DEPARTMENT OF ZOOLOGY
DDU GORAKHPUR UNIVERSITY
GORAKHPUR

National Education Policy-2020

Common Minimum Syllabus for all UP State Universities and Colleges
For First Three Years of Higher Education (UG)

DEPARTMENT OF ZOOLOGY
DDU GORAKHPUR UNIVERSITY
GORAKHPUR

Subject: <u>Regarding Implementation of CBCS in UG Programme</u>

The university is going to implement CBCS at UG level in the university as per the recommendation of NEP 2020 and the Uttar Pradesh Government.

1. The CBCS structure for a student of **B.Sc with Zoology** as one of the major subjects is attached.

2. The common minimum syllabus Committee of Uttar pradesh Government has recommended that along with major discipline a student admitted to UG programme will also opt for **Minor/ Elective courses** (for two Years, completing minimum **8 credits**), **Co-curricular courses** (for all three years, completing minimum **12 credits**) and **Vocational Courses** (for two years, competing minimum **8 credits**) to fulfill the degree requirements.

3. ***Minor/Elective***, ***Co-curricular*** *and* ***Vocational courses*** *may be chosen from the central pool of courses approved by the Academic Council and made available by any department of the University, with approval of the Dean of Faculty in which he/she is admitted.*

4. The Basic course offered in first semester of the department will be available as Minor elective for students of other departments in even Semester.

5. A student may choose a regular course of 3 or 4 credits of other department and complete the credit requirement of minor elective.

PROPOSED COURSE STRUCTURE OF UG PROGRAM IN ZOOLOGY

SEMESTER-WISE TITTLES OF THE PAPERS IN UG ZOOLOGY PROGRAM			
Year	**Course Code**	**Paper Tittle**	**Credit**
	SEMESTER I		
FIRST	ZOO001	Basics of Zoology	2+0
	ZOO101 B050101T	Cytology, Genetics and Immunology	4+0
	ZOO102 B050102P	Cell Biology and Cytogenetics Lab	0+2
	SEMESTER II		
	ZOO103 B050201T	Biochemistry and Physiology	4+0
	ZOO104 B050202P	Physiological, Biochemical & Hematology Lab	0+2
SECOND	**SEMESTER III**		
	ZOO201 B050301T	Molecular Biology, Bioinstrumentation & Biotechniques	4+0
	ZOO202 B050302P	Bioinstrumentation & Molecular Biology Lab	0+2
	SEMESTER IV		
	ZOO203 B050401T	Gene Technology and Human Welfare	4+0
	ZOO204 B050402P	Genetic Engineering Lab, Genetic Counseling & Telemedicine	0+2
THIRD	**SEMESTER V**		
	ZOO301 B050501T	Diversity of Non-Chordates, Parasitological and Economic Zoology	4+0
	ZOO302 B050502T	Diversity of Chordates and Comparative Anatomy	4+0
	ZOO 303 B050503P	Lab on Virtual Dissection, Anatomy, Economic Zoology and Parasitological	0+2
	SEMESTER VI		
	ZOO304 B050601T	Evolutionary Biology and Developmental Biology	4+0
	ZOO305 B050602T	Ecology ,Ethology, Environmental Science and Wildlife	4+0
	ZOO306 B050603P	Lab on Environmental Science, Behavioral Ecology, Developmental Biology, Wildlife, Ethology	0+2

Structure for a student of B.Sc with Zoology as one of the major subjects

Year	Semester	Subject Major 1	Subject* Major 2	Subject* Major 3	Minor/ Elective (other faculty)	Co-curricular Minor	Vocational Minor	Industrial Training Project	Credits (Major + Minor)	Remarks
1	I	ZOOLOGY 8Credits (4+2)+2			Any 2 Credits per Semester Course as offered in other departments during corresponding odd/ even year	NCC/ NSS/ Rovers Rangers/ Sports/ Cultural Activities etc. 2 Credits per Semester	2 Credit per Semester as available		24+4=28 (+2 co-curr)	BASIC COURSE
	II	ZOOLOGY 6Credits (4+2)							18+4=22 (+2 co-curr)	
2	III	ZOOLOGY 6Credits (4+2)							18+4=22 (+2 co-curr)	
	IV	ZOOLOGY 6Credits (4+2)							18+4=22 (+2 co-curr)	
3	V	ZOOLOGY 6Credits (4+2)						4 Credits	20+(2+4)	ONLY TWO MAJOR TO BE OPTED
	VI	ZOOLOGY 6Credits (4+2)						4 Credits	20+(2+4)	
Total Credits		46 Credits	46 Credits	26 Credits	8 Credit	12 Qualifying Credits	8 Credits	8 Qualifying Credits	134 Credits +20 Qual. Credits	

*Major subjects offered in DDU Gorakhpur University Gorakhpur to a student of B.Sc. Bio group are Zoology, Botany, Chemistry, Defense Studies and Industrial Microbiology. A student can take any three and leave any one in 3rd year/ V & VI semester

Subject prerequisite

To study Zoology in undergraduate, a student must have studied Biology, Biotechnology or Life Science in Class 12.

Programme Objectives (POs)

1. The programme has been designed in such a way so that the students get the flavor of both classical and modern aspects of Zoology/Animal Sciences. It aims to enable the students to study animal diversity in Indian subcontinent, environmental science and behavioral ecology.
2. The modern areas including cell biology and genetics, molecular biology, biochemistry, physiology followed by biostatistics, Evolutionary biology, bioinformatics and genetic engineering have been included to make the study of animals more interesting and relevant to human studies which is the requirement in recent times.
3. The lab courses have been designed in such a way that students will be trained to join public or private lab.

B.Sc I Programme Specific Outcomes (PSOs)

PSO1	This course introduces System Biology and various functional components of an organism. Emphasis will be on physiological understanding abnormalities and anomalies associated with white blood cells and red blood cells. The course emphasizes cell identification, cell differentiation and cell morphology evaluation procedures. This will enhance hematology analytical skills along with skill of using many instruments.
PSO 2	The students will learn the basic principles of genetics and how to prepare karyotypes to study the chromosomes.
PSO 3	How chromosomal aberrations are inherited in humans by pedigree analysis in families.
PSO 4	The students will have hands-on training in the techniques like microscopy, centrifugation and chromatography, and various biochemical techniques, which will help them in getting employment in pathology labs and contribute to health care system.
PSO 5	**The Certificate courses will enable students to apply for technical positions in government and private labs/institutes.** **Diploma in Molecular Diagnostics and Genetic Counseling.**

B.Sc II Programme Specific Outcomes (PSOs)

PSO1	The student at the completion of the course will be able to have a detailed and conceptual understanding of molecular processes *viz.* DNA to trait. The differential regulation of genes in prokaryotes and eukaryotes leads to the development of an organism from an embryo.
PSO 2	The students will be able to understand and apply the principles and techniques of molecular biology which prepares students for further career in molecular biology. Independently execute a laboratory experiment using the standard methods and techniques.
PSO 3	The principles of genetic engineering, gene cloning and related technologies will enable students to play an important role in applications of biotechnology in various fields like agriculture, forensic sciences, industry and human health and make a career out of it. Students can have their own start-ups as well.
PSO 4	The basic tools of bioinformatics will enable students to analyze large amount of genomic data and its application to evolutionary biology. Apply knowledge and awareness of the basic principles and concepts of biology, computer science and mathematics existing software effectively to extract information from large databases and to use this information in computer modeling.
PSO 5	**The Diploma courses will ensure employability in Hospitals/Diagnostics and Pathology labs with good hands-on training. It will also enable students to take up higher studies and Research as their career and work in renowned labs in the country and abroad.**

B.Sc IIIProgramme Specific Outcomes (PSOs)

PSO1	This programme aims to introduce students to animal diversity of invertebrates and vertebrates. The students will be taught about invertebrates and vertebrates using observational strategies, museum specimens and field report.
PSO 2	A variety of interacting processes generate an organism's heterogeneous shapes, size, and structural features.
PSO 3	Inclusion of ecology and environmental sciences will enrich students with our world which is crucial for human well being and prosperity. This section will provide new knowledge of the interdependence between people and nature that is vital for food production, maintaining clean air and water, and sustaining biodiversity in a changing climate.
PSO 4	Students will also come to know about the basic principle of life, how a cell divides leading to the growth of an organism and also reproduces to form new organisms.
PSO 5	The basic concepts of biosystematics, evolutionary biology and biodiversity will enable students to solve the biological problems related to environment.
PSO 6	At the end of the course the students will be capable enough to comprehend the reason behind such a huge diversity of animals and reason out why two animals are grouped together or remain separate due to similarities and differences which exist at many levels along with ecological, environmental and cellular inputs.
PSO 7	**The Degree courses will enable students to go for higher studies like Masters and Ph.D in Zoology and Allied subjects.**

Programme/Class: Certificate	**Year**: First	**Semester**: First
Subject: ZOOLOGY		
Course Code: B050101T	**Course Title**	
ZOO001	**Basics of Zoology**	

Course outcomes:

The completion of this course will be enable students to:

- Understand about the fundamental concepts, principles and processes underlying the academic field of Zoology
- Understand evolutionary principles and animal diversity.
- Understand, appreciate and respect the concept of coexistence of humans with other animals in nature.
- Respect other animals that share our planet.
- Be aware of the various disciplines encompassed by the field of zoology and to encourage them to pursue those areas that interests them through further reading and coursework.

Credits: 2	**Core:** Compulsory
Max. Marks: 25+75	**Min. Passing Marks:** as per rules

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P:** 2-0-0

Unit	Topics	Total No. of Lectures (30)
I	**Basic Concepts of Zoology and Scope of Zoology** 1. Role of Zoology in Amelioration of Human problems (Vector, Parasite and Pest Control) 2. Application of Zoology in Everyday life: Domestication of Livestock, Poultry, Fisheries, Prawn Culture, Pearl culture Apiculture, Sericulture, Vermiculture	**7**
II	**Origin of Life on Earth, Products of evolutionary process** 1. Origin of life on Earth: Arrival of simple form from primordial chemicals, Multicellularity: from simple collections of poorly differentiated cells to complex body plans. 2. Biological diversity, Systematics and taxonomy, Species concept. 3. Nomenclature and utility of scientific names. 4. Classification: morphological and evolutionary (molecular) 5. Phylogenetic Relationship of taxa	**8**
III	**Structural and Functional Unit of Life** 1. Cell Theory 2. Macromolecules in Cell 3. Flow of energy and Information in Cell 4. Concept of continuity of life 5. Concept of Inheritance: Phenotype, Genotype, Genes, Alleles and Linkage	7
IV	**Interaction between Environment and Human population** 1. Flow of energy- Trapping Solar energy, Energy pathway, Food Chain, Food Web 2. Biogeochemical Cycles 3. Natural Resources and their Conservation	**8**

	4. Anthropogenic Effects- Acid rain, Global Warming, Ozone Depletion, Pollution.	

Suggested Readings:

1. Alberts et al: Molecular Biology of the Cell: Garland (2002).
2. Lodish et al: Molecular Cell Biology: Freeman & Co, USA (2004).
3. Cooper: Cell: A Molecular Approach: ASM Press (2000).
4. Nelson & Cox: Lehninger's Principles of Biochemistry: McMillan (2000)
5. Pierce B. Genetics. Freeman (2004).
6. Neilsen (2012). Animal Evolution: Interrelationships amongst living Phyla. Oxford
7. Parasitology- Chatterjee
8. Ridley, M (2004) Evolution (3rd edition) Blackwell publishing
9. Hall, B.K. and Hallgrimson, B (2008) Evolution (4th edition) Jones and Barlett Publishers.
10. Woodroffe, R., Thirgood, S. and Rabinowitz, A. (2005) People and Wildlife, Conflict or Co-existence? Cambridge University
11. Shukla, G.S. and Upadhyaya, V.B. (1999-2000). Economic Zoology (Rastogi Publishers).
12. Mani, M.S. (2006). Insects, NBT, India.
13. Jabde, P.V. (2005) Text Book of Applied Zoology: Vermiculture, Apiculture, Sericulture, Lac culture.
14. Fundamental Processes in Ecology: An Earth system Approach. 2007. Wilkinson, D.M. Oxford University Press, UK.
15. Fundamentals of Ecology. E.P. Odum& Gray. W. Barrett, 1971, Saunders

Course Books published in Hindi must be prescribed by the Universities and Colleges

Course prerequisites: To study this course, a student must have had the subject biology in class/12th

Suggested Continuous Evaluation Methods: **Total Marks: 25**

House Examination/Test: 10 Marks

Written Assignment/Presentation/Project/Research Orientation / Term Papers/Seminar: 10 Marks

Class performance/Participation: 5 Marks

Further Suggestions: None

At the End of the whole syllabus any remarks/ suggestions: None

Programme/Class: Certificate	**Year: First**	**Semester: First**
Subject: ZOOLOGY		
Course Code::B050101T	**Course Title**	
ZOO101	**Cytology**	

Course outcomes:

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

- Understand the structure and function of all the cell organelles.
- Know about the chromatin structure and its location.
- To be familiar with the basic principle of life, how a cell divides leading to the growth of an organism and also reproduces to form new organisms.
- How one cell communicates with its neighboring cells?
- Understand the basic principles of genetics and how genes (earlier called factors) are inherited from one generation to another.
- Understand the Mendel's laws and the deviations from conventional patterns of inheritance.
- Comprehend how environment plays an important role by interacting with genetic factors.
- How to detect chromosomal aberrations in humans and study the pattern of inheritance by pedigree analysis in families.
- To have an in depth understanding about Immune System & its mechanisms.

Credits: 4		**Core:** Compulsory
Max. Marks: 25+75		**Min. Passing Marks:** as per rules

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P:** 4-0-0

Unit	**Topic**	**Total No. of Lectures (60)**
I	**Structure and Function of Cell Organelles I** • Plasma membrane: chemical structure—lipids and proteins • Endomembrane system: protein targeting and sorting, endocytosis, exocytosis **Introduction to all national Biologists (Zoologists) who have contributed/contributing to Zoological and Life Sciences as a mark of tribute to ancient and modern biology will be included as part of the Continuous Internal Evaluation (CIE)**	**8**
II	**Structure and Function of Cell Organelles II** • Cytoskeleton: microtubules, microfilaments, intermediate filaments • Mitochondria: Structure, oxidative phosphorylation Peroxisome and ribosome: structure and function	**6**
III	**Nucleus and Chromatin Structure** • Structure and function of nucleus in eukaryotes • Chemical structure and base composition of DNA and RNA • DNA supercoiling, chromatin organization, structure of chromosomes • Types of DNA and RNA	**8**
IV	**Cell cycle, Cell Division and Cell Signaling** • Cell division: mitosis and meiosis • Cell cycle and its regulation, apoptosis, Signal transduction: intracellular signaling and cell surface receptors via G-protein linked receptors, JAK-STAT pathway	**8**

V	**Mendelism and Sex Determination** • Basic principles of heredity: Mendel's laws, monohybrid and dihybrid crosses • Complete and Incomplete Dominance, • Penetrance and expressivity, • Genic Sex-Determining Systems, Environmental Sex Determination, Sex Determination in *Drosophila*, Sex Determination in Humans, • Sex-linked characteristics and Dosage compensation	**8**
VI	**Extensions of Mendelism, Genes and Environment** • Extensions of Mendelism: Multiple Alleles, Gene Interaction, • Cytoplasmic Inheritance, Genetic Maternal Effects, • Genomic Imprinting, Anticipation, • Interaction Between Genes and Environment: Environmental Effects on Gene Expression, Inheritance of Continuous Characteristics	**8**
VII	**Human Chromosomes and Patterns of Inheritance** • Human karyotype, Chromosomal anomalies: Structural and numerical aberrations with examples, • Pedigree analysis,	**6**
VIII	**Immune System and its Components** • Historical perspective of Immunology, Innate and Adaptive Immunity, Structure and functions of different classes of immunoglobulins, Hypersensitivity, • Immune system: innate and adaptive immunity, clonal selection, complement system, • Humoral immunity and cell mediated immunity, • Immunoglobulin and T-cell receptor genes: organization of Ig gene loci, molecular mechanism of generation of antibody diversity HLA complex: organization, class I and II HLA molecules, expression of HLA genes	**8**

Suggested Readings:

1. Alberts et al: Molecular Biology of the Cell: Garland (2002).
2. Lodish et al: Molecular Cell Biology: Freeman & Co, USA (2004).
3. Cooper: Cell: A Molecular Approach: ASM Press (2000).
4. Karp: Cell and Molecular Biology: Wiley (2002). Pierce B. Genetics. Freeman (2004).
5. Lewin B. Genes VIII. Pearson (2004).
6. Watson et al. Molecular Biology of the Gene. Pearson (2004).
7. Thomas J. Kindt, Richard A. Goldsby, Barbara A. Osborne, Janis KubyKuby Immunology. W H Freeman (2007).
8. Delves Peter J., Martin Seamus J., Burton Dennis R., Roitt Ivan M. Roitt's Essential Immunology, 13th Edition. Wiley Blackwell (2017).
9. Shetty Nandini Immunology Introductory Textbook. New Age International. (2005)

Course Books published in Hindi must be prescribed by the Universities and Colleges

To study this course, a student must have had the subject biology in class/12th.

Suggested Continuous Evaluation Methods:
House Examination/Test: 10 Marks
Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks
Class performance/Participation: 5 Marks

Further Suggestions: None, At the End of the whole syllabus any remarks/ suggestions: None

Programme/Class: Certificate	**Year: First**	**Semester: First**
Subject: ZOOLOGY		
Course Code: B050102P	**Course Title**	
ZOO102	**Cell Biology & Cytogenetics Lab**	

Course outcomes:

At the completion of the course students will learn Hands-on:

- To use simple and compound microscopes.
- To prepare slides and stain them to see the cell organelles.
- To be familiar with the basic principle of life, how a cell divides leading to the growth of an organism and also reproduces to form new organisms.
- The chromosomal aberrations by preparing karyotypes.
- How chromosomal aberrations are inherited in humans by pedigree analysis in families.
- The antigen-antibody reaction.

Credits: 2		**Core:** Compulsory
Max. Marks: 25+75		**Min. Passing Marks:** as per rules

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P:** 0-0-4

Unit	**Topic**	**Total No. of Lectures (60)**
I	1. To study different cell types such as buccal epithelial cells, neurons, striated muscle cells using Methylene blue. 2. To study the different stages of Mitosis in root tip of onion. 3. To study the different stages of Meiosis in grasshopper testis. 4. To prepare molecular models of nucleotides, amino acids, dipeptides using bead and stick method. 5. To check the permeability of cells using salt solution of different concentrations.	**15**
II	1. To study different mammalian blood cell types using Leishman stain. 2. Determination of ABO Blood group 3. Cell counting and viability test from splenocytes of farm bred animals/cell lines. 4. Enumeration of red blood cells and white blood cells using haemocytometer	**15**
III	1. Study of mutant phenotypes of *Drosophila.* 2. Preparation of polytene chromosomes. 3. Study of sex chromatin (Barr bodies) in buccal smear and hair bud cells (Human). 4. Preparation of human karyotype and study the chromosomal aberrations with respect to number, translocation, deletion etc. from the pictures provided. 5. To prepare family pedigrees.	**15**
IV	**Virtual Labs** 1. https://www.vlab.co.in 2. https://zoologysan.blogspot.com 3. www.vlab.iitb.ac.in/vlab 4. www.onlinelabs.in	**15**

	5. www.powershow.com, 6. https://vlab.amrita.edu **7.** https://sites.dartmouth.edu	

Suggested Readings:

1. Lodish et al: Molecular Cell Biology: Freeman & Co, USA (2004).
2. Alberts et al: Molecular Biology of the Cell: Garland (2002).
3. Cooper: Cell: A Molecular Approach: ASM Press (2000).
4. Karp: Cell and Molecular Biology: Wiley (2002). Pierce B. Genetics. Freeman (2004).
5. Thomas J. Kindt, Richard A. Goldsby, Barbara A. Osborne, Janis KubyKuby Immunology. W H Freeman (2007).
6. Kesar, Saroj and Vashishta N. (2007). Experimental Physiology: Comprehensive Manual. Heritage Publishers, New Delhi

Course Books published in Hindi must be prescribed by the Universities and Colleges

To study this course, a student must have had the subject biology in class/12thThe eligibility for this paper is 10+2 from Arts/ Commerce/ Science.

Suggested Continuous Evaluation Methods:

Total Marks: 25

House Examination/Test: 10 Marks

Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks

Class performance/Participation: 5 Marks

Further Suggestions: None, At the End of the whole syllabus any remarks/ suggestions: None

Programme/Class: Certificate	**Year: First**	**Semester:** Second
Subject: ZOOLOGY		
Course Code: B050201T	**Course Title**	
ZOO103	**Biochemistryand Physiology**	

Course outcomes:

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

- To develop a deep understanding of structure of biomolecules like proteins, lipids and carbohydrates
- How simple molecules together form complex macromolecules.
- To understand the thermodynamics of enzyme catalyzed reactions.
- Mechanisms of energy production at cellular and molecular levels.
- To understand systems biology and various functional components of an organism.
- To explore the complex network of these functional components.
- To comprehend the regulatory mechanisms for maintenance of function in the body

Credits: 4		**Core:** Compulsory
Max. Marks: 25+75		**Min. Passing Marks:** as per rules

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P:**4-0-0

Unit	Topic	Total No. of Lectures (60)
I	**Structure and Function of Biomolecules** • Structure and Biological importance of carbohydrates (Monosaccharides, Disaccharides, Polysaccharides and Glycoconjugates) • Lipids (saturated and unsaturated fatty acids, Tri-acylglycerols, Phospholipids, Glycolipids, Steroids) • Structure, Classification and General properties of α-amino acids; Essential and non-essential α-amino acids, • Levels of organization in proteins; Simple and conjugate proteins	**8**
II	**Enzyme Action and Regulation** • Nomenclature and classification of enzymes; Cofactors; Specificity of enzyme action; • Isozymes; Mechanism of enzyme action; • Enzyme kinetics; Factors affecting rate of enzyme-catalyzed reactions; Derivation of Michaelis-Menten equation, Concept of Km and Vmax, Lineweaver-Burk plot; Enzyme inhibition; • Allosteric enzymes and their kinetics; Regulation of enzyme action	**8**
III	**Metabolism of Carbohydrates and Lipids** • Metabolism of Carbohydrates: glycolysis, citric acid cycle, gluconeogenesis, phosphate pentose pathway Glycogenolysis and Glycogenesis • Lipids --- Biosynthesis of palmitic acid; Ketogenesis, β-oxidation and omega -oxidation of saturated fatty acids with even and odd number of carbon atoms	**8**
IV	**Metabolism of Proteins and Nucleotides** • Catabolism of amino acids: Transamination, Deamination, Urea cycle • Nucleotides and vitamins • Review of mitochondrial respiratory chain, Oxidative	**6**

	phosphorylation, and its regulation	
V	**Digestion and Respiration** • Structural organization and functions of gastrointestinal tract and associated glands • Mechanical and chemical digestion of food; Absorptions of carbohydrates, lipids, proteins, water, minerals and vitamins; • Histology of trachea and lung, • Mechanism of respiration, Pulmonary ventilation; Respiratory volumes and capacities; Transport of oxygen and carbon dioxide in blood,Respiratory pigments, Dissociation curves and the factors influencing it; Control of respiration	**7**
VI	**Circulation and Excretion** • Components of blood and their functions • Haemostasis: Blood clotting system, • Blood groups: Rh factor, ABO and MN • Structure of mammalian heart, Cardiac cycle; Cardiac output and its regulation, Electrocardiogram, Blood pressure and its regulation • Structure of kidney and its functional unit; Mechanism of urine formation	**8**
VII	**Nervous System and Endocrinology** • Structure of neuron, resting membrane potential • Origin of action potential and its propagation across the myelinated and unmyelinated nerve fibers • Types of synapse • Endocrine glands - pineal, pituitary, thyroid, parathyroid, pancreas, adrenal; hormones secreted by them • Classification of hormones; Mechanism of Hormone action	**8**
VIII	**Muscular System** • Histology of different types of muscle, • Ultra structure of skeletal muscle; • Molecular and chemical basis of muscle contraction; • Characteristics of muscle twitch; Motor unit, summation and tetanus	**7**

Suggested Readings:

1. Nelson & Cox: Lehninger's Principles of Biochemistry: McMillan (2000)
2. Zubay*et al:* Principles of Biochemistry: WCB (1995)
3. Voet&Voet: Biochemistry Vols 1 & 2: Wiley (2004)
4. Murray *et al:* Harper's Illustrated Biochemistry: McGraw Hill (2003) Elliott and Elliott:
5. Biochemistry and Molecular Biology: Oxford University Press
6. Guyton, A.C. & Hall, J.E. Textbook of Medical Physiology. XI Edition. Hercourt Asia PTE Ltd. /W.B. Saunders Company. (2006).
7. Tortora, G.J. & Grabowski, S. Principles of Anatomy & Physiology. XI Edition John Wiley & sons (2006).
8. Christopher D. Moyes, Patricia M. Schulte. Principles of Animal Physiology. 3rd Edition, Pearson Education (2016).
9. Hill, Richard W., et al. Animal physiology. Vol. 2. Sunderland, MA: Sinauer Associates, (2004).

10. Chatterjee C C Human Physiology Volume 1 & 2. 11th edition. CBS Publishers (2016).
Course Books published in Hindi must be prescribed by the Universities and Colleges
To study this course, a student must have had the subject biology in class/12th.
Suggested Continuous Evaluation Methods: **House Examination/Test**: 10 Marks **Written Assignment/Presentation/Project / Term Papers/Seminar**: 10 Marks **Class performance/Participation**: 5 Marks
Further Suggestions: None, At the End of the whole syllabus any remarks/ suggestions: None

Programme/Class: Certificate	**Year: First**	**Semester:** Second
Subject: ZOOLOGY		
Course Code: B050201T	**Course Title**	
ZOO104	**Physiological, Biochemical & Hematology Lab**	

Course outcomes:

At the completion of the course students will learn Hands-on:

- Understand the structure of biomolecules like proteins, lipids and carbohydrates Perform basic hematological laboratory testing,
- Distinguish normal and abnormal hematological laboratory findings to predict the diagnosis of hematological disorders and diseases.

Credits: 2		**Core:** Compulsory
Max. Marks: 25+75		**Min. Passing Marks:** as per rules

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P:** 0-0-4

Unit	Topic	Total No. of Lectures (60)
I	1. Estimation of haemoglobin using Sahli's haemoglobinometer 2. Preparation of haemin and haemochromogen crystals 3. Recording of blood pressure using a sphygmomanometer 4. Recording of blood glucose level by using glucometer 5. Preparation of molecular models of amino acids, dipeptides etc.	**15**
II	1. Study of permanent slides of Mammalian skin, Cartilage, Bone, 2. Spinal cord, Nerve cell, Pituitary, Pancreas, Testis, Ovary, Adrenal, Thyroid and Parathyroid 3. Recording of simple muscle twitch with electrical stimulation (or Virtual) 4. Demonstration of the unconditioned reflex action (Deep tendon reflex such as knee jerk reflex)	**15**
III	1. Ninhydrin test for -amino acids. 2. Benedict's test for reducing sugar and iodine test for starch. 3. Test for sugar and acetone in urine. 4. Qualitative tests of functional groups in carbohydrates, proteins and lipids. 5. Paper chromatography of amino acids. 6. Action of salivary amylase under optimum conditions	**15**
IV	**Virtual Labs** 1. https://www.vlab.co.in 2. https://zoologysan.blogspot.com 3. www.vlab.iitb.ac.in/vlab 4. www.onlinelabs.in 5. www.powershow.com 6. https://vlab.amrita.edu 7. https://sites.dartmouth.edu	**15**

Suggested Readings:

Cox, M.M and Nelson, D.L. (2008). Lehninger's Principles of Biochemistry, V Edition, W.H. Freeman and Co., New York.

Berg, J.M., Tymoczko, J.L. and Stryer, L. (2007). Biochemistry, VI Edition, W.H. Freeman and Co., New

York.

1. Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Hercourt Asia PTE Ltd. /W.B. Saunders Company.
2. Tortora,G.J.& Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition John Wiley & sons
3. Victor P. Eroschenko. (2008). diFiore's Atlas of Histology with Functional correlations. XII Edition.LippincottW. & Wilkins.
4. Arey, L.B. (1974). Human Histology. IV Edition. W.B. Saunders.
5. Kesar, Saroj and Vashishta N. (2007). Experimental Physiology: Comprehensive Manual. Heritage Publishers, New Delhi

Course Books published in Hindi must be prescribed by the Universities and Colleges

To study this course, a student must have had the subject biology in class/12thThe eligibility for this paper is 10+2 from Arts/ Commerce/ Science.

Suggested Continuous Evaluation Methods:
Total Marks: 25
House Examination/Test: 10 Marks
Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks
Class performance/Participation: 5 Marks

Further Suggestions: None, At the End of the whole syllabus any remarks/ suggestions: None

Programme/Class: Certificate	**Year: Second**	**Semester:** Third
Subject: ZOOLOGY		
Course Code: B050301T	**Course Title**	
ZOO201	**Molecular Biologyand Bioinstrumentation& Biotechniques**	

Course outcomes:

- The student at the completion of the course will be able to have:
- A detailed and conceptual understanding of molecular processes *viz.* DNA to trait
- A clear understanding of the processes of central dogma *viz.* transcription, translation *etc.* underlying survival and propagation of life at molecular level
- Understanding of how genes are ultimately expressed as proteins which are responsible for the structure and function of all organisms
- Learn how four sequences (3 letter codons) generate the transcripts of life and determine the phenotypes of organisms.
- How genes are regulated differently at different time and place in prokaryotes and eukaryotes
- Understand the basic principles of microscopy, working of different types of microscopes
- Understand the basic techniques of centrifugation and chromatography for studying cells and separation of biomolecules
- Understand the principle of measuring the concentrations of macromolecules in solutions by colorimeter and spectrophotometer and use them in Biochemistry
- Learn about some of the commonly used advance DNA testing methods.

Credits: 4		**Core:** Compulsory
Max. Marks: 25+75		**Min. Passing Marks:** as per rules

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P:**4-0-0

Unit	**Topic**	**Total No. of Lectures (60)**
I	**Process of Transcription** • Fine structure of gene • RNA polymerases • Transcription factors and machinery • Formation of initiation complex • Initiation, elongation and termination of transcription in prokaryotes and eukaryotes	**7**
II	**Process of Translation** • The Genetic code • Ribosome • Factors involved in translation • Aminoacylation of tRNA, tRNA-identity, aminoacyl Trna synthetase • Initiation, elongation and termination of translation in prokaryotes and eukaryotes	**7**
III	**Regulation of Gene Expression I** • Regulation of gene expression in prokaryotes: *lac* and *trp*operons in *E. coli* • Regulation of gene expression in eukaryotes: Role of chromatin in gene expression • Regulation at transcriptional level, Post-transcriptional modifications: Capping, Splicing, Polyadenylation, RNA editing.	**8**
IV	**Regulation of Gene Expression II** • Regulation of gene expression in eukaryotes: • Regulation at translational level, Post- translational	**8**

	modifications: protein folding etc. • Intracellular protein degradation • Gene silencing, RNA interference (RNAi)	
V	**Principle and Types of Microscopes** • Principle of Microscopy and Applications • Types of Microscopes: light microscopy, dark field microscopy, phase-contrast microscopy, • Fluorescence microscopy, confocal microscopy, electron microscopy	**6**
VI	**Centrifugation and Chromatography** • Principle of Centrifugation: • Types of Centrifuges: high speed and ultracentrifuge • Types of rotors: Vertical, Swing-out, Fixed-angle etc. • Principle and Types of Chromatography: paper, thin layer, column---ion-exchange, gel filtration, HPLC, affinity	**8**
VII	**Spectrophotometry and Biochemical Techniques** • Colorimetry and spectrophotometry: Beer-lambert law, absorption spectrum • Biochemical techniques: Measurement of pH, • Preparation of buffers and solutions • Measurement, applications and safety measures of radio-tracer techniques	**8**
VIII	**Molecular Techniques** • Nucleic acid fractionation, detection by electrophoresis, DNA sequencing, Polymerase Chain Reaction (PCR), primer designing, DNA fingerprinting, site directed mutagenesis, RFLP • Molecular cloning, genomic libraries, Gene transfer techniques: electroporation, microinjection • Detection of proteins, PAGE, ELISA, Western blotting, • Hybridoma technology	**8**

Suggested Readings:

1. Lodish et al: Molecular Cell Biology: Freeman & Co, USA (2004).
2. Alberts et al: Molecular Biology of the Cell: Garland (2002).
3. Cooper: Cell: A Molecular Approach: ASM Press (2000).
4. Karp: Cell and Molecular Biology: Wiley (2002).
5. Watson et al. Molecular Biology of the Gene. Pearson (2004).
6. Lewin. Genes VIII. Pearson (2004).
7. Pierce B. Genetics. Freeman (2004).
8. Sambrook *et al* .Molecular Cloning Vols I, II, III. CSHL (2001).
9. Pierce B. Genetics. Freeman (2004).
10. Sambrook *et al* .Molecular Cloning Vols I, II, III. CSHL (2001).
11. Primrose. Molecular Biotechnology. Panima (2001).
12. Clark & Switzer. Experimental Biochemistry. Freeman (2000)
13. Koehler, J. K. Advanced techniques in biological electron microscopy. Springer-Verlag, Berlin (1973)
14. Alberts et al: Molecular Biology of the Cell: Garland (2002).
15. Cooper: Cell: A Molecular Approach: ASM Press (2000).
16. Karp: Cell and Molecular Biology: Wiley (2002).
17. Watson et al. Molecular Biology of the Gene. Pearson (2004).
18. Lewin. Genes VIII. Pearson (2004).

19. Pierce B. Genetics. Freeman (2004).
20. Sambrook *et al* .Molecular Cloning Vols I, II, III. CSHL (2001).
21. Primrose. Molecular Biotechnology. Panima (2001).
22. Clark & Switzer. Experimental Biochemistry. Freeman (2000)
23. Brown, S.B. An introduction to Spectroscopy for biochemists, Academic Press, London (1980)

Course Books published in Hindi must be prescribed by the Universities and Colleges

To study this course, a student must have had the subject biology in class/12th.

Suggested Continuous Evaluation Methods:
House Examination/Test: 10 Marks
Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks
Class performance/Participation: 5 Marks

Further Suggestions: None, At the End of the whole syllabus any remarks/ suggestions: None

Programme/Class: Diploma	**Year:** Second	**Semester:** Third
Subject: ZOOLOGY		
Course Code: B050302P	**Course Title**	
ZOO202	**Bioinstrumentation &Molecular Biology Lab**	

Course outcomes:

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

- Understand the basic principles of microscopy, working of different types of microscopes
- Understand the basic techniques of centrifugation and chromatography for studying cells and separation of biomolecules
- Understand the principle of measuring the concentrations of macromolecules in solutions by colorimeter and spectrophotometer and use them in Biochemistry
- Learn about some of the commonly used advance DNA testing methods.

Credits: 2		**Core:** Compulsory
Max. Marks: 25+75		**Min. Passing Marks:** as per rules

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P:** 0-0-4

Unit	**Topic**	**Total No. of Lectures (60)**
I	1. To study the working principle and Simple, Compound and Binocular microscopes. 2. To study the working principle of various lab equipments such as pH Meter, Electronic balance, vortex mixer, use of glass and micropipettes, Laminar flow, Incubator shaker, Waterbath, Centrifuge, Chromatography apparatus, etc.	**15**
II	1. To prepare solutions and buffers. 2. To learn the working of Colorimeter and Spectrophotometer. 3. Demonstration of differential centrifugation to fractionate different components in a mixture	**15**
III	1. To prepare dilutions of Riboflavin and verify the principle of spectrophotometer. 2. To identify different amino acids in a mixture using paper chromatography. 3. Demonstration of DNA extraction from blood or tissue samples. 4. To estimate amount of DNA using spectrophotometer.	**15**
IV	**Virtual Labs** 1. www.labinapp.com 2. www.uwlax.edu 3. www.labster.com 4. www.onlinelabs.in 5. www.powershow.in 6. https://vlab.amrita.edu 7. info@premiereducationaltechnologyies.com 8. https://li.wsu.edu	**15**

Suggested Readings:

1. Sambrook *et al* .Molecular Cloning Vols I, II, III. CSHL (2001).

2. Primrose. Molecular Biotechnology. Panima (2001). 3. Clark & Switzer. Experimental Biochemistry. Freeman (2000)
Course Books published in Hindi must be prescribed by the Universities and Colleges
This course can be opted as an elective by the students of following subjects: The eligibility for this paper is 10+2 from Arts/Commerce/Science
Suggested Continuous Evaluation Methods: **House Examination/Test**: 10 Marks **Written Assignment/Presentation/Project / Term Papers/Seminar**: 10 Marks **Class performance/Participation**: 5 Marks
Further Suggestions: None, At the End of the whole syllabus any remarks/ suggestions: None

Programme/Class: Diploma	**Year:** Second	**Semester:** Fourth
Subject: ZOOLOGY		
Course Code: B050401T	**Course Title**	
ZOO203	**Gene Technology and Human Welfare**	

Course outcomes:

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

- Understand the principles of genetic engineering, how genes can be cloned in bacteria and the various technologies involved in it.
- Know the applications of biotechnology in various fields like agriculture, industry and human health.
- Know the basics of industrial biotechnology.
- Get introduced to DNA testing and utility of genetic engineering in forensic sciences.
- Get introduced to computers and use of bioinformatics tools.
- This coursewill make them suitably knowledgeable to undertake the computer jobs in the offices inthehospitals,scientificacademies,fundingagenciesinadditiontotheteachinginstitutions.
- **Enable students to get employment in pathology/Hospital.**
- **Take up research in biological sciences.**

Credits: 4		**Core:** Compulsory
Max. Marks: 25+75		**Min. Passing Marks:** as per rules

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P:**4-0-0

Unit	**Topic**	**Total No. of Lectures (60)**
I	**Principles of Gene Manipulation** • Recombinant DNA Technology • Restriction Enzymes, DNA modifying enzymes, Cloning Vectors, Ligation • Gene transfer techniques, Gene therapy • Selection and identification of recombinant cells	**10**
II	**Applications of Genetic Engineering** • Single cell proteins, • Biosensors, Biochips, • Crop and live stock, Improvement, Development of transgenic organisms , • Development of DNA drugs and, vaccines.	**8**
III	**Enzyme Technology** • Microbial culture, • Methods of enzyme production, • Immobilization of enzymes, • Applications	**6**
IV	**DNA Diagnostics** • Genetic analysis of human diseases, detection of known and unknown mutations • DNA fingerprinting • Concept of pharmacogenomics and pharmacogenetics • Personalized medicine—optimizing drug therapy	**6**
V	**Biostatistics I** • Calculations of mean, median, mode, variance, standard • Deviation, • Concepts of coefficient of variation, Skewness, Kurtosis • Elementary idea of probability and application	**8**
VI	**Biostatistics II**	**7**

	• Data summarizing: frequency distribution, graphical,presentation—bar, pie diagram, histogram, • Tests of significance: one and two sample tests, t-test and Chi-square test	
VII	**Basics of Computers** • Basics (CPU, I/O units) and operating systems, • Concept of homepages and websites, World Wide Web, URLs, using search engines	**7**
VIII	**Bioinformatics** • Databases: nucleic acids, genomes, protein sequences, and structures, Bibliography, • Sequence analysis (homology): pairwise and multiple, sequence alignments-BLAST, CLUSTALW, • Phylogenetic analysis	**8**

Suggested Readings:

1. Primrose & Twyman. Principles of Genome Analysis and Genomics. Blackwell (2003).
2. Hartl& Jones. Genetics: principles &Analsysis of Genes & Genomes. Jones & Bartlett (1998).
3. Sambrook *et al* .Molecular Cloning Vols I, II, III. CSHL (2001).
4. Primrose. Molecular Biotechnology. Panima (2001).
5. Clark & Switzer. Experimental Biochemistry. Freeman (2000)
6. Sudbery. Human Molecular Genetics. Prentice-Hall (2002).
7. Wilson. Clinical Genetics-A Short Course, Wiley (2000).
8. Pasternak. An Introduction to Molecular Human Genetics. Fritzgerald (2000).
9. Biostatistical Analysis (Fourth Edition) by Jerrold H. Zarr, Pearson Education Inc., Delhi.
10. Statistical Methods (Eighth Edition) by G. W. Snecdecor and W. G. Cochran, Willey Blackwell
11. Biostatistics (Tenth Edition) by W.W. Daniel and C. L. Cross, Wiley
12. Introductory Biological Statistics (Fourth Edition) by John E. Havel, Raymond E. Hampton and Scott J. Meiners
13. Westhead *et al* Bioinformatics: Instant Notes. Viva Books (2003).

Course Books published in Hindi must be prescribed by the Universities and Colleges

This course can be opted as an elective by the students of following subjects:
The eligibility for this paper is 10+2 with Biology as one of the subject

Suggested Continuous Evaluation Methods:
House Examination/Test: 10 Marks
Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks
Class performance/Participation: 5 Marks

Further Suggestions: None, At the End of the whole syllabus any remarks/ suggestions: None

Programme/Class: Diploma	**Year:** Second	**Semester:** Fourth
Subject: ZOOLOGY		
Course Code: B050402P/R	**Course Title**	
ZOO204	Genetic Engineering Lab, Genetic Counseling& Telemedicine	

Course outcomes:

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

- Understand the principles of genetic engineering with hands-on experiments in mutation detection, testing of infectious diseases like COVID 19.
- Get introduced to DNA testing and utility of genetic engineering in forensic sciences.
- Apply knowledge and awareness of the basic principles and concepts of biology, computer science and mathematics existing software effectively to extract information from large databases and to use
- this information in computer modeling.
- Use bioinformatics tools to find out evolutionary/phylogenetic relationship of organisms using gene sequences.
- Get employment in Hospitals/Diagnostic and forensic labs/Counsel families with genetic disorders.
- **Enable students to take up research in biological sciences.**

Credits: 2		**Core:** Compulsory
Max. Marks: 25+75		**Min. Passing Marks:** as per rules
Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P:** 0-0-4		

Unit	**Topic**	**Total No. of Lectures (60)**
I	1. Measure the pre and post clitellar lengths of earthwormsand calculate mean, median, mode, standard deviation etc. 2. Measure the height and weight of all students in the class and apply statistical measures.	**10**
II	1. To perform bacterial culture and calculate generation time of bacteria. 2. To study Restriction enzyme digestion using teaching kits. 3. To study Polymerase Chain Reaction (PCR) using teaching kits. 4. Demonstration of agarose gel electrophoresis for detection of DNA. 5. Demonstration of Polyacrylamide Gel Electrophoresis (PAGE) for detection of proteins. 6. To calculate molecular weight of unknown DNA and protein fragments from gel pictures.	**20**
III	1. To learn the basics of computer applications 2. To learn sequence analysis using BLAST 3. To learn Multiple sequence alignment usingCLUSTALW 4. To learn about Phylogenetic analysis using theprogramme PHYLIP. 5. To learn how to perform Primer designing for PCR using available softwares etc.	**15**
IV	1. Gel Documentation Systemhttps://youtu.be/WPpt3-FanNE	**15**

	2. Colorimeter- https://youtu.be/v4aK6G0bGuU 3. PCR Part 1- https://youtu.be/CpGX1UFSl4A 4. PCR Part 2- https://youtu.be/6IcHAYPTAEw 5. DNA isolation Part 1-https://youtu.be/QE7Ul0JnY9A 6. DNA isolation part 2-https://youtu.be/-efr_HFeHxM 7. DNA curve- https://youtu.be/ubL8QxTeuG4 8. Spectrophotometer-https://youtu.be/ubL8QxTeuG4 9. Agarose Part 1- https://youtu.be/7gvHPFww--g 10. Agarose part 2- https://youtu.be/j_bOZCHNsSg	

Suggested Readings:

1. Primrose & Twyman. Principles of Genome Analysis and Genomics. Blackwell (2003).
2. Hartl& Jones. Genetics: principles &Analsysis of Genes & Genomes. Jones & Bartlett (1998).
3. Sambrook *et al* .Molecular Cloning Vols I, II, III. CSHL (2001).
4. Primrose. Molecular Biotechnology. Panima (2001).
5. Clark & Switzer. Experimental Biochemistry. Freeman (2000)
6. Sudbery. Human Molecular Genetics. Prentice-Hall (2002).
7. Wilson. Clinical Genetics-A Short Course, Wiley (2000).
8. Pasternak. An Introduction to Molecular Human Genetics. Fritzgerald (2000).
9. Biostatistical Analysis (Fourth Edition) by Jerrold H. Zarr, Pearson Education Inc., Delhi.
10. Statistical Methods (Eighth Edition) by G. W. Snecdecor and W. G. Cochran, Willey Blackwell
11. Biostatistics (Tenth Edition) by W.W. Daniel and C. L. Cross, Wiley
12. Introductory Biological Statistics (Fourth Edition) by John E. Havel, Raymond E. Hampton and Scott J. Meiners
13. Westhead *et al* Bioinformatics: Instant Notes. Viva Books (2003).

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This course can be opted as an elective by the students of following subjects:
The eligibility for this paper is 10+2 with Biology as one of the subject.

Suggested Continuous Evaluation Methods:
House Examination/Test: 10 Marks
Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks
Class performance/Participation: 5 Marks

Further Suggestions: None, At the End of the whole syllabus any remarks/ suggestions: None

Programme/Class: Diploma	**Year: Third**	**Semester: Fifth**
Subject: ZOOLOGY		
Course Code::B050501T	**Course Title**	
ZOO301	**Diversity of Non-Chordates, Parasitology and Economic Zoology**	

Course outcomes:

- The student at the completion of the course will be able to demonstrate comprehensive identification abilities of non-chordate diversity,
- explain structural and functional diversity of non-chordate,
- explain evolutionary relationship amongst non-chordate groups,
- Get employment in different applied sectors,
- Students can start their own business i.e. self employments,
- Enable students to take up research in Biological Science.
- Understandthebiologybehindhost-parasiteinteractions
- Learnaboutepidemiologicalconceptsofparasiticinfectionsofglobalimportance
- Trainedtodiagnose,identifyanddetectsomeimportantparasites
- Learnpathologicalchangesassociatedwithparasiteinfections
- Discusstheroleofvectorsandintermediatehostsinparasitetransmission
- Learn theroleof vertebrateinnateand adaptiveimmune system in controllingparasites
- Get employment in different applied sectors,
- Students can start their own business i.e. self employments,
- Enable students to take up research in Biological Science.

Credits: 4		**Core:** Compulsory
Max. Marks: 25+75		**Min. Passing Marks:** as per rules

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P:**4-0-0

Unit	Topic	Total No. of Lectures (30)
I	**Protozoa to Coelenterate** • Protozoa - *Euglena*, *Monocystis* and *Paramecium* • Porifera - *Sycon* • Coelenterata - *Obelia* and *Aurelia*	**7**
II	**Ctenophora to Nemathelminthes** • Ctenophora - Salient features • Platyhelminthes - *Fasciola* (Liver fluke) and *Taenia* (Tape worm) Nemathelminthes - *Ancylostoma* (Hook worm)	**7**
III	**Annelida to Arthropoda** • Annelida - *Nereis* and *Hirudinaria* (Leech) • Arthropoda - *Palaemon* (Prawn) and *Schistocerca*(Locust)	**7**
IV	**Mollusca to Hemichordata** • Mollusca - *Lamellidens* (Fresh water mussel) and *Pila* • Echinodermata -*Pentaceros* (excluding development)	**8**
V	**Parasitology** • Structure, life cycle, pathogenicity, including diseases, causes symptoms and control of the following parasites of domestic animals and humans: *Trypanosoma, Giardia and Wuchereria*	**8**
VI	**Vectors and pests** • Life cycle and their control of following pests: Gundhi	**8**

	bug, Sugarcane leafhopper, Rodents. Termites and Mosquitoes and their control.	
VII	**Economic Zoology-1** • Animal breeding and culture: Aquaculture, Pisciculture, Poultry	**7**
VIII	**Economic Zoology- 2** • Sericulture, Apiculture, Lac-culture, Vermiculture	**7**

Suggested Readings:

1. Barnes et al (2009). The Invertebrates: A synthesis. Wiley Backwell 17
2. Hunter: Life of Invertebrates (1979, Collier Macmillan)
3. Marshall: Parker & Haswell Text Book of Zoology, Vol. I (7th ed 1972, Macmillan)
4. Moore: An Introduction to the Invertebrates (2001, Cambridge University Press)
5. Brusca and Brusca (2016) Invertebrates. Sinauer
6. Jan Pechenik (2014) Biology of the invertebrates. McGraw Hill
7. Neilsen (2012). Animal Evolution: Interrelationships amongst living Phyla. Oxford
8. Parasitology- Chatterjee
9. Parasitology- Chakraborty
10. Thomos C. Chung. General Parasitology. Hardcourt Brace and Co. Ltd. Asia, New Delhi.
11. Gerard D. Schmidt and Larry S Roberts. Foundations of Parasitology. McGraw Hill.
12. Bisht. D.S., *Apiculture*, ICAR Publication.
13. Singh S., *Beekeeping in India*, Indian council of Agricultural Research, New Delhi.
14. Jhingran. V.G. Fish and fisheries in India.,
15. Khanna. S.S, An introduction to fishes
16. Boyd. C.E. &Tucker.C.S, Pond aquaculture water quality management,
17. Biswas.K.P, Fish and prawn diseases,
18. Pedigo, L.P. (2002). *Entomology and Pest Management*, Prentice Hall.
19. Lee, Earthworm Ecology
20. Stevenson, Biology of Earthworms
21. Destructive and Useful Insects by C. L. Metcalf
22. Sericulture for Rural Development :Hanumappa (1978), Himalaya Publication,
23. Sriculture in India Sarkar, D.C. (1988), CSB, Bangalore.

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This course can be opted as an elective by the students of following subjects:
The eligibility for this paper is 10+2 with Biology as one of the subject.

Suggested Continuous Evaluation Methods:
House Examination/Test: 10 Marks
Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks
Class performance/Participation: 5 Marks

Further Suggestions: None, At the End of the whole syllabus any remarks/ suggestions: None

Programme/Class: Diploma	**Year: Third**	**Semester: Fifth**
Subject: ZOOLOGY		
Course Code::B050502T	**Course Title**	
ZOO302	**Diversity of Chordatesand Comparative Anatomy**	

Course outcomes:

- The student at the completion of the course will be able to demonstrate comprehensive identification abilities of chordate diversity,
- explain structural and functional diversity of chordate,
- explain evolutionary relationship amongst chordate groups,
- Get employment in different applied sectors,
- Students can start their own business i.e. self employments,
- Enable students to take up research in Biological Science.

Credits: 4		**Core:** Compulsory
Max. Marks: 25+75		**Min. Passing Marks:** as per rules

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P:**4-0-0

Unit	Topic	Total No. of Lectures (60)
I	**Origin of Chordates &Hemichordata** • Origin of Chordates. • Classification of Phylum Chordata upto the Order. • Hemichordata: General characteristics, classification and detailed study of *Balanoglossus* (Habit and Habitat, Morphology, Anatomy, Physiology and Development).	**8**
II	**Cephalochordata and Urochordata** • Cephalochordata : General characteristics, classification and detailed study of *Branchiostoma* (*Amphioxus*) (Habit and Habitat, Morphology, Anatomy, Physiology). • Urochordata : General characteristics, classification and detailed study of *Herdmania* (Habit and Habitat, Morphology Anatomy, Physiology and Post Embryonic Development).	**8**
III	**Classification and General Characteristics of Vertebrates** • General characters and Classification of different classes of Pisces and Amphibia up to the order with examples. • Neoteny and Paedogenesis	**6**
IV	**Classification and General Characteristics of Vertebrates** • General characters and Classification of different classes of Reptilia, Aves and Mammalia up to the order with examples. • Poisonous and Non Poisonous Snakes, Biting mechanism of snakes. • Flight Adaptations in Birds • Adaptive Radiations in Eutheria	**8**
V	**Integumentary System** • Structure, functions and derivatives of integument **Skeletal System** • Overview of axial and appendicular skeleton, Jaw	**7**

	suspensorium Visceral arches	
VI	**Digestive System** • Alimentary canal and associated glands **Respiratory System** • Skin, gills, lungs and air sacs; Accessory respiratory organs	**8**
VII	**Circulatory System** • General plan of circulation, evolution of heart and aortic arches **Urinogenital System** • Succession of kidney, Evolution of urinogenital ducts, Types of mammalian uteri	**8**
VIII	**Nervous System** • Comparative account of brain Autonomic nervous system, Spinal cord, Cranial nerves in mammals **Sense Organs** • Classification of receptors Brief account of visual and auditory receptors in man	**7**

Suggested Readings:

1. Harvey et al: The Vertebrate Life (2006)
2. Colbert et al: Colbert's Evolution of the Vertebrates: A history of the backboned animals through time(5th ed 2002,Wiley - Liss)
3. Hildebrand: Analysis of Vertebrate Structure (4th ed 1995, John Wiley)
4. Kenneth V. Kardong (2015) Vertebrates: Comparative Anatomy, Function, Evolution McGraw Hill McFarland et al: Vertebrate Life(1979, Macmillan Publishing)
5. Parker and Haswell: TextBook of Zoology, Vol. II (1978, ELBS)
6. Romer and Parsons: The Vertebrate Body (6th ed 1986, CBS Publishing Japan) Young: The Life of vertebrates (3rd ed 2006, ELBS/Oxford)
7. Weichert C.K and William Presch (1970). Elements of Chordate Anatomy, Tata McGraw Hills

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This course can be opted as an elective by the students of following subjects:
The eligibility for this paper is 10+2 with Biology as one of the subject.

Suggested Continuous Evaluation Methods:
House Examination/Test: 10 Marks
Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks
Class performance/Participation: 5 Marks

Further Suggestions: None, At the End of the whole syllabus any remarks/ suggestions: None

Programme/Class: Diploma	**Year: Third**	**Semester: Fifth**
Subject: ZOOLOGY		
Course Code::B050503P	**Course Title**	
ZOO303	Lab on Virtual Dissection, Anatomy, Economic Zoology and Parasitology	

Course outcomes:

- The student at the completion of the course will be able to demonstrate comprehensive identification abilities of non chordata and chordate diversity,
- explain structural and functional diversity of chordates and non- chordates
- explain evolutionary relationship amongst chordates and non- chordates Generate self employment
- Enable students to take up research in Biological Science.

Credits: 2		**Core:** Compulsory
Max. Marks: 25+75		**Min. Passing Marks:** as per rules

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P:** 0-0-4

Unit	**Topic**	**Total No. of Lectures (60)**
I	1. Study of animal specimens of various animal phyla. 2. To prepare permanent stained slide of septal nephridia of earthworm. 3. To take out the nerve ring of earthworm To take out hastate plate from *Palaemon*	**15**
II	1. Study of animal specimens of various animal phyla 2. Study on use and ethical handling of model organisms(Mice, rats, rabbit and pig). 3. To prepare stained/unstained slide of placoid scales 4. Comparative study of bones of different vertebrates 5. Comparative study of histological slides of different tissues of vertebrates.	**15**
III	1. Permanent Preparation of: *Euglena, Paramecium* 2. Study of prepared slides/ specimens of *Entamoeba Giardia, Leishmania, Trypanosoma, Plasmodium Fasciola, Cotugnia, Taenia, Rallietina, Polystoma Schistosoma, Echinococcus, Enterobius, Ascaris and Ancylostoma*; 3. Permanent Preparation of *Cimex* (bed bug)/ *Pediculus*(Louse), *Haematopinus* (cattle louse), fresh water annelids, arthropods; and soil arthropods, Larval stages of helminths and arthropods 4. Permanent mount of wings, mouth parts and developmental stages of mosquito and house fly 5. Permanent preparation of ticks/ mites, abdominal gills of aquatid insects viz. Chironomus larva, dragonfly and mayfly nymphs, preparation of antenna of housefly Identification of pests. 6. Life history of silkworm, honeybee and lac insect 7. Different types of important edible fishes of India 8. Slides of plant nematodes 9. Study of an aquatic ecosystem, its biotic components and food chain	**15**

	10. Project Report/ model chart making 11. **Dissections** : through multimedia / models *12.* **Cockroach** : Central nervous system 13. ***Wallago*** : Afferent and efferent branchial vessels Cranial nerves, Weberian ossicles	
IV	**Virtual Labs** 1. https://www.vlab.co.in 2. https://zoologysan.blogspot.com 3. www.vlab.iitb.ac.in/vlab 4. https://www.vlab.co.in 5. https://zoologysan.blogspot.com 6. www.vlab.iitb.ac.in/vlabwww.onlinelabs.in 7. www.powershow.comhttps://vlab.amrita.edu 8. https://sites.dartmouth.edu	**15**

Suggested Readings:

1. Harvey et al: The Vertebrate Life (2006)
2. Colbert et al: Colbert's Evolution of the Vertebrates: A history of the backboned animals through time (5th ed 2002,Wiley - Liss)
3. Hildebrand: Analysis of Vertebrate Structure (4th ed 1995, John Wiley)
4. Kenneth V. Kardong (2015) Vertebrates: Comparative Anatomy, Function, Evolution McGraw Hill
5. McFarland et al: Vertebrate Life (1979, Macmillan Publishing)
6. Parker and Haswell: TextBook of Zoology, Vol. II (1978, ELBS)
7. Romer and Parsons: The Vertebrate Body (6th ed 1986, CBS Publishing Japan)
8. Young: The Life of vertebrates (3rd ed 2006, ELBS/Oxford)
9. Barnes et al (2009). The Invertebrates: A synthesis. Wiley Backwell 17
10. Marshall: Parker & Haswell Text Book of Zoology, Vol. I (7th ed 1972, Macmillan
11. Moore: An Introduction to the Invertebrates (2001, Cambridge University Press)
12. Brusca and Brusca (2016) Invertebrates. Sinauer
13. Jan Pechenik (2014) Biology of the invertebrates. McGraw Hill
14. Boradale, L.A. and Potts, E.A. (1961).
15. Invertebrates: A Manual for the use of Students Asia Publishing Home
16. Robert Leo Smith Ecology and field biology Harper and Row publisher
17. Handbook of Practical Sericulture :Ullal, S.R. and Narasimhanna, M.N. (1987), Central Silk Board Publication, Bangalore
18. Prost, P. J. (1962). *Apiculture*. Oxford and IBH, New Delhi
19. Bisht. D.S., *Apiculture*, ICAR Publication
20. Singh S., *Beekeeping in India*, Indian council of Agricultural Research, New Delhi.
21. Ullal S.R. and Narasimhanna, M.N. Handbook of Practical Sericulture: CSB,Bangalore
22. Jolly. M. S. Appropriate Sericultural Techniques; Ed., Director, CSR & TI, Mysore
23. Handbook of Silkworm Rearing: Agriculture and Technical Manual-1, Fuzi Pub. Co.
24. Santanam, B. *et al*, A manual of freshwater aquaculture
25. Boyd. C.E. &Tucker.C.S, Pond aquaculture water quality management
26. Pedigo, L.P. (2002). *Entomology and Pest Management*, Prentice Hall.
27. Ranganathan L.S, Vermicomposting technology- soil health to human health

Course Books published in Hindi must be prescribed by the Universities and Colleges

This course can be opted as an elective by the students of following subjects:

The eligibility for this paper is 10+2 with Biology as one of the subject.
Suggested Continuous Evaluation Methods: **House Examination/Test**: 10 Marks **Written Assignment/Presentation/Project / Term Papers/Seminar**: 10 Marks **Class performance/Participation**: 5 Marks
Further Suggestions: None, At the End of the whole syllabus any remarks/ suggestions: None

Programme/Class: Degree	**Year: Third**	**Semester: Sixth**
Subject: ZOOLOGY		
Course Code::B050601T	**Course Title**	
ZOO304	**Evolutionary and Developmental Biology**	

Course outcomes:

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

- Understand that by biological evolution we mean that many of the organisms that inhabit the earth today are different from those that inhabited it in the past
- Understand that natural selection is one of several processes that can bring about evolution, although it can also promote stability rather than change
- Understand how the single cell formed at fertilization forms an embryo and then a full adult organism
- Integrate genetics, molecular biology, biochemistry, cell biology, anatomy and physiology during embryonic development.
- Understand a variety of interacting processes, which generate an organism's heterogeneous shapes, size, and structural features
- Understand how a cell behaves in response to an autonomous determinant or an external signal, and the scientific reasoning exhibited in experimental life science
- Enable students to take up research in Biological Science.

Credits: 4		**Core:** Compulsory
Max. Marks: 25+75		**Min. Passing Marks:** as per rules

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P:**4-0-0

Unit	Topic	Total No. of Lectures (60)
I	**Theories of Evolution** • Origin of Life • Historical review of evolutionary concept: Lamarckism, Darwinism (Natural, Sexual and Artifical selection) • Modern synthetic theory of evolution • Patterns of evolution (Divergence, Convergence Parallel, Coevolution)	**8**
II	**Population Genetics** • Microevolution and Macroevolution: allele frequencies, genotype frequencies, • Hardy Weinberg equilibrium and conditions for its maintenance • Forces of evolution: mutation, selection, genetic drift	**8**
III	**Direct Evidences of Evolution** • Types of fossils, Incompleteness of fossil record, • Dating of fossils, Phylogeny of horse	**7**
IV	**Species Concept and Extinction** • Biological species concept (Advantages and Limitations); • Modes of speciation(Allopatric, Sympatric) • Mass extinction (Causes, Names of five major extinctions)	**7**
V	**Gamete Fertilization and Early Development** • Gametogenesis, Fertilization • Cleavage pattern • Gastrulation, fate maps • Developmental mechanics of cell specification	**6**

	• Morphogenesis and cell adhesion	
VI	**Developmental Genes** • Genes and development • Molecular basis of development • Differential gene expression	**8**
VII	**Early Vertebrate Development** • Early development of vertebrates (fish, birds & mammals) • Metamorphosis, regeneration and stem cells • Environmental regulation of development	**8**
VIII	**Late Developmental Processes** • The dynamics of organ development • Development of eye, kidney, limb • Metamorphosis: the hormonal reactivation of development in amphibians, insects • Regeneration: salamander limbs, mammalian liver, Hydras • Aging: the biology of senescence	**8**

Suggested Readings:

1. Ridley, M. (2004). *Evolution*. III Edition. Blackwell Publishing
2. Barton, N. H., Briggs, D. E. G., Eisen, J. A., Goldstein, D. B. and Patel, N. H. (2007). *Evolution* Cold Spring, Harbour Laboratory Press
3. Hall, B. K. and Hallgrimsson, B. (2008). *Evolution*. IV Edition. Jones and Bartlett Publishers
4. Campbell, N. A. and Reece J. B. (2011). *Biology*. IX Edition, Pearson, Benjamin, Cummings
5. Douglas, J. Futuyma (1997). *Evolutionary Biology*. Sinauer Associates.
6. Developmental Biology: Michael J. F. Barresi, Scott F. Gilbert, Oxford University Press. (2019).
7. Developmental Biology: T. Subramaniam, (Reprint), Narosa Publishing House Pvt. Ltd., New Delhi (2013).
8. Essential Developmental Biology: Jonathan M. W. Slack, (3rd ed.), Wiley-Blackwell. (2012).
9. Developmental Biology: From a Cell to an Organism (Genetics & Evolution) eBook: Russ Hodge, Infobase Publishing. (2009).
10. Current Topics in Developmental Biology: Roger A. Pedersen, Gerald P. Schatten, Elsevier. (1998).
11. Developmental biology: Werner A. Müller, Springer Science & Business Media. (2012).
12. Human Embryology and Developmental Biology E-Book: Bruce M. Carlson, Elsevier Health Sciences. (2018).
13. Developmental Biology: Michael J. F. Barresi, Scott F. Gilbert, Oxford University Press. (2019).

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This course can be opted as an elective by the students of following subjects:
The eligibility for this paper is 10+2 with Biology as one of the subject.

Suggested Continuous Evaluation Methods:
House Examination/Test: 10 Marks
Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks
Class performance/Participation: 5 Marks

Further Suggestions: None, At the End of the whole syllabus any remarks/ suggestions: None

Programme/Class: Degree	**Year: Third**	**Semester: Sixth**
Subject: ZOOLOGY		
Course Code::B050602T	**Course Title**	
ZOO305	**Ecology, Ethology, Environmental Biology and Wildlife**	

Course outcomes:

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

- Complexities and interconnectedness of various environmental levels and their functioning
- Global environmental issues, their causes, consequences and amelioration
- To understand and identify behaviors in a variety of taxa.
- The proximate and ultimate causes of various behaviors
- About the molecules, cells, and systems of biological timing systems
- Conceptualizing how species profitably inhabit in the temporal environment and space out their activities at different times of the day and seasons
- To interpret the cause and effect of lifestyle disorders contributing to public understanding of biological timing.
- To understand the importance of wildlife conservation

Credits: 4		**Core:** Compulsory
Max. Marks: 25+75		**Min. Passing Marks:** as per rules

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P:**4-0-0

Unit	**Topic**	**Total No. of Lectures (30)**
I	**Introduction to Ecology** • History of ecology, Autecology and synecology Levels of organization, Laws of limiting factors Study of physical factors	**4**
II	**Organization of Ecosystem** • Levels of organization, Laws of limiting factors Study of physical factors, • Population: Density, natality, mortality, life tables, fecundity tables, survivorship curves, age ratio, sex ratio, dispersal and dispersion, Exponential and logistic growth, • Types of ecosystems with one example in detail, Food chain: Detritus and grazing food chains, , Food web, Energy flow through the ecosystem • Ecological pyramids and Ecological efficiencies, Nutrient and biogeochemical cycle with one example of Carbon cycle	**12**
III	**Community Ecology** • Community characteristics: species richness, dominance diversity, abundance, Ecological succession with one example	**7**
IV	**Environmental Hazards** • Sources of Environmental hazards • Climate changes • Greenhouse gases and global warming • Acid rain, Ozone layer destruction	**7**
V	**Effects of Climate Change** • Effect of climate change on public health	**7**

	• Sources of waste, types and characteristics Sewage disposal and its management, Solid waste disposal, Biomedical waste handling and disposal, • Nuclear waste handling and disposal, Waste from thermal power plants, • Case histories on Bhopal gas tragedy, Chernobyl disaster, Seveso disaster and Three Mile Island accident and their aftermath.	
VI	**Behavioural Ecology and Chronobiology** • Origin and history of Ethology • Instinct vs. Learnt Behaviour • Associative learning, classical and operant conditioning, Habituation, Imprinting • Circadian rhythms; Tidal rhythms and Lunar rhythms • Chronomedicine	**7**
VII	**Introduction to Wild Life** • Values of wild life - positive and negative; • Conservation ethics; • Importance of conservation; • Causes of depletion; • World conservation strategies.	**8**
VIII	**Protected areas** • National parks & sanctuaries, • Community reserve; • Important features of protected areas in India; • Tiger conservation - Tiger reserves in India; • Management challenges in Tiger reserve	**8**

Suggested Readings:

1. Ecology: Theories & Applications. Peter D. Stiling, 2001, Prentice Hall
2. Ecological Modeling. 2008. Grant, W.E. and Swannack, T.M., Blackwell
3. Ecology: The Experimental Analysis of Distribution and Abundance. Charles J. Krebs, 2016, Pearson Education Inc. Elements of Ecology. T.M. Smith and R.L. Smith, 2014, Pearson Education Inc.
4. Environmental Chemistry. 2010. Stanley and Manahan, E. CRC, Taylor & Francis. London
5. Environment. Raven, Berg, Johnson, 1993, Saunders College Publishing
6. Essentials of Ecology. G.T. Miller, Jr. & Scott. E. Spoolman, 2014, Brooks/Cole, Cengage Learning
7. Freshwater Ecology: A Scientific Introduction. 2004. Closs, G., Downes, B. and Boulton, A. Wiley Blackwell publisher, Oxford
8. Fundamental Processes in Ecology: An Earth system Approach. 2007. Wilkinson, D.M. Oxford University Press, UK.
9. Fundamentals of Ecology. E.P. Odum& Gray. W. Barrett, 1971, Saunders
10. Caughley, G., and Sinclair, A.R.E. (1994). Wildlife Ecology and Management. Blackwell Science
11. Woodroffe R., Thirgood, S. and Rabinowitz, A. (2005). People and Wildlife, Conflict or Co-existence? Cambridge University
12. Bookhout, T.A. (1996). Research and Management Techniques for Wildlife and Habitats, 5 th edition. The Wildlife Society, Allen Press.

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This course can be opted as an elective by the students of following subjects:
The eligibility for this paper is 10+2 with Biology as one of the subject.

Suggested Continuous Evaluation Methods: **House Examination/Test**: 10 Marks **Written Assignment/Presentation/Project / Term Papers/Seminar**: 10 Marks **Class performance/Participation**: 5 Marks
Further Suggestions: None, At the End of the whole syllabus any remarks/ suggestions: None

Programme/Class: Degree	**Year: Third**	**Semester: Sixth**
Subject: ZOOLOGY		
Course Code::B050603P	**Course Title**	
ZOO306	**Lab on Ecology, Environmental Science, Behavioral Ecology & wildlife**	

Course outcomes:

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

- To understand the basic concepts, importance, status and interaction between organisms and environment.
- Get employment in forest services, sanctuaries, conservatories etc.
- Enable students to take up research in wildlife.

Credits: 2		**Core:** Compulsory
Max. Marks: 25+75		**Min. Passing Marks:** as per rules

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P:** 0-0-4

Unit	**Topic**	**Total No. of Lectures (60)**
I	1. Study of life tables and plotting of survivorship curves of different types from the hypothetical/real data provided. 2. Study of population dynamics through numerical problems. 3. Study of circadian functions in humans (daily eating, sleep and temperature patterns).	**26**
II	1. Report on a visit to National Park/Biodiversity Park/Wild life sanctuary	**4**
III	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, pellet groups, nest antlers etc. 4. Demonstration of different field techniques for flora and fauna	**15**
IV	**Virtual Labs** 1. https://www.vlab.co.in 2. https://zoologysan.blogspot.com 3. www.vlab.iitb.ac.in/vlab	**15**

Suggested Readings:

1. Ecology: The Experimental Analysis of Distribution and Abundance. Charles J. Krebs, 2016, Pearson Education Inc
2. Fundamentals of Ecology. E.P. Odum& Gray. W. Barrett, 1971, Saunders
3. Robert Leo Smith Ecology and field biology Harper and Row publisher
4. Bookhout, T.A. (1996). Research and Management Techniques for Wildlife and Habitats 5th edition. The Wildlife Society, Allen Press.
5. Methods and Practice in biodiversity Conservation by David Hawks worth, Springer publication

Course Books published in Hindi must be prescribed by the Universities and Colleges

This course can be opted as an elective by the students of following subjects:

The eligibility for this paper is 10+2 FROM Arts Commerce and Science
Suggested Continuous Evaluation Methods: **House Examination/Test**: 10 Marks **Written Assignment/Presentation/Project / Term Papers/Seminar**: 10 Marks **Class performance/Participation**: 5 Marks
Further Suggestions: None At the End of the whole syllabus any remarks/ suggestions: None