SYLLABUS OF B.Sc. (Hons.) ZOOLOGY

As per

NATIONAL EDUCATION POLICY – 2020

(NEP-2020)

CURRICULAR FRAMEWORK FOR FOUR YEARS GRADUATE PROGRAMME IN

GURUKULA KANGRI (DEEMED TO BE UNIVERSITY) UNDER NEP-2020

in

ZOOLOGY

DEPARMENT OF ZOOLOGY & ENVIRONMENTAL SCIENCES

GURUKULA KANGRI (DEEMED TO BE UNIVERSITY)

HARIDWAR – 249404

(2022)

S. No.	Subject Code	Subject Title	Period			Evaluation Scheme			Subject Total
						Sessional		ESE	
			L	P	Credit	CT	TA		
B.Sc. I Year									
SEMESTER – I									
DSC 1	BZO-C101	Animal Diversity: Nonchordata	4		4	20	10	70	100
AECC		Environmental Science and sustainable development /Language and Literature –I (English)	4		4	20	10	70	100
SEC 1		NSS/NCC/Cultural (Music/Arts/Painting/Dance/) **(Qualifying)**	0						
VAC1		Yogic Science/Physical Education and Sports/Human Psychology	2		2	20	10	70	100
	BZO-P151	Lab course		2		15	15	70	100
			Total 12					**400**	
SEMESTER – II									
DSC 2	BZO-C201	Animal Diversity: Chordata	4		4	20	10	70	100
AECC		Environmental Science and sustainable development /Language and Literature –I (English)	4		4	20	10	70	100
SEC 2		NSS/NCC/Cultural (Music/Arts/Painting/Dance/) **(Qualifying)**	0						
VAC2		Yogic Science/Physical Education and Sports/Human Psychology	2		2	20	10	70	100
	BZO-P251	Lab course	2		4	15	15	70	100
				Total 12				**400**	
B.Sc. II Year									
SEMESTER – III									
DSC 3	BZO-C301	Animal Physiology and Biochemistry	4		4	20	10	70	100
SEC 3	BZO-S302	Medical Diagnostic Technology	4		2	20	10	70	100
VAC3	BZO-V303	IT Skills, Data analysis/Digital literacy and Cyber Security	2		2	20	10	70	100
	BZO-P351	Lab course		2	4	15	15	70	100
			Total 12			**400**			
SEMESTER – IV									
DSC 4	BZO-C401	Cell Biology	4		4	20	10	70	100
SEC 4	BZO-S402	Animal Biotechnology	4		2	20	10	70	100
VAC4	BZO-V403	Language and literature II (Sanskrit) 2	2		2	20	10	70	100
	BZO-451	Lab course		2	2	15	15	70	100
			Total 12					**400**	

B.Sc. III Year									
SEMESTER – V									
DSE 5	BZO-E501	*Comparative Anatomy and Developmental Biology of Vertebrates	4		4	20	10	70	100
DSE 5	BZO-E502	*Economic Zoology	4		2	20	10	70	100
SEC5	BZO-S503	Biostatistics and Computer Applications	4		2	20	10	70	100
VAC5		Innovation and entrepreneurship/Data Science and Applications/Biotechniques	2		2	20	10	70	100
	BZO-P551	Lab course		2	2	15	15	70	100
			Total 12				**400**		
SEMESTER – VI									
DSE 6	BZO-E601	*Genetics and Evolutionary biology	4		4	20	10	70	100
DSE 6	BZO-E602	*Molecular Biology	4		4	20	10	70	100
SEC 6	BZO-S603	Genetic diseases and counselling	4		2	20	10	70	100
VAC 6	BZO-V603	Ethics and Culture/The essence of Indian Tradition Knowledge /BKT/ Vedic science	2		2	20	10	70	100
	BZO-P651	Lab course		2	2	15	15	70	100
			Total 12				**400**		
B.Sc. IV Year									
SEMESTER – VII									
DSC 7	BZO–C701	Reproductive Biology	4		4	20	10	70	100
DSC 8	BZO–C702	Applied Zoology	4		4	20	10	70	100
DSC 9	BZO–C703	Endocrinology	4		4	20	10	70	100
SEC 7	BZO–S704	Animal Behavior	2		2	20	10	70	100
VAC 7		Research Training/ Field Studies	6						100
	BZO –P751	Lab Course		2	2	15	15	70	100
	BZO-P752	Lab Course		2	2	15	15	70	100
			Total 24				**700**		
SEMESTER – VIII									
DSC 10	BZO–C801	Wild Life Biology	4		4	20	10	70	100
DSC11	BZO–C802	Aquatic biology	4		4	20	10	70	100
DSC12	BZO–C803	Research Methods and Instrumentation	4		4	20	10	70	100
SEC 7	BZO–S804	Biotechniques	2		2	20	10	70	100
VAC 8	BZO–S805	Research Project/ Dissertation	6						100
	BZO–P851	Lab Course		2	2	15	15	70	100
	BZO–P852	Lab Course		2	2	15	15	70	100
			Total 24				**700**		
			Credit Total 120				Grand Total		3800

CURRICULUM STRUCTURE FOR THE UNDERGRADUATE DEGREE PROGRAMME - B.Sc. (BASIC/HONS.)

Total Credits for the Programme: **192**

Starting year of implementation: **2022-2023**

Name of the Degree Programme: **B.Sc. (Basic/Hons.)**

Discipline/Subject: **Zoology**

Programme Articulation Matrix

Semester	Title /Name of the course	Course outcomes that the course addresses	Pre-requisite course(s)	Pedagogy	Assessment
1	**BZO-C-101** – Animal Diversity: Nonchordata	To develop the knowledge and understanding of the various types of the nonchordates and able to understand the holistic relationship between them.	Intermediate or equivalent in Science subjects	Theory and course projects	Continuous internal assessment (Formative assessment) - 30%. End Semester Examination (Summative assessment) - 70%
	BZO-P-151 – Lab Course	To provide the basic understanding of various nonchordates and their practical understanding.		Practical	

Semester	Title /Name of the course	Course outcomes that the course addresses (not more than 3 per course)	Pre-requisite course (s)	Pedagogy	Assessment
2	**BZO-C-201** – Animal Diversity: Chordata	To develop the knowledge and understanding of the various types of the chordates and able to appreciate the holistic relationship between them.	-	Theory, case studies and course projects	Continuous internal assessment (Formative assessment) -30%. End Semester Examination (Summative assessment) - 70%
	BZO-P-251- Lab Course	To provide the basic understanding of various nonchordates and their practical understanding.		Practical	
Exit option with Certificate in Science					

Semester	Title /Name of the course	Course outcomes that the course addresses	Pre-requisite course (s)	Pedagogy	Assessment
3	**BZO-C-301-** Animal Physiology and Biochemistry	To develop a sound knowledge of Physiology and Biochemistry in vertebrates.	Certificate in Science with Environmental Science as a subject and a total credit score of 50	Theory, case studies and problem solving methods	Continuous internal assessment (Formative assessment)-30%. End Semester Examination (Summative assessment) -70%
	BZO-S-302- Medical Diagnostic Technology	To develop the skill of basic tools and techniques related with the medical Diagnostic Technology.			
	BZO-P-351- Lab Course	To provide the basic practical knowledge of Animal Physiology and Biochemistry		Hands-on-training and field studies	
Semester	**Title /Name of the course**	**Course outcomes that the course addresses**	**Pre-requisite course (s)**	**Pedagogy**	**Assessment**
4	**BZO-C-401-** Cell Biology	To provide the basic understanding of different types of cells and cellular organelles.	Certificate in Science with Environmental Science as a subject and a total credit score of 50	Theory, case studies and problem solving methods	Continuous internal assessment (Formative assessment)-30%. End Semester Examination (Summative assessment) -70%
	BZO-S-402- Animal Biotechnology	To provide the knowledge and understanding of animal biotechnology.			
	BZO-C-451- Lab Course	To provide the practical knowledge for various types of cellular machinery and cell functions.		Hands-on-training and field studies	

Semester	Title /Name of the course	Course outcomes that the course addresses	Pre- requisite course (s)	Pedagogy	Assessment
5	**BZO-E-501-** Comparative Anatomy and Developmental Biology of Vertebrates	To develop an understanding of Comparative Anatomy and Developmental Biology of Vertebrates	Certificate in Science with Environmental Science as a subject and a total credit score of 50	Theory, case studies and problem solving methods	Continuous internal assessment (Formative assessment)-30%. End Semester Examination summative assessment) -70%
	BZO-E-502- Economic Zoology	To develop a sound knowledge and understanding of benefits and economical perspectives of zoology.			
	BZO-S-503 Biostatistics and Computer Applications	To develop a sound knowledge and understanding of Biostatistics and Computer Applications			
	BZO-P-551- Lab Course	To develop the practical knowledge for - Comparative Anatomy and Developmental Biology of Vertebrates		Hands-on-training and field studies	
Semester	**Title /Name of the course**	**Course outcomes that the course addresses**	**Pre- requisite course (s)**	**Pedagogy**	**Assessment**
6	**BZO-E -601-** Genetics and Evolutionary biology	To develop a basic understanding for Genetics and Evolutionary biology.	Certificate in Science with Environmental Science as a subject and a total credit score of 50	Theory, case studies and problem solving methods	Continuous internal assessment (Formative assessment)-30%. End Semester Examination (Summative assessment) -70%
	BZO-E-602- Molecular Biology	To create the knowledge and understanding of molecular biology.			
	BZO-E-603 Genetic diseases and counselling	To develop knowledge and understanding for various Genetic diseases and counselling			
	BZO-P -651- Lab Course	To create the practical knowledge and understanding on Genetics, Evolutionary biology and molecular biology.		Hands-on-training and field studies	

Semester	Title /Name of the course	Programme outcomes that the course addresses (not more than 3 per course)	Pre- requisite course (s)	Pedagogy	Assessment
7	**BZO-C-701-** Reproductive Biology	To create an understanding and knowledge for the reproductive biology.	Certificate in Science with Environmental Science as a subject and a total credit score of 50	Theory, case studies and problem solving methods	Continuous internal assessment (Formative assessment)-30%. End Semester Examination summative assessment) -70%
	BZO-C-702- Applied Zoology	To develop the knowledge and understanding of Applied Zoology.			
	BZO-C-703- Endocrinology	To create an understanding of Various endocrine glands and their functions and various endocrine disorder.		Hands-on-training and field studies	
	BZO-S-704- Animal Behaviour	To create an understanding of Various endocrine glands and their functions and various endocrine disorder			
	BZO-P-751- Lab Course	To provide the practical knowledge of reproductive biology.			
	BZO-P-752- Lab Course	To provide the practical knowledge of Applied Zoology			
Semester	**Title /Name of the course**	**Course outcomes that the course addresses**	**Pre- requisite course (s)**	**Pedagogy**	**Assessment**
8	**BZO-C-801-** Wild Life Biology	To develop the knowledge and understanding of the various wild life organisms.	Certificate in Science with Environmental Science as a subject and a total credit score of 50	Theory, case studies and problem solving methods	Continuous internal assessment (Formative assessment)-30%. End Semester Examinationproblem-solvingessment) -70%
	BZO-C-802- Aquatic biology	To create the knowledge and understanding for Aquatic organisms and their structure and functions			
	BZO-C-803- Research Methods and Instrumentation	To develop the knowledge and understanding for various instruments used in biology.			
	BZO-S-804 Biotechniques	To develop the knowledge and understanding for various biotechniques.			
	BZO-P-851- Lab Course	To create the practical knowledge to identify various wild life organisms		Hands-on-training and field studies	
	BZO-P-852- Lab Course	To create the practical knowledge of basic research problems and their understanding.			

DISCIPLINE SPECIFIC CORE COURSE

BZO:C101 ANIMAL DIVERSITY: NONCHORDATA

(Credits: Theory-4, Practical-2)

SEMESTER –I **Lectures: 60**

Unit 1

Phylum -Protista: General characters and classification up to classes; Locomotory Organelles and locomotion in Protozoa: Porifera: General characters and classification up to classes; Canal System in *Sycon*

Unit 2

Cnidaria: General characters and classification up to classes; Polymorphism in Hydrozoa: Platyhelminthes: General characters and classification up to classes; Life history of *Taenia solium*

Unit 3

Phylum: Nemathelminthes: General characters and classification up to classes; Life history of *Ascaris lumbricoides* and its parasitic adaptations: Annelida: General characters and classification up to classes; Metamerism in Annelida

Unit 4

Arthropoda: General characters and classification up to classes; Vision in Arthropoda, Metamorphosis in Insects Phylum: Mollusca: General characters and classification up to classes; Torsion in Gastropods:

Unit 5

Echinodermata: General characters and classification up to classes, Water-vascular system in Asteroidea: Protochordates: General features and Phylogeny of Protochordata

Note: Classification to be followed from "Barnes, R.D. (1982). *Invertebrate Zoology*, V Edition."

SUGGESTED READINGS

1. Barnes, R.D. (1982). *Invertebrate Zoology*, V Edition. Holt Saunders International Edition.
2. 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
3. Barrington, E.J.W. (1979). *Invertebrate Structure and Functions*. II Edition, E.L.B.S. and Nelson
4. Young, J. Z. (2004). *The Life of Vertebrates*. III Edition. Oxford university press.
5. Pough H. *Vertebrate life*, VIII Edition, Pearson International.
6. Hall B.K. and Hallgrimsson B. (2008). *Strickberger's Evolution*. IV Edition. Jones and Bartlett Publishers Inc.

Lab Course BZO: P151

1.Kingdom: Protista: *Amoeba, Euglena, Plasmodium, Paramecium*
2.Phylum: Porifera: *Sycon* (including T.S. and L.S.), *Hyalonema,* and *Euplectella*
3.Phylum: Cnidaria: *Obelia, Physalia, Aurelia, Tubipora, Metridium*
4.Phylum: Platyhelminthes: *Taenia solium* and Study of its life history stages
5.Phylum: Nemathelminthes: Male and female *Ascaris lumbricoides*
6.Phylum: Annelida: *Aphrodite, Nereis, Pheretima, Hirudinaria*
7.Phylum: Arthropoda: *Palaemon, Cancer, Limulus, Palamnaeus, Scolopendra, Julus, Periplaneta, Apis*
8.Phylum: Mollusca: *Chiton, Dentalium, Pila, Unio, Loligo, Sepia, Octopus*
9.Phylum: Echinodermata: *Pentaceros, Ophiura, Echinus, Cucumaria* and *Antedon*
10. Take water from ponds and identify different genera of invertebrates

An "animal album" containing photographs, cut outs, with appropriate write up about the abovementioned taxa. Different taxa/ topics may be given to different sets of students for this purpose. These need not be repeated as drawings by the album maker.

DISCIPLINE SPECIFIC CORE COURSE

BZO: C201 ANIMAL DIVERSITY: CHORDATA

(Credits: Theory-4, Practicals-2)

SEMESTER –II **Lectures: 60**

Unit 1

Introduction and Origin of Chordata

General characteristics and outline classification, Dipleurula concept and the Echinoderm theory of origin of chordates

Unit 2

Protochordata and Agnatha

General characteristics of Hemichordata, Urochordata and Cephalochordata; Study of larval forms in protochordates; Retrogressive metamorphosis in Urochordata, General features of Agnatha and classification of cyclostomes up to classes

Unit 3

Pisces and Amphibia

General characteristics of Chondrichthyes and Osteichthyes, Classification up to order

Migration, Osmoregulation and Swim bladder in Fish, Origin of Tetrapoda (Evolution of terrestrial ectotherms); General characteristics and classification up to order; Parental care in Fishes and Amphibians

Unit 4

Reptilia and Aves

General features and Classification up to orders; Poisonous and nonpoisonous snakes, Biting mechanism in snakes, General characteristics and classification up to order; Flight adaptations and migration in birds

Unit 5

Mammalia

General characters and classification up to order; Affinities of Prototheria; Adaptive radiation with reference to locomotory appendages

SUGGESTED READINGS

1. Young, J. Z. (2004). *The Life of Vertebrates*. III Edition. Oxford university press.
2. Pough H. *Vertebrate life,* VIII Edition, Pearson International.
3. Hall B.K. and Hallgrimsson B. (2008). *Strickberger's Evolution*. IV Edition. Jones and Bartlett Publishers Inc.

BZO: P251 Lab Course

Protochordata: *Balanoglossus, Herdmania, Branchiostoma*
Agnatha: *Petromyzon*
Pisces: *Sphyrna, Pristis, Torpedo, Labeo, Exocoetus, Anguilla*
Amphibia: *Ichthyophis/Ureotyphlus, Salamandra, Bufo, Hyla*
Reptilia: *Chelone, Hemidactylus, Chamaeleon, Draco, Vipera, Naja, Crocodylus, Gavialis*
Key for Identification of poisonous and non-poisonous snakes
Aves: Study of six common birds from different orders
Mammalia: *Sorex*, Bat, *Funambulus, Loris*
An "animal album" containing photographs, cut outs, with appropriate write up about the above mentioned taxa. Different taxa/ topics may be given to different sets of students for this purpose. These need not be repeated as drawings by the album maker.

DISCIPLINE SPECIFIC CORE COURSE
BZO:C301 ANIMAL PHYSIOLOGY AND BIOCHEMISTRY
(Credits: Theory-4, Practicals-2)

SEMESTER –III **LECTURES: 60**

Unit 1

Nerve and muscle: Structure of a neuron, Resting membrane potential, Graded potential, Origin of Action potential and its propagation in myelinated and non-myelinated nerve fibres, Ultrastructure of skeletal muscle, Molecular and chemical basis of muscle contraction

Unit 2

Digestion: Digestion in different segments of the alimentary canal; Absorption of carbohydrates, proteins, lipids: Respiration: Pulmonary ventilation, Respiratory volumes and capacities, Transport of Oxygen and carbon dioxide in blood

Unit 3

Excretion: Structure of nephron, mechanism of Urine formation; Cardiovascular system
Blood: Composition, Hemostasis, Heart structure, Origin and conduction of the cardiac impulse, cardiac cycle

Unit 4

Reproduction and Endocrine Glands: Physiology of male reproduction: hormonal control of spermatogenesis; Physiology of female reproduction: hormonal control of menstrual cycle; Structure and function of pituitary, thyroid, parathyroid, pancreas and adrenal

Unit 5

Carbohydrate Metabolism: Glycolysis, Krebs Cycle, Pentose phosphate pathway, Gluconeogenesis, Glycogen metabolism, Review of electron transport chain: Lipid Metabolism: Biosynthesis and β oxidation of palmitic acid: Protein metabolism: Transamination, Deamination and Urea Cycle: Enzymes: Introduction, Mechanism of action, Kinetics, Inhibition and Regulation

SUGGESTED READINGS: PHYSIOLOGY

- Tortora, G.J.& Derrickson, B.H. (2009). Principles of Anatomy and Physiology, 12thedn., John Wiley & Sons, Inc.
- Widmaier, E.P., Raff, H. & Strang, K.T. (2008) Vander's Human Physiology, 11thedn., McGraw Hill
- Guyton, A.C. & Hall, J.E. (2011) Textbook of Medical Physiology, 12th edn., Harcourt Asia Pvt. Ltd/ W.B. Saunders Company

SUGGESTED READINGS: BIOCHEMISTRY

- Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). Biochemistry. VI Edition. W.HFreeman and Co.
- Nelson. D. L., Cox, M. M. and Lehninger, A.L. (2009). Principles of Biochemistry.IV Edition. W.H Freeman and Co.
- Murray, R. K., Granner, D. K., Mayes, P. A. and Rodwell, V. W. (2009). Harper'sIllustrated Biochemistry. XXVIII Edition. Lange Medical Books/Mc Graw3Hill.

SKILL ENHANCEMENT COURSE
BZO: S302 MEDICAL DIAGNOSTIC TECHNOLOGY
(Credits: Theory-4, Practical -2)

SEMESTER –III **LECTURES: 60**

Unit 1: Medical Diagnostics and its importance: Introduction, History of medical diagnostics, Medical ethics, Ancient Indian diagnostic techniques, Comparison between modern and ancient diagnostic methods

Unit 2: Medical Diagnostics of body fluids
Blood composition, Blood bank, Transfusion of blood, RBC, WBC and platelet count using haemocytometer, Erythrocyte Sedimentary Rate (E.S.R), Packed Cell Volume (P.C.V.), Analysis of urine, sputum, faeces and semen (sperm count)

Unit 3: Medical Diagnostics of Non-infectious Diseases
Causes, types, symptoms, complications, diagnosis and prevention of Diabetes (Type I and Type II), Hypertension (Primary and secondary), Diagnosis and detection of types of tumors, strokes and mental ill health

Unit 4: Diagnostics Microbiology
Methods to diagnose and isolate infectious agents of diseases like Tuberculosis, Rabies, Measles, Hepatitis, AIDS and COVID.

Unit 5: Diagnostic Medical Imaging
Principle of Medical imaging techniques like X-Ray of Bone fracture, PET, MRI and CT Scan

LAB COURSE- BZO: 351

A. PHYSIOLOGY

1. Preparation of hemin and hemochromogen crystals
2. Examination of permanent histological sections of mammalian pituitary, thyroid, parathyroid, pancreas, adrenal,
3. Examination of permanent slides of spinal cord, duodenum, liver, lung, kidney, bone, cartilage

B. BIOCHEMISTRY

1. Identification of unknown carbohydrates in given solutions (Starch, Sucrose, Lactose, Galactose, Glucose, Fructose)
2. Colour reactions to identify functional group in the given solution of proteins
3. Study of activity of salivary amylase under optimum conditions

DISCIPLINE SPECIFIC CORE COURSES

BZO: C401: CELL BIOLOGY

(Credits: Theory-4, Practicals-2)

SEMESTER –IV **Lectures: 60**

Unit 1

Overview of Cells and Plasma Membrane

Prokaryotic and Eukaryotic cells, Virus, Viroids, Mycoplasma, Prions,

Unit 2

Plasma Membrane

Various models of plasma membrane structures, Transport across membranes: active and passive transport, facilitated transport; Cell-cell junctions, structures and functions: Tight junctions, adherens junctions, gap junctions

Unit 3

Endomembrane system

Structure and Functions: Endoplasmic Reticulum, Signal hypothesis, Vesicular transport from ER to Golgi apparatus; Protein sorting and transport from Golgi apparatus; Golgi apparatus, Vesicular transport: Coated Vesicles; Lysosomes; Peroxisomes.

Unit 4

Mitochondria and Nucleus

Structure, Endo-symbiotic hypothesis; Respiratory chain, Chemiosmotic hypothesis and ATP Synthase., Structure of Nucleus: Nuclear envelope, Nuclear pore complex, Chromatin: euchromatin, heterochromatin and packaging, nucleosome, nucleolus

Unit 5

Cytoskeleton and Cell Division

Structure and Functions: Microtubules, Microfilaments and Intermediate filaments. Mitosis, Meiosis, Cell cycle and its regulation

SUGGESTED READINGS

1. Karp, G. (2010). *Cell and Molecular Biology: Concepts and Experiments.* VI Edition. John Wiley and Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). *Cell and Molecular Biology.* VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
3. Cooper, G.M. and Hausman, R.E. (2009). *The Cell: A Molecular Approach.* V Edition. ASM Press and Sunderland, Washington, D.C.; Sinauer Associates, MA.
4. Becker, W.M., Klein smith, L.J., Hardin. J. and Bertoni, G. P. (2009). *The World of the Cell.* VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.
5. Bruce Albert, Bray Dennis, Levis Julian, Raff Martin, Roberts Keith and Watson James (2008). *Molecular Biology of the Cell,* V Edition, Garland publishing Inc., New York and London.

SKILL ENHANCEMENT COURSE
BZO: S402 ANIMAL BIOTECHNOLOGY
(Credits: Theory-4)

SEMESTER –IV **Lectures: 60**

Unit 1

Introduction
Definition, History of biotechnology, Types of biotechnology, Concept and scope of biotechnology

Unit 2

Basic Tools for Gene Manipulation
Cloning vectors: Plasmids, Cosmids, Phasmids, Lambda Bacteriophage, M13, BAC, YAC, MAC and Expression vectors (characteristics). Restriction enzymes: DNA modifying enzymes. Basic concept of Recombinant DNA Technology (RDT)

Unit 3

Molecular Tools and Techniques
Southern, Northern and Western blotting, DNA sequencing: Sanger method, Next generation sequencing (Illumina), Polymerase Chain Reaction, DNA Finger Printing

Unit 4

Genetically Modified Organisms
Production of cloned and transgenic animals: Nuclear Transplantation, Retroviral Method, DNA microinjection; Applications of transgenic animals: Production of pharmaceuticals, production of donor organs

Unit 5

Applications of Genetic Engineering
Molecular diagnosis of genetic diseases (Cystic fibrosis, Sickle cell anemia), Recombinant DNA in medicines: Recombinant insulin and human growth hormone, Gene therapy

SUGGESTED READINGS

1. Brown, T.A. (1998). *Molecular Biology Labfax II: Gene Cloning and DNA Analysis*. II Edition, Academic Press, California, USA.
2. Glick, B.R. and Pasternak, J.J. (2009). *Molecular Biotechnology - Principles and Applications of Recombinant DNA*. IV Edition, ASM press, Washington, USA.
3. Griffiths, A.J.F., J.H. Miller, Suzuki, D.T., Lewontin, R.C. and Gelbart, W.M. (2009). *An Introduction to Genetic Analysis*. IX Edition. Freeman and Co., N.Y., USA.

Lab Course: BZO: P451

A. CELL BIOLOGY

1. Principle of Light microscope, Phase contrast microscope and Electron microscope and principle of cell fixation, staining and fractionation.
2. Gram's staining technique for visualization of prokaryotic cells
3. Study various stages of mitosis from permanent slides
4. Study various stages of meiosis from permanent slides.
5. Study the presence of Barr body in human female blood cells/cheek cells. (Preparation of permanent slides)

DISCIPLINE SPECIFIC ELECTIVE COURSE

BZO: E501 COMPARATIVE ANATOMY AND DEVELOPMENTAL BIOLOGY OF VERTEBRATES

(Credits: Theory-4, Practical-2)

SEMESTER – V **Lectures: 60**

Unit 1

Integumentary System: Derivatives of integument w.r.t. glands and digital tips; Skeletal System: Evolution of visceral arches; Digestive System: Brief account of alimentary canal and digestive glands; Respiratory System: Gills, lungs, air sacs and swim bladder.

Unit 2

Circulatory System: Evolution of heart and aortic arch; Urinogenital System: Succession of kidney, Evolution of urinogenital ducts.

Unit 3

Nervous System: Comparative account of brain; Sense Organs: Types of receptors

Unit 4

Early embryonic development: Gametogenesis: Spermatogenesis and oogenesis w.r.t mammals, vitellogenesis in birds; Fertilization: external (amphibians), internal (mammals), blocks to polyspermy; Early development of frog and humans (structure of mature egg and its membranes, patterns of cleavage, fate map, up to formation of gastrula); types of morphogenetic movements; Fate of germ layers; Neurulation in frog embryo.

Unit 5

Late embryonic development: Implantation of embryo in humans, Formation of human placenta and functions, other types of placenta on the basis of histology; Metamorphic events in frog life cycle and its hormonal regulation.; Control of Development: Fundamental processes in development (brief idea) – Gene activation, determination, induction, Differentiation, morphogenesis, intercellular communication, cell movements and cell death.

SUGGESTED READINGS: A. COMPARATIVE ANATOMY

- Kardong, K.V. (2005) *Vertebrates' Comparative Anatomy, Function and Evolution*. IV Edition. McGraw-Hill Higher Education.
- Kent, G.C. and Carr R.K. (2000). *Comparative Anatomy of the Vertebrates*. IX Edition. The McGraw-Hill Companies.
- Weichert C.K and William Presch (1970). *Elements of Chordate Anatomy*, TataMcGraw Hills
- Hilderbrand, M and Gaslow G.E. *Analysis of Vertebrate Structure*, John Wiley and Sons.
- Walter, H.E. and Sayles, L.P; *Biology of Vertebrates*, Khosla Publishing House.

B. DEVELOPMENTAL BIOLOGY

SUGGESTED READINGS

- Gilbert, S. F. (2006). Developmental Biology, VIII Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA.
- Balinsky, B.I. (2008). An introduction to Embryology, International Thomson Computer Press.
- Carlson, Bruce M (1996). Patten's Foundations of Embryology, McGraw Hill, Inc.

DISCIPLINE SPECIFIC ELECTIVE COURSE
BZO: E502 ECONOMIC ZOOLOGY
(Credits: Theory-4)

SEMESTER – V **LECTURES: 60**

Unit 1

Apiculture (Bee-keeping)
Introduction, Varieties of honey bees and Bee pasturage; Setting up an apiary: Langstroth's/Newton's hive, bee veil, brood and storage chambers, iron frames and comb sheets, drone excluder, rearing equipments, handling of bees, artificial diet; Economy

Unit 2

Sericulture
Introduction, Different types of silk and silkworms in India; Rearing of Bombyx mori – Rearing racks and trays, Chawki rearing, bed cleaning, montages, harvesting of cocoons; Silk reeling techniques and their management

Unit 3

Lac Culture
Introduction, Life History of *Tachardia lacca*, Host plants for Lac cultivation, Cultivation of lac, Different types of Lacs and Lac production, Lac industries in India

Unit 4

Livestock Technology
Introduction, Dairy Industry, Poultry industry, Piggery and their production and economics

Unit 5

Aquaculture
Introduction, Pearl culture, Prawn culture, and Fresh water fish culture, and their production and economics

SUGGESTED READINGS

1.Prost, P. J. (1962). *Apiculture*. Oxford and IBH, New Delhi.
2. Sericulture, *FAO Manual of Sericulture.*
3. Hafez, E. S. E. (1962). *Reproduction in Farm Animals*, Lea and Fabiger Publishers.
4. Srivastava, C. B. L. (1999). *Fishery Science and Indian Fisheries*. Kitab Mahal publications, India.
5. Sardar Singh, *Beekeeping in India*, Indian council of Agricultural Research, New Delhi
6. Dharam Singh Bisht, *Apiculture*, ICAR Publication.
7. Knobil, E. and Neill, J. D. (2006). *The Physiology of Reproduction*, Vol. 2, Elsevier Publishers.
8. Dunham R. A. (2004). *Aquaculture and Fisheries Biotechnology - Genetic Approaches*. CABI publications, U.K.

SKILL ENHANCEMENT COURSE
BZO: S503 BIOSTATISTICS AND COMPUTER APPLICATIONS
(Credits: Theory-4)

SEMESTER – V **LECTURES: 60**

Unit 1
Introduction to Biostatistics; Development, Definition, Characteristics, Importance and limitations, Preliminary concept (variables and constants, Testing hypothesis)

Unit 2
Primary and secondary data, Presentation of data, Line diagram, Histogram and Pie diagram, Measure of central tendencies Mean, Mode and Median, standard deviation, Standard error

Unit 3
Elementary knowledge of probability, Correlation and Linear regression,

Unit 4
Distribution- Normal, Binomial and Poisson, Analysis of Variance, test of Significance: t-test, F- test and Chi-square test, ANOVA

Unit 5
Components and computer organizations, Applications of Computer, Internet, Concept of Operating system, computer graphics, MS office and Excel, Power point presentation

BZO-P551: LAB COURSE

A. COMPARATIVE ANATOMY

1. Osteology:

a. Disarticulated skeleton of fowl and rabbit

b. Carapace and plastron of turtle /tortoise

c. Mammalian skulls: One herbivorous and one carnivorous animal.

B. DEVELOPMENTAL BIOLOGY

1. Frog - Study of developmental stages - whole mounts and sections through permanent slides – cleavage stages, blastula, gastrula, neurula, tail bud stage, tadpole-external and internal gill stages.

2. Study of the different types of placentae- histological sections through permanent slides or photomicrographs.

3. Study of placental development in humans by ultrasound scans.

4. Examination of gametes - frog/rat - sperm and ova through permanent slides or photomicrographs.

DISCIPLINE SPECIFIC ELECTIVE COURSE
BZO: E601 GENETICS AND EVOLUTIONARY BIOLOGY
(Credits: Theory-4, Practicals-2)

SEMESTER – VI **Lectures: 60**

Unit 1

Introduction to Genetics: Mendel's work on transmission of traits, Genetic Variation, Molecular basis of Genetic Information; Mendelian Genetics and its Extension: Principles of Inheritance, Chromosome theory of inheritance, Pedigree analysis, Incomplete dominance and codominance, Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Environmental effects on phenotypic expression, sex linked inheritance, extrachromosomal inheritance involving mitochondria and chloroplast.

Unit 2

Linkage, Crossing Over and Chromosomal Mapping: Linkage and crossing over, Cytological basis of crossing over, Molecular mechanism of crossing over, Recombination frequency as a measure of linkage intensity, two factor and three factor crosses, Interference and coincidence, Somatic cell genetics – an alternative approach to gene mapping.

Unit 3

Mutations: Chromosomal Mutations: Deletion, Duplication, Inversion, Translocation, Aneuploidy and Polyploidy; Gene mutations: Induced versus Spontaneous mutations, Back versus Suppressor mutations, Molecular basis of Mutations; Sex determination; Chromosomal mechanisms, dosage compensation; Quantitative Genetics: Quantitative and multifactor inheritance, Transgressive variations, Heterosis.

Unit 4

History of Life: Major Events in History of Life; Introduction to Evolutionary Theories: Lamarckism, Darwinism, Neo-Darwinism; Direct Evidences of Evolution: Types of fossils, Incompleteness of fossil record, Dating of fossils, Phylogeny of horse: Processes of Evolutionary Change: Organic variations; Isolating Mechanisms; Natural selection (Example: Industrial melanism); Types of natural selection (Directional, Stabilizing, Disruptive), Artificial selection.

Unit 5

Species Concept: Biological species concept (Advantages and Limitations); Modes of speciation (Allopatric, Sympatric); Evolution above species level: Macro-evolutionary Principles (example: Darwin's Finches); Extinction: Mass extinction (Causes, Names of five major extinctions, K-T extinction in detail), Role of extinction in evolution.

SUGGESTED READINGS: A. GENETICS

Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). *Principles of Genetics*. VIII Edition. Wiley India.

Snustad, D.P., Simmons, M.J. (2009). *Principles of Genetics*. V Edition. John Wiley and Sons Inc.

Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). *Concepts of Genetics*. X Edition. Benjamin Cummings.

Russell, P. J. (2009). *Genetics- A Molecular Approach*. III Edition. Benjamin Cummings.

Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. *Introduction to Genetic Analysis*. IX Edition. W. H. Freeman and Co.

SUGGESTED READINGS: B. EVOLUTIONARY BIOLOGY

- Ridley, M. (2004). *Evolution*. III Edition. Blackwell Publishing
- Barton, N. H., Briggs, D. E. G., Eisen, J. A., Goldstein, D. B. and Patel, N. H. (2007). *Evolution*. Cold Spring, Harbour Laboratory Press.
- Hall, B. K. and Hallgrimsson, B. (2008). *Evolution*. IV Edition. Jones and Bartlett Publishers
- Campbell, N. A. and Reece J. B. (2011). *Biology*. IX Edition, Pearson, Benjamin, Cummings.

- Douglas, J. Futuyma (1997). *Evolutionary Biology*. Sinauer Associates.
- Minkoff, E. (1983). *Evolutionary Biology*. Addison-Wesley.

DISCIPLINE SPECIFIC ELECTIVE COURSE
BZO: E602 MOLECULAR BIOLOGY
(Credits: Theory-4)

SEMESTER –VI **Lectures: 60**

Unit 1

Molecular Biology

Concept and scope of molecular biology

Unit 2

Nucleic Acid

Salient features of DNA and types of RNA (mRNA, rRNA and tRNA); Watson and Crick model of DNA.

Unit 3

DNA Replication

DNA replication in prokaryotes and eukaryotes – replication machinery and mechanisms, semi-conservative, bidirectional and semi-discontinuous replication

Unit 4

Transcription

Machinery and mechanism of transcription in prokaryotes and eukaryotes-RNA polymerases,

Unit 5

Translation

Genetic code, Degeneracy of the genetic code and Wobble hypothesis; Process of protein synthesis in prokaryotes:

SKILL ENHANCEMENT COURSE (SEC)

BZO: S603 GENETICS DISEASES AND COUNCELLING

(Credits: Theory-4)

SEMESTER –VI **Lectures: 60**

Unit 1
Nucleic Acids

Overview of the structure of DNA and RNA; Replication, transcription and translation (in brief); Control of gene expression, DNA methylation and imprinting.

Unit 2

Basics of human cytogenetic nomenclature; Chromosome identification; Various techniques of karyotyping; Autosomal and sex chromosomal abnormalities

Unit 3
Mendelian Genetics

Mendel's experiments- laws and their exceptions; Introduction to linkage and recombination; Autosomal and X-linked inheritances; Multifactorial, Mitochondrial and complex inheritance.

Unit 4
Genetics of Human diseases

Molecular genetics of Human disease; Genetic basis of various diseases like Sickle cell anaemia, PKU, Thalassemia, Alzheimer's', Diabetes, Hypertension, cardiovascular, Cancer; Pedigree analysis (Symbols, preparation and analysis); Prenatal diagnosis of genetic disorders

Unit 5
Genetic Counselling

History, Famous Case Studies, Theory and Practice; Psycho-social aspects for the individual and the family in connection with genetic investigations; Legal aspects related to genetics, Medical termination of pregnancy act, PC-PNDT act and other aspects of medical jurisprudence, Introductory Gene Therapy

BZO: P651: LAB COURSE

GENETICS

1. Study of Mendelian Inheritance and gene interactions (Non Mendelian Inheritance) using suitable examples. Verify the results using Chi-square test.
2. Study of Linkage, recombination, gene mapping using the data.
3. Study of Human Karyotypes (normal and abnormal).

B. EVOLUTIONARY BIOLOGY

1. Study of fossil evidences from plaster cast models and pictures
2. Study of homology and analogy from suitable specimens/ pictures
3. Charts:

a. Phylogeny of horse with diagrams/ cut outs of limbs and teeth of horse ancestors

b. Darwin's Finches with diagrams/ cut outs of beaks of different species

4. Visit to Natural History Museum, submission of report

Discipline Specific Core Courses
BZO: C701 Reproductive Biology
(Credits: Theory-4, Practical 2)

SEMESTER – VII **Lectures: 60**

Unit 1

Reproductive Endocrinology: Gonadal hormones and mechanism of hormone action, steroids, glycoprotein hormones, and prostaglandins, hypothalamo – hypophyseal – gonadal axis, regulation of gonadotrophin secretion in male and female; Reproductive System: Development and differentiation of gonads, genital ducts, external genitalia, mechanism of sex differentiation.

Unit 2

Functional anatomy of male reproduction: Outline and histological of male reproductive system in rat and human; Testis: Cellular functions, germ cell, system cell renewal; Spermatogenesis: kinetics and hormonal regulation; Androgen synthesis and metabolism; Epididymal function and sperm maturation; Accessory glands functions; Sperm transportation in male tract

Unit 3

Functional anatomy of female reproduction: Outline and histological of female reproductive system in rat and human; Ovary: folliculogenesis, ovulation, corpus luteum formation and regression; Steroidogenesis and secretion of ovarian hormones; Reproductive cycles (rat and human) and their regulation, changes in the female tract; Ovum transport in the fallopian tubes; Sperm transport in the female tract, fertilization;

Unit 4

Hormonal control of implantation; Hormonal regulation of gestation, pregnancy diagnosis, foeto – maternal relationship; Mechanism of parturition and its hormonal regulation; Lactation and its regulation

Unit 5

Reproductive Health

Infertility in male and female: causes, diagnosis and management; Assisted Reproductive Technology: sex selection, sperm banks, frozen embryos, in vitro fertilization, ET, EFT, IUT, ZIFT, GIFT, ICSI, PROST; Modern contraceptive technologies; Demographic terminology used in family planning

SUGGESTED READINGS

- Austin, C.R. and Short, R.V. reproduction in Mammals. Cambridge University Press.
- Degroot, L.J. and Jameson, J.L. (eds). Endocrinology. W.B. Saunders and Company.
- Knobil, E. et al. (eds). The Physiology of Reproduction. Raven Press Ltd.
- Hatcher, R.A. et al. The Essentials of Contraceptive Technology. Population Information Programme.

DISCIPLINE SPECIFIC CORE COURSES
BZO:C702 APPLIED ZOOLOGY
(Credits: Theory-4, Practicals-2)

SEMESTER – VII **Lectures: 60**

Unit 1

Introduction to Host-parasite Relationship and Epidemiology of Diseases:
Host, Definitive host, Intermediate host, Parasitism, Symbiosis, Commensalism, Reservoir, Zoonosis, Transmission, Prevention and control of diseases: Tuberculosis, swine flu, typhoid, Rickettsiae and Spirochaetes, Brief account of *Rickettsia prowazekii, Borrelia recurrentis* and *Treponema pallidum*

Unit 2

Parasitic Protozoa and Helminthes:
Life history and pathogenicity of *Entamoeba histolytica, Plasmodium vivax* and *Trypanosoma gambiense*, Life history and pathogenicity of *Schistosoma haematobium, Ancylostoma duodenale* and, *Wuchereria bancrofti*

Unit 3

Insects of Economic and Medical Importance:
Biology, Control and damage caused by *Helicoverpa armigera, Pyrilla perpusilla* and *Papilio demoleus, Callosobruchus chinensis, Sitophilus oryzae* and *Tribolium castaneum*; Safe storage of stored grains, Life cycle, medical importance and control of *Pediculus humanus corporis, Anopheles, Culex, Aedes, Xenopsylla cheopis, Phlebotomus argentipes*

Unit 4

Animal Husbandry and Poultry Farming:
Preservation and artificial insemination in cattle; Induction of early puberty and synchronization of estrus in cattle, Principles of poultry breeding, Management of breeding stock and broilers, Processing and, preservation of eggs

Unit 5

Fish Technology:
Genetic improvements in aquaculture industry; Induced breeding and transportation of fish Seed.

Discipline Specific Core Courses
BZO: C703 Endocrinology
(Credits: Theory-4)

SEMESTER – VII **Lectures: 60**

Unit 1
Introduction to Endocrinology
Overview of the endocrine system, Classification of hormones and their synthesis, Transport of Hormones, Metabolism of hormones and their half-lives.

Unit 2
Neuroendocrinology
Structure of pineal gland, Secretions and their functions in biological rhythms and reproduction. Structure of hypothalamus, Hypothalamic nuclei and their functions, Regulation of neuroendocrine glands, Feedback mechanisms,

Unit 3
Pituitary Glands
Structure of pituitary gland, Hormones and their functions, Hypothalamo-hypophyseal portal system, Disorders of pituitary gland

Unit 4
Peripheral Endocrine Glands
Functional histology and Regulation of Thyroid, Parathyroid, Adrenal, Endocrine Pancreas, Gonads; Disorders related to hypersecretion and hyposecretion of hormones

Unit 5
Molecular Endocrinology
Hormone receptors, Transduction and regulation Hormone action at Molecular level: Molecular mediators (GPCR Family; DAG-Calcium Signaling Systems; RTKs, Protein Kinases and Phosphatases in Cellular Signaling); Steroid Hormone Receptor Families.

SKILL ENHANCEMENT COURSE (SEC)
BZO: S704 Animal Behavior
(Credits: Theory-2)

SEMESTER – VII **Lectures: 30**

Unit 1

Introduction to Animal Behavior

Origin and history of Ethology; Pioneers of Modern Ethology: Karl *von* Frisch, Ivan Pavlov, Konrad Lorenz, Niko Tinbergen; Proximate and ultimate causes of behavior;

Unit 2

Patterns of Behavior

Stereotyped behaviors (Orientation, Reflexes); Individual behavioral patterns; Instinct *versus* Learned behavior; Associative learning, Classical and Operant conditioning, Habituation, Imprinting

Unit 3

Social Behavior

Social Behavior: Concept of Society, Communication and the senses (Chemical, Tactile, Auditory, Visual); Altruism, Inclusive fitness, Hamilton's rule; Insects' society (Example: Honey bee); Foraging in honey bee and advantages of the waggle dance.

Unit 4

Introduction to Chronobiology

Historical developments in chronobiology, Biological oscillation: the concept of Average, amplitude, phase and period. Adaptive significance of biological clocks

Unit 5

Biological Rhythm

Characteristics of biological rhythms; Short-and Long-term rhythms; Circadian rhythms; Tidal rhythms and Lunar rhythms; Concept of synchronization and masking; Photic and nonphotic zeitgebers; Circannual rhythms; Photoperiod and regulation of seasonal reproduction of vertebrates

Lab Course BZO: P751 REPRODUCTIVE ZOOLOGY

1. Study of animal house: set up and maintenance of animal house, breeding techniques, care of normal and experimental animals.
2. Examination of vaginal smear rats from live animals.
3. Surgical techniques: principles of surgery in endocrinology. Ovarectomy, hysterectorny, castration and vasectomy in rats.
4. Examination of histological sections from photomicrographs/ permanent slides of rat/human: testis, epididymis and accessory glands of male reproductive systems; Sections of ovary, fallopian tube, uterus (proliferative and secretory stages), cervix and vagina.
5. Human vaginal exfoliate cytology.
6. Sperm count and sperm motility in rat
7. Study of modern contraceptive devices

LAB COURSE BZO: P752 APPLIED ZOOLOGY

1. Study of permanent slides/photomicrographs and specimens of *Plasmodium vivax, Entamoeba histolytica, Trypanosoma gambiense, Schistosoma haematobium, Ancylostoma duodenale* and *Wuchereria bancrofti*
2. Study of arthropod vectors associated with human diseases: *Pediculus, Culex, Anopheles, Aedes* and *Xenopsylla.*
3. Study of insect damage to different plant parts/stored grains through damaged products/photographs.
4. Identifying feature and economic importance of *Helicoverpa* (Heliothis) *armigera, Papiliodemoleus, Pyrillaperpusilla, Callosobruchus chinensis, Sitophilus oryzae* and *Tribolium castaneum*
5. Field Collection of economic important insects (Larva and adults)
6. Visit to poultry farm or animal breeding centre. Submission of visit report
7. Maintenance of freshwater aquarium

DISCIPLINE SPECIFIC CORE COURSE
BZO: 801: WILD LIFE BIOLOGY
(Credits: Theory-4, Practical-2)

SEMESTER –VIII **Lectures: 60**

Unit 1
Wild life
Values of wild life - positive and negative; conservation ethics; Importance of conservation; Causes of depletion, Endangered species

Unit 2
Habitat analysis, Evaluation and management of wild life
Physical parameters: Topography, Geology, Soil and water; Biological Parameters: food, cover, forage, browse and cover estimation; Standard evaluation procedures

Unit 3
Population estimation
Population density, Natality, Birth rate, Mortality, fertility
schedules and sex ratio computation; Faecal analysis of ungulates and carnivores: Faecal samples, slide preparation, Hair identification, Pug marks and census method.

Unit 4
Wild life Legislation – Wild Protection act - 1972, its amendments and implementation

Unit 5
Management planning of wild life in protected areas; Estimation of carrying capacity; Case study of any endangered species in Himalayan region

DISCIPLINE SPECIFIC CORE COURSE
BZO: C802 Aquatic Biology
(Credits: Theory-4, Practical-2)

SEMESTER – VIII **Lectures: 60**

UNIT-1

Aquatic Biomes: Brief introduction of the aquatic biomes: Freshwater ecosystem (lakes, wetlands, streams and rivers), estuaries, intertidal zones, oceanic pelagic zone, marine benthic zone and coral reefs.

UNIT-2

Freshwater Biology Lakes: Origin and classification, Lake as an Ecosystem, Lake morphometry, River & Streams: Types, Different type of river basin Different stages of stream development.

UNIT-3

Physico–chemical Characteristics: Light, Temperature, Thermal stratification, pH, Dissolved Solids, Carbonate, Bicarbonates, Phosphates and Nitrates, Turbidity; dissolved gases (Oxygen, Carbon dioxide). Nutrient Cycles in Lakes-Nitrogen, Sulphur and Phosphorous.

UNIT-4

Marine Biology: Types of Oceans, Salinity and density of Sea water, Continental shelf, Adaptations of deep-sea organisms, Coral reefs, Sea weeds.

UNIT-5

Management of Aquatic Resources: Causes of pollution- Agricultural, Industrial, Sewage, Thermal and Oil spills, Eutrophication, Management and conservation (legislations), Water quality assessment- DO, BOD and COD, Sewage treatments. Aquatic biodiversity- Plankton, Benthos & Hill stream fishes.

DISCIPLINE SPECIFIC CORE COURSE
BZO: 803: RESEARCH METHODS AND LABORATORY ETHICS
(Credits: Theory-4)

Semester VIII **Lectures: 60**

Unit 1
The Nature of Research
Definition of Research, Significance of research, Objectives of research, Components of research problem, Steps in scientific research.

Unit 2
Literature Survey and Types of Research
Sources of scientific literature: Print and Digital; Descriptive vs Analytical; Applied vs Basic; Qualitative vs Quantitative; Conceptual vs Empirical; Survey vs Experimental.

Unit 3
Research Process
Formulation of research problem; Inductive reasoning; Hypothesis; Preparing the research design; Sample design – deliberate, random, systematic, stratified, quota, cluster, area, multistage, sequential.

Unit 4
Data collection
Observation, interview, questionnaires, schedules; Categorization and summarization of data, Presentation of data – tabulation, graphical presentation – Bar, Line, Pie; Analysis of data -Statistical methods, Software; Recording of data through photographs; Hypothesis testing; Generalizations, Interpretation, Research Article writing

Unit 5
Bio-safety and Ethical Aspects of Biological Research
Awareness about handling of toxic laboratory chemicals, Use of pathogenic micro-organisms, Radioactive hazards, Safe disposal of animals and chemicals Ethical principles and government regulations governing use of live animals as objects of research; Copyright and plagiarism; Patents; Peer review; Conflict of interest; IPR issues.

SKILL ENHANCEMENT COURSE (SEC)
BZO: S 804: BIOTECHNIQUES
(CREDITS: THEORY-2)

SEMESTER – VIII **LECTURES: 30**

Unit 1
Study of animal house
Different laboratory animals, set up and maintenance of animal house, breeding techniques, care of normal and experimental animals.

Unit 2
Bio-assays
Definition and criteria of reliability; Chemical assays; Biological assays – *in* vivo *and* vitro assays. Histochemical and Cytochemical techniques

Unit 3
Principles and uses of analytical instruments
Balances, pH meter, calorimeter, Hot plate spectrophotometer, centrifuge, ultracentrifuge.

Unit 4
Microscopy
Principle of light transmission, electron, phase- contrast, fluorescence, electron, confocal, scanning and transmission electron microscopy.

Unit 5
Electrophoresis and PCR
Agarose gel electrophoresis, SDS PAGE, PCR, Real-time PCR

Lab Course: BZO P- 851

1. Identification of mammalian fauna, avian fauna, herpeto-fauna through direct and indirect evidences seen on a field trip to a wildlife conservation site.
2. Demonstration of basic equipment needed in wildlife studies use, care and maintenance (Compass, Binoculars, Spotting scope, Range Finders, Global Positioning System, Various types of Cameras and lenses).
3. Familiarization and study of animal evidences in the field: Identification of animals through pug marks, hoof marks, scats, nests and antlers.
4. Demonstration of different field techniques for flora and fauna: PCQM.
5. Trail / transect monitoring for abundance and diversity estimation of mammals and bird (direct and indirect evidences).
6. Identification of big cats: Lion, tiger, panther, cheetah, leopard and jaguar.
7. A report based on a visit to National Park/Wildlife Sanctuary/Biodiversity Park or any other wildlife conservation site.

Subject Expert Committee Members actively participated in the preparation of curriculum for four years B.Sc. (Basic/Hons.) degree in Zoology. BOS meetings conducted physically with Zoology subject committee experts; and the curriculum is approved by the Chairpersons, External subject experts and committee members of Department of Zoology and Environmental Science.

NEP-2020- SUBJECT EXPERT COMMITTEE- ZOOLOGY

Name	Designation and address	Position	Signature
Prof. A.K. Chaubey	Professor, Department of Zoology, Chaudhary Charan Singh University, Meerut	Subject expert	
Prof. Kusum Arunachalam	School of Environment and Natural Resources, Doon University, Dehradun	Subject expert	
Prof. Namita Joshi	Department of Environmental Science, Kanya Gurukul Campus, Gurukula Kangri (DU) , Haridwar	Member	
Dr. Rakesh Bhutiani	Assistant Professor, Department of Zoology and Environmental science, Gurukula Kangri (DU) , Haridwar	Member	
Dr. Sangeeta Madan	Department of Environmental Science, Kanya Gurukul Campus, Gurukula Kangri (DU) , Haridwar	Member	
Dr. Nitin Kamboj	Assistant Professor, Department of Zoology and Environmental science, Gurukula Kangri (DU) , Haridwar	Member	
Dr. Vinod Kumar	Assistant Professor, Department of Zoology and Environmental science, Gurukula Kangri (DU) , Haridwar	Member	
Dr. Gagan Matta	Assistant Professor, Department of Zoology and Environmental science, Gurukula Kangri (DU) , Haridwar	Member	
Dr. Nitin Bhardwaj	Assistant Professor, Department of Zoology and Environmental science, Gurukula Kangri (DU) , Haridwar	Member	
Prof. D.S. Malik	Head, Department of Zoology and Environmental science, Gurukula Kangri (DU) , Haridwar	Convener	