Hours/Week	Internal Assessment marks	End Term Marks	Max. Marks	Exam Duration
VAC-02 2 credit	241/ZOO/VA302	Human Genetic Syndromes	2	2	15	35	50	3 hrs.

Course Learning Outcomes (CLO)

1. Students will gain knowledge about genetic syndromes
2. It will generate initiative among students for their clinical management
3. Students will know about genetic counseling
4. Expand the knowledge of researchers to explore ethical consideration in genetic testing

Instructions for Paper-Setter

1. Five questions will be set in all. All questions will carry equal marks.
2. Question No. 1, which will be short answer type covering the entire syllabus, will be compulsory. The remaining four questions will be set unitwise selecting two questions from each Unit . The candidate will be required to attempt question No. 1 and two more questions selecting one question from each unit.

UNIT	TOPICS	CONTACT HOURS
I	**Overview of Genetic Syndromes**: Definition and classification of genetic disorders. **Chromosomal and Single-Gene Disorders**: Examples like Down syndrome, Turner syndrome, Klinefelter syndrome, Patau Syndrome, cystic fibrosis, and their inheritance patterns. **Multifactorial and Mitochondrial Disorders**: Impact of genetic and environmental factors, and examples like spina bifida.	15
II	**Diagnostic Techniques**: Methods such as karyotyping and genetic testing. **Management and Ethical Issues**: Clinical management, genetic counseling, and ethical considerations in genetic testing and family planning.	15

Learning Resources

1. **"Genetics in Medicine"** by James S. Thompson and Margaret W. Thompson
2. **"Medical Genetics"** by William S. McDermott and Nancy A. N. Jones
3. **"Genetic Syndromes and Genetic Counseling"** by Margaret R. L. K. D. Shrimpton and Dorothy R. R. Little
4. **"The Genetics of Human Disease"** edited by Edward W. C. B. Robert and Robert D. L. R. G. McGowan