M.SC. ZOOLOGY

Scheme A2: Semester 1st

Course Code	Course Title	Course ID	L	T	P	L	T	P	Total Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
Core Course(s)														
CC-A01	Diversity of Invertebrates	261/ZOO/CC101	03	00	02	03	00	01	04	25	50	05	20	**100**
CC-A02	Molecular Biology	261/ZOO/CC102	03	00	02	03	00	01	04	25	50	05	20	**100**
CC-A03	Cell Biology	261/ZOO/CC103	03	00	02	03	00	01	04	25	50	05	20	**100**
Discipline Specific Elective Courses (Select any one course from the following)														
DSE-01	Bio-statistical methods and Data Analysis OR Genetic Engineering	261/ZOO/DS101	02	00	02	02	00	01	03	15	35	05	20	**75**
Multidisciplinary Course(s)														
MDC-01	One from the Pool	261/ZOO/MD101	02	00	02	02	00	01	03	15	35	05	20	**75**
Ability Enhancement Course(s)														
AEC-01	One from the Pool		02	00	00	02	00	00	02	00	50	00	00	**50**
Value-added Course(s)														
VAC-01	One from the Pool	261/ZOO/VA101	02	00	00	02	00	00	02	15	35	00	00	**50**
Total Credits									**22**					**550**



Scheme A2: Semester 2nd

Course Code	Course Title	Course ID	L	T	P	L	T	P	Total Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
Core Course(s)														
CC-A04	Diversity of Vertebrates	261/ZOO/CC204	03	00	02	03	00	01	04	25	50	05	20	**100**
CC-A05	Biochemistry & Biotechniques	261/ZOO/CC205	03	00	02	03	00	01	04	25	50	05	20	**100**
CC-A06	Molecular Cytogenetics	261/ZOO/CC206	03	00	02	03	00	01	04	25	50	05	20	**100**
Discipline Specific Elective Courses (Select any one course from the following)														
DSE-02	Bioinformatics OR Molecular Endocrinology & Neural Physiology	261/ZOO/DS202	02	00	02	02	00	01	03	15	35	05	20	**75**
Multidisciplinary Course(s)														
MDC-02	One from the Pool	261/ZOO/MD202	02	00	02	02	00	01	03	15	35	05	20	**75**
Ability Enhancement Course(s)														
AEC-02	One from the Pool		02	00	00	02	00	00	02	00	50	00	00	**50**
Skill Enhancement Course(s)														
SEC-01	One from the Pool	261/ZOO/SE201	02	00	00	02	00	00	02	15	35	00	00	**50**
Total Credits									**22**					**550**

Note: *internship or field training or project of 4-6 weeks during summer vacation @ 4 credits.*

Scheme A2: Semester 3rd

Course Code	Course Title	Course ID	L (Hrs)	T (Hrs)	P (Hrs)	L Credits	T Credits	P Credits	Total Credits	MARKS TI	MARKS TE	MARKS PI	MARKS PE	MARKS Total
Core Course(s)														
CC-A07	Animal Physiology	261/ZOO/CC307	03	00	02	03	00	01	04	25	50	05	20	**100**
CC-A08	Developmental Biology	261/ZOO/CC308	03	00	02	03	00	01	04	25	50	05	20	**100**
CC-A09	Immunology	261/ZOO/CC309	03	00	02	03	00	01	04	25	50	05	20	**100**
Discipline Specific Elective Courses (Select any one course from the following)														
DSE-03	Animal Behavior and Wild-Life Conservation OR Fish, Fisheries and Aquaculture	261/ZOO/DS303	02	00	02	02	00	01	03	15	35	05	20	**75**
Multidisciplinary Course(s)														
MDC-03	One from the Pool	261/ZOO/MD303	02	00	02	02	00	01	03	15	35	05	20	**75**
Skill Enhancement Course(s)														
SEC-02	One from the Pool	261/ZOO/SE302	02	00	00	02	00	00	02	15	35	00	00	**50**
Value added Course(s)														
VAC-02	One from the Pool	261/ZOO/VA302	02	00	00	02	00	00	02	15	35	00	00	**50**
Seminars														
Seminar	Seminar	261/ZOO/SEMINAR301	02	00	00	02	00	00	02	00	50	00	00	**50**
Internship/Field Activity#														
INTRSP	Industrial Visit/ Field Work and Report Writing	261/ZOO/INTRSP301	02	00	00	02	00	00	02	00	50	00	00	**50**
Total Credits									**26**					**650**

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

Scheme A2: Semester 4th

Course Code	Course Title	Course ID	L	T	P	L	T	P	Total Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
Ability Enhancement Course(s)														
AEC-03	Manuscript Writing**/ Pool	261/ZOO/AE403	02	00	00	02	00	00	02	15	35	00	00	**50**
Dissertation/Project Work														
Dissertation	Industrial Training/Research Project/ Dissertation	261/ZOO/DISSERTATION401	0	0	40	0	0	20	20	00	00	100	400	**500**
Total Credits									**22**					**550**



ZOOLOGY: SEMESTER-I								
Course Code	**Course ID**	**Course Title**	**Credit**	**Contact Hours/Week**	**Internal Assessment marks**	**End Term Marks**	**Max. Marks**	**Exam Duration**
CC-A01	261/ZOO/CC101	**Diversity of Invertebrates**	**3**	**3**	**25**	**50**	**75**	**03 hrs.**
		Practical	**1**	**2**	**5**	**20**	**25**	**02 hrs.**

Course Learning Outcomes (CLO)

1. The study of invertebrates reveals progressive evolutionary history of organisms.
2. Students will acquire a clear understanding about organization of minor phyla.
3. Students will be able to understand detailed structure of diverse life forms.
4. Will have detailed understanding of adaptations and significance of Invertebrates.

Instructions for Paper-Setter

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

UNIT	TOPICS	CONTACT HOURS
I	Introduction to invertebrates with their general characters and classification up to order Level, difference between invertebrate and non-chordates, diversity of invertebrates, major and minor phyla of invertebrates. Basic concept of lower and higher invertebrates. Phylogeny and characteristics of invertebrates, classification criteria of animals including, coelom, body plan, grade of organization, germ layers, segmentation, symmetry, blastopores and physiological systems. Concept, significance and general characters of minor phyla	12
II	Locomotion: Flagella and ciliary movement in Protozoa, Hydrostatic movement in coelenterates, Annelida and Echinodermata, Nutrition and Digestion: Pattens of feeding and digestion in lower metazoan, Filter feeding in Polychaeta Mollusca and Echinodermata, Respiration: Respiratory pigments and mechanism of respiration. Organs of respiration Gills, lungs and trachea	11
III	Excretion system: Organs of excretion: coelom, coelomoducts, Nephridia and Malpighian tubules, Mechanism of excretion, Excretion and osmoregulation Nervous system, Primitive nervous system: Coelenterata and Echinodermata, Advanced nervous system: Annelida, Arthropoda (Crustacea and Insecta) and Mollusca (Cephalopoda), Trends in neural evolution. Mode of reproduction	11
IV	Invertebrate larvae, Larval forms of free-living invertebrates, Strategies and Evolutionary, significance of larval forms, Conservation and economic importance of invertebrates including minor phyla.	11
Practical	1. Live demonstration of Amoeboidal movements, conjugation in paramecium and flagellar movements in euglena. 2. Slides and Museum specimens: 3. PROTOZOA: *Gregarina*, *Monocystis*, *Ceratium*, *Euplotes*, *Didinium, Noctiluca,Radiolaria, Stentor, Opalina*. 4. PORIFERA: Sectional view of Sycon (T.S., L.S.), *Grantia* (T.S.) *5.* CNIDARIA: *Obelia* polyp and Medusa, *Pennaria,* 6. ANNELIDA: *Ozobranchus, Glossiphonia, Eunice, Chloea Flava, Polynoe,Terebella,Eurythoe*. 7. ARTHROPODA: *Cyclops, Daphnia, Chelifer*, section of *Peripatus, Balanus,Lepas,Palinurus, Uca, Pyna, Hippa, Gongylus, Bellostoma, Limulus, Squilla, Eupagurus*. *8.* MOLLUSCA: Museum specimens of *Dolabella, Pteria, Nertie, Sanguinolaria, Chicoreus, Ficus, Lambis, Tridacna, Onchidium, Olcia, Murex, Turritella, Bulla, Cardium, Area.* *9.* ECHINODERMATA: Museum specimen of *Linckia, Echinodiscus, Holothuria, Antedon.* *10.* Study of Slides of *Bugula, Plumatella, Cristatella, Pectinatella* 11. Study of mouth parts of different insects. *12.* Mounting: Trachea, Crustacean Larva, *Cyclops, Nauplius, Daphnia, Zoea, Mysis, Cercaria.* 13. Demonstration of Dissections via video lectures: Loligo/Sepia, grass-hopper, Prawn, Cockroach, Earthworm to expose various systems.	30

Learning Resources

1. Hyman, L.H. The invertebrates, Vol. I. Protozoa through Ctenophora, McGraw Hill Co.,New York.
2. Barrington, E.J.W. Invertebrate structure and function. Thomas Nelson and Sons Ltr J.London.
3. Jagerstein, G. Evolution of Metazoan life cycle, Academic Press, New York & London.
4. Hyman, L.H. The Invertebrates. Vol.2. McGraw Hill Co., New York.
5. Hyman, L.H. The Invertebrates. Vol.8. McGraw Hill. Co., New York.
6. Barnes, R.D. Invertebrate Zoology, IIIrd edition. W.B. Saundrs Co., Philadelphia.
7. Russel-Hunter, W.D. A Biology of higher invertebrates, the Macmillin Co. Ltd. London.
8. Hyman, L.H. the Invertebrates smaller coelomate groups, Vol. V. McGraw Hill Co., NewYork
9. Read, C.P. Animal Parasitism. Prentice Hall Inc., New Jersey.
10. Sedgwick, A.A. Student text book of Zoology. Vol. I, II and III Central Book Depot,Allahabad
11. Parker, T.J., Haswell, W.A. Text book of Zoology, McMillan Co., London.



ZOOLOGY: SEMESTER-I								
Course Code	**Course ID**	**Course Title**	**Credit**	**Contact Hours/Week**	**Internal Assessment marks**	**End Term Marks**	**Max. Marks**	**Exam Duration**
CC-A02	**261/ZOO/CC102**	**Molecular Biology**	**3**	**3**	**25**	**50**	**75**	**3 hrs.**
		Practical	**1**	**2**	**5**	**20**	**25**	**2 hrs.**

Course Learning Outcomes (CLO)

1. Students will know about DNA replication and DNA repair mechanisms
2. Students will come to know about the process of protein sorting and its mechanisms
3. Students will get the knowledge about the genes and the proteins associated with Cancer i.e. oncogenes and tumor suppressor proteins

Instructions for Paper-Setter

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

UNIT	TOPICS	CONTACT HOURS
I	DNA Replication: Mechanism of DNA replication in Prokaryotic and eukaryotic cells. Enzymes and accessory proteins involved in DNA replication and DNA repair. Transcription: Prokaryotic & Eukaryotic transcription, RNA polymerase, General and specific transcription factors, Transcriptional and post-transcriptional gene silencing, Modifications in RNA: 5'- Cap formation, Transcription termination, 3'-end processing and polyadenylation, Splicing, Editing, Nuclear export of mRNA & its stability.	12
II	Translation: Prokaryotic and eukaryotic translation, Regulation of translation, co- and post translational modifications of proteins. Protein Localization: Synthesis of secretory and membrane protein & their import into nucleus, mitochondria, and peroxisomes, Receptor mediated endocytosis, Oncogenes and Tumor Suppressor Genes: Viral and cellular oncogenes, Structure, Function and mechanism of action of pRB and p53 tumor suppressor proteins	11
III	Antisense and Ribozyme Technology: Molecular mechanism of antisense molecules, inhibition of splicing, polyadenylation and translation, disruption of RNA structure and capping, Biochemistry of ribozyme; hammer head & their designing strategies, hairpin and other ribozymes. Applications of Antisense and ribozyme technologies. Homologous Recombination: Holliday junction, gene targeting, gene disruption, and' Cre/Lox recombination, RecA and other recombinases Molecular Mapping of Genome: Genetic and physical maps & their applications.	11
IV	Molecular markers in genome analysis: RFLP, RAPD and AFLP analysis, Molecular markers & their applications viz., forensic, disease prognosis, genetic counseling, Pedigree, animal trafficking and poaching; Germplasm maintenance, taxonomy and bio-diversity Genome Sequencing: Genome sizes, organelle genomes, Genomic libraries, YAC, BAC libraries, Strategies for sequencing genome, Packaging, transfection and recovery of clones, Application of Sequencing, sequence information for identification of defective genes.	11
Practical	1. Isolation of Genomic DNA. 2. Isolation of RNA. 3. Quantification of RNA/DNA 4. Restriction digestion of DNA. 5. Ligation of DNA fragments. 6. Molecular weight analysis using agarose gel electrophoresis. 7. Isolation of plasmid DNA. 8. Western blotting. 9. Southern blotting. 10. Preparation of competent cell.	30

Learning Resources
1. Molecular Biology of the Gene, J.D. Watson, N.H. Hopkins, J.W. Roberts, J.A. Steitzand A.M. Weiner. The Benjamin/Cummings Pub. Co., Inc., California. 2. Molecular Cell Biology, J. Darnell, H. Lodish and D. Baltimore Scientific American Books, Inc., USA. 3. Molecular Biology of the Cell, B. Alberts, D. Bray, J. Lewis, M. Raff, K. Roberts and J.D. Watson. Garland Publishing Inc., New York. 3. Gene VI, Benjamin Lewin, Oxford University Press, U.K. 4. Molecular Biology and Biotechnology. A comprehensive desk reference, R.A. Meyers(Ed.), VCH Publishers, Inc., New York. 5. Molecular Cloning: a Laboratory Manual, J. Sambrook, E.F. Fritsch and T. Maniatis, 6. Cold Spring Harbor Laboratory Press, New York. 7. Introduction to Practical Molecular Biology, P.D. Dabre, John Wiley & Sons Ltd., New York. 8. Molecular Biology LabFax, T.A. Brown (Ed.), Bios Scientific Publishers Ltd., Oxford



ZOOLOGY: SEMESTER-I								
Course Code	**Course ID**	**Course Title**	**Credit**	**Contact Hours/Week**	**Internal Assessment marks**	**End Term Marks**	**Max. Marks**	**Exam Duration**
CC-A03	**261/ZOO/CC103**	**Cell Biology**	**3**	**3**	**25**	**50**	**75**	**3 hrs.**
		Practical	**1**	**2**	**5**	**20**	**25**	**2 hrs.**

Course Learning Outcomes (CLO)

1. This core course will make students able to understand how the cell functions as a unit of life.
2. Through this course, students will be able to appreciate the importance of various cell function and structures in the evolution of multicellular organisms.
3. The studies will make the students reveal elegance, dynamics and economy in the living cell and a gratifying unity in the principles by which a cell functions.
4. The students will know about the basic cellular and molecular approaches for cancer development and treatment.

Instructions for Paper-Setter

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

UNIT	TOPICS	CONTACT HOURS
I	Bio-membranes: Molecular composition and arrangement, functional consequences, membrane transportation; diffusion, active transport and pumps, uniports, symports and antiport, Donnan equilibrium; ion movements and cell function, Maintenance of cellular pH; Receptor mediated endocytosis, The Extra Cellular Matrix Cell-cell interactions: adhesion junctions, tight junctions, gap junctions, plasmodesmata Ca^{++} dependent and Ca^{++} independent Homophilic cell-cell adhesion	12
II	Cytoskeleton and cell movement: Structure and organization of actin filaments, Actin, myosin and cellular movements, Structure and dynamic organizations of microtubules, Intermediate filaments, Cilia and flagella, Cell matrix adhesion, Integrins, Collagen, Non-collagen components, Protein sorting and transport, Protein uptake into the ER, Membrane proteins and Golgi sorting, Mechanism of vesicular transport, Lysosomes, Molecular mechanism of secretory pathway	11
III	Cell cycle: The eukaryotic cell cycle, Regulators of cell cycle progression, the events of M phase, Meiosis and fertilization, Genome organization, Chromosomal organization of genes and noncoding DNA, Mobile DNA, Pathways of intracellular signal transduction, Signaling networks	11
IV	Cell death and cell renewal: Apoptosis, Stem cells and the maintenance of adult tissues, Embryonic stem cells and therapeutic cloning, Biology of Cancer, Oncogenes, Tumor suppressor genes, Molecular approaches to cancer treatment, Biology of Ageing	11
Practical	1. Preparation of mitotic and meiotic chromosomes. 2. Calculation of morphometric data and preparations of ideogram. 3. Preparation of karyotype from micrograph. 4. Study of permanent slides of meiosis 5. Study of permanent slides of mitosis. 6. Study of permanent slides of different types of cancer and their stages 7. Measurement of different types of cells by micrometry. 8. Study of cell membrane permeability using plant/animal cells. 9. Detection of cellular components using histochemical staining.	30

Learning Resources

1. Molecular Cell, Biology, J. Darnell, H. Lodish and D. Baltimore Scientific American Book, Inc., USA.
2. Molecular Biology of the Cell, B. Alberts, D. Bray, J. Lewis, M. Raff, K. Roberts and J.D. Watson. Garland Publishing Inc., New York.
3. The Cell A molecular approach by Geoffrey M. Cooper, Oxford University press
4. Essential cell Biology 5th edition, by Albert, Hopkin, Johnson, and Walter, WW Norton & Co
5. Karp's Cell & Molecular Biology, 9th Edition, by Gerald Carp, Janet Iwasa, Wallace Marshall, John willey & sons., 2020



ZOOLOGY: SEMESTER-I								
Course Code	**Course ID**	**Course Title**	**Credit**	**Contact Hours/Week**	**Internal Assessment marks**	**End Term Marks**	**Max. Marks**	**Exam Duration**
DSE-01	261/ZOO/DS-101	**Bio-statistical methods and Data Analysis**	**2**	**2**	**15**	**35**	**50**	**3 hrs.**
		Practical	**1**	**2**	**5**	**20**	**25**	**2 hrs.**

Course Learning Outcomes (CLO)

1. This paper will help in understanding the students about a set of observations and then designing an experiment.
2. Students will be able to acquire, analyze and understand the significance of data.

Instructions for Paper-Setter

1. Seven questions will be set in all.
2. Question No. 1, which will be short answer type (14 marks), covering the entire syllabus, will be compulsory.
3. The remaining six questions will be set unit wise selecting two questions from each Unit I to III.
4. The candidate will be required to attempt question No. 1 and three more questions selecting one question from each unit.

UNIT	TOPICS	CONTACT HOURS
I	Data Analytics: Introduction, types, characteristics and advantages of data analytics. Descriptive statistical techniques: Central tendency, Dispersion, Skewness and Kurtosis. Correlation and Regression: Simple, Partial and Multiple.	10
II	Probability Theory: Concept and Approaches, Application of Additive and Multiplication Laws, Bay's Theorem, Mathematical Expectations. Probability Distribution: Binomial, Poisson, Normal.	10
III	Hypothesis Testing. Parametric tests: t-test and Analysis of Variance – one way classification, two-way classification. Chi-Square test & its application.	10
Practical	1. Descriptive statistics: Systemic tabular summarization of data (before analysis), 2. To study measures of central tendency 3. To study measures of dispersion (using calculators). 4. Mean, Standard Deviation, proportion. 5. Chi Square Test 6. T-Test 7. Co-relation and Regression 8. Analysis of Variance (One way and two ways).	30

Learning Resources

1. Daniel, Wayne W. (2007) Biostatistics: A Foundation for Analysis in Health Sciences 10th Edition, Wiley Series.
2. Pagano, Marcello and Gauvreau, Kimberlee (2000) Principles of Biostatistics, 2nd Edition, CRC Press
3. Chap T. Le, Introductory Biostatistics (2017), Wiley India Pvt Ltd.
4. P.N. Arora and P. K. Malhan, Biostatistics, Himalaya Publishing House
5. B. K. Mahajan, Methods in Biostatistics: For Medical Students and Research Workers, JPB



ZOOLOGY: SEMESTER-I								
Course Code	**Course ID**	**Course Title**	**Credit**	**Contact Hours/Week**	**Internal Assessment marks**	**End Term Marks**	**Max. Marks**	**Exam Duration**
DSE-101	261/ZOO/DS101	**Genetic Engineering**	**2**	**2**	**15**	**35**	**50**	**3 hrs.**
		Practical	**1**	**2**	**05**	**20**	**25**	**2 hrs.**

Course Learning Outcomes (CLO)

1. The student should be able to design and comprehend experimental strategies for alteration of genes and gene products in variety of organisms.
2. CO2 Students could use various approaches to conduct genetic engineering and their applications in biological research as well as in biotechnology industries.
3. This paper deals with various scopes in genetic engineering along with molecular tools.
4. The students will gain the knowledge about the gene tagging and its role.

Instructions for Paper-Setter

1. Seven questions will be set in all.
2. Question No. 1, which will be short answer type (14marks) covering the entire syllabus, will be compulsory.
3. The remaining six questions will be set unit wise selecting two questions from each Unit I to III.
4. The candidate will be required to attempt question No. 1 and three more questions selecting one question from each unit.

UNIT	TOPICS	CONTACT HOURS
I	Scope in Genetic Engineering. Isolation of enzymes, DNA sequencing, synthesis and mutation, detection and separation, cloning, gene expression. Cloning and patenting of life forms. Molecular Tools and Their Applications, Restriction enzymes, modification enzymes, DNA and RNA markers.	10
II	Nucleic Acid Purification, Yield Analysis, Amplification and its Applications, Gene Cloning Vectors, Restriction Mapping of DNA Fragments and Map Construction, Nucleic Acid Sequencing, cDNA Synthesis and cloning. Alternative Strategies of Gene Cloning. Transgenic and gene knockout technologies.	10
III	Microarray, Site-directed Mutagenesis and Protein Engineering. DNA transfection, Northern blot, Primer extension, Reporter assays. Recombinant proteins: Purification and folding, characterization and stabilization. Phage Display, T-DNA and Transposon Tagging. Gene tagging and its role	10
Practical	1. Bacterial culture and antibiotic selection Medias. 2. Preparation of competent cells. 3. Isolation of plasmid DNA. 4. Construction of restriction map of plasmid DNA. 5. Preparation of single stranded DNA template. 6. DNA sequencing 7. Gene expression in E. coli and analysis of gene product PCR 8. Transformation of DNA in E.Coli.	30

Learning Resources

1. Gene cloning and DNA analysis – An Introduction (2006) 5th edition, T.A Brown, Blackwell publisher.
2. Essential genes (2006), Benzamin Lewin, Pearson education international.
3. Genome-3 (2007) T.A Brown. Garland science, Taylor & Francis, NewYork.
4. Principles of gene manipulation and Genomics (2006) 7th edition, S.B Primose and R.M Twyman, Blackwell publishing.
5. Principles of Genetic Engineering (2009), Mousumi Debnath, pointer publisher, Jaipur.
6. Molecular Biotechnology-Principles and Applications of Recombinant DNA (2003) 3rd edition, Bernard R Glick and Jack J pasternak. ASM press, Washington.
7. Human Molecular Genetics (2004) 3rd edition, Tom Strachan & Andrew P Read, Garland science.
8. Molecular Biology of Gene (2008) 6th edition, Watson, Baker,Bell. Gann,Levine and Losick, Pearson education Inc.
9. Biotechnology-Applying the genetic Revolution (2009), Clark and Pazdernik, Academic Press
10. Molecular Cloning : A Laboratory Manual (2000), J. sambrook, E.F. Fritsch and T.Maniatis, Cold Spring Harbor Laboratory Press, New York
11. DNA Cloning : A Practical Approach (1995) , D.M. Glover and B.D. Hames, IRL Press, Oxford,

ZOOLOGY: SEMESTER-II

Course Code	Course ID	Course Title	Credit	Contact Hours/Week	Internal Assessment marks	End Term Marks	Max. Marks	Exam Duration
CC-A04	261/ZOO/CC204	**Diversity of Vertebrates**	**3**	**3**	**25**	**50**	**75**	**3 hrs.**
		Practical	**1**	**2**	**5**	**20**	**25**	**2 hrs.**

Course Learning Outcomes (CLO)

1. The youth will be able to understand the evolution of life forms from primitive to most advanced forms.
2. The study will help the students to know different vertebrates' diversity around them
3. Even the course will help in understanding the adaptations and dentition in vertebrates

Instructions for Paper-Setter

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

UNIT	TOPICS	CONTACT HOURS
I	Origin of chordate, classification (up to order) and general characters of Protochordate, (hemichordate, urochordate & Cephalochordate) and chordate Vertebrate integument and its derivatives: Development, general structure and functions of skin and its derivatives, Glands, scales, horns, claws, nails, hoofs, feathers and hairs	12
II	Skeletal system: Types, function, and skeletal elements of the body, Comparative account of jaw suspensorium, Vertebral column, Limbs and girdles Digestive system: Comparative account of Dentition, Stomach, Digestive organs & Glands	11
III	Respiratory system: Characteristics of respiratory tissue, Internal and External Respiration, Comparative account of respiratory organs Circulatory system: General plan & types of circulation in various groups, Blood, Evolution of heart, Evolution of aortic arches, and Portal systems.	11
IV	Urinogenital system: evolution and comparison of urinogenital system in vertebrate. Structure and functior of different type of kidney, urinogenital ducts. Nervous system; Comparative anatomy of the brain in relation to its functions, Comparative anatomy o spinal cord, Nerves-Cranial, Peripheral and Autonomous nervous systems	11
Practical	1. Museum specimen and slides 1. Protochordates (Balanoglossus, Cephalodiscus, Herdmania, salpa, dolium, amphioxus etc) 2. Fishes (cyclostomes, Chondrichthyes, Ostrichthyes (bony fishes and Lung fishes) 3. Amphibians (Ichthyophis, Proteus, Ambystoma maculatum, Axolotal larva, Siren, Alytes, Bufo etc) 4. Reptiles (Testudo, Chelon, Trionyx, Calotes, Chemaelon, Varanus, Python, Natrix, Vipera etc) 5. Birds (Pavo cristatus, Columbia livia, Dendrocarpus, Passer domesticus etc) 6. Mammals (Ornithorynchus, Echidna, Macropus, Loris, Hyaena, Equus caballus, Rhinoceros, Ovis etc) 2. Comparative Osteology 1. Skull and lower jaw	30

	2. Vertebrae 3. Girdles 4. Limb bones 3. Temporary/Permanent mounts of Hair & Scales 4. Different types of Feathers, Scales & Hair	

ZOOLOGY: SEMESTER-II								
Course Code	**Course ID**	**Course Title**	**Credit**	**Contact Hours/Week**	**Internal Assessment marks**	**End Term Marks**	**Max. Marks**	**Exam Duration**
CC-A05	**261/ZOO/CC205**	**Biochemistry & Biotechniques**	**3**	**3**	**25**	**50**	**75**	**3 hrs.**
		Practical	**1**	**2**	**5**	**20**	**25**	**2 hrs.**

Course Learning Outcomes (CLO)

1. Students will be able to understand the general reactions of various metabolic pathways.
2. It will make the students to understand the structure and classification of biomolecules.
3. This paper will provide the basic understanding of various biological techniques.
4. The youth will be able to understand the basics of various techniques
5. It will make the students to understand the applications of these techniques for animal kindness.

Instructions for Paper-Setter

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

UNIT	TOPICS	CONTACT HOURS
I	General introduction to biomolecules, amino acids, peptide classification, chemical reactions, and physical properties. Protein Biology; secondary, tertiary, quaternary structure of protein: Ramachandran plot and its significance Enzymes: classification and Nomenclature, co-enzymes and cofactors, induced fit and lock & key hypothesis of mechanism of enzyme action, enzyme feedback mechanism, isozymes	12
II	Nucleic acid; structure & function, DNA Structure, types (A-, B-, and Z- DNA) and function, RNA structure, types (rRNA, mRNA, tRNA) and function. Sugar; classification & reactions, metabolism of carbohydrates (glycolysis, TCA cycle, Glycogenesis, Glycogenolysis, Gluconeogenesis, and the Pentose phosphate pathway and energetics), oxidative phosphorylation Lipids; classification, structure and functions, Saturated and unsaturated fatty acid and their metabolism. Cholesterol Biosynthesis and its metabolism .	11
III	Microscopic Techniques; Principles and applications of light microscope, phase contrast microscope, fluorescence microscopes, Electron Microscope (EM); Scanning and Transmission electron microscopes. (SEM, TEM). Centrifugation; Principles of sedimentation; types, care and safety aspects of centrifuge, differential centrifugation, density gradient centrifugation and their applications. Chromatography: Principles and applications of gel filtration, ion-exchange, affinity, thin layer, gas chromatography and high-pressure liquid chromatography (HPLC) and FPLC.	11

IV	Electrophoresis; Principles and applications of agarose and polyacrylamide gel electrophoresis. Principle and uses of analytical instruments; spectrophotometer, NMR spectrophotometer Immuno-techniques; antibody generation, detection of molecules using ELISA, RIA, Immunoprecipitation and immunofluorescence microscopy; detection of molecules in living cells.	11
Practical	1. Titration of amino acids and determination of pKa values. 2. Determination of isoelectric point of an amino acid. 3. Isolation of proteins. 4. Quantitation of Proteins. 5. Benedict test for reducing sugar. 6. Demonstration of UV, Visible, and Fluorescence spectroscopy. 7. Demonstration of working of different types of microscopes. 8. Demonstration of Chromatography i.e. TLC/ HPLC/ GC. 9. To demonstrate the separation of proteins with the help of electrophoresis.	30
	Suggested Readings 1. Devi, P. 2000. Principles and Methods of Plant Molecular Biology, Biochemistry and Genetics. Agrobios, Jodhpur, India. 2. Cooper, T.G. 1977. Tools in Biochemistry. John Wiley, New York, USA. 3. Dryer, R. L. and Lata, G. F. 1989. Experimental Biochemistry. Oxford University Press, NewYork. 4. Hames, B.D.(Ed.).1998. Gel Electrophoresis of Proteins: A Practical Approach, 8th edition.PAS, Oxford University Press, Oxford, UK. 5. Scott, R.P.W. 1995. Techniques and Practice of Chromatography. Marcel Dekker, Inc., NewYork. 6. Wilson, K. and Walker, J. 1994. Practical Biochemistry: Principles and Techniques, 4th edition.Cambridge University Press, Cambridge, U 7. A Biologists guide to Principles and Techniques of Practical Biochemistry, K. Wilson and K.H.Goulding, ELBS Edn. 8. Lehninger AL, Nelson DL & Cox MM (1993) Principles of Biochemistry, 2nd edn. New York: Worth. 9. Stryer L (1995) Biochemistry, 4th edn. New York: WH Freeman. 10. Voet D, Voet JG & Pratt CW (1999) Fundamentals of Biochemistry. New York: Wiley	



ZOOLOGY: SEMESTER-II

Course ID	Course Code	Course Title	Credit	Contact Hours/Week	Internal Assessment marks	End Term Marks	Max. Marks	Exam Duration
CC-A06	261/ZOO/CC206	Molecular Cytogenetics	3	3	25	50	75	3 hrs.
		Practical	1	2	5	20	25	2 hrs.

Course Learning Outcomes (CLO)

1. Students will be able to study the molecular composition of the chromosomes.
2. They will gain the knowledge about mutations and molecular basis of cell cycle and its check points
3. The paper deals with nature and mechanism of genomic imprinting.
4. Students will gain the knowledge about mutations and detection of mutagens.

Instructions for Paper-Setter

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

UNIT	TOPICS	CONTACT HOURS
I	Biology of Chromosomes: Molecular anatomy of eukaryotic chromosomes; Metaphase chromosomes: Centromere, Kinetochore, Nucleolus organizers and rRNA genes, Telomere: structure and Functions, Heterochromatin and euchromatin, Giant Chromosomes: Polytene Chromosomes, Lampbrush Chromosomes	12
II	Sex Chromosomes: Sex determination and the Y Chromosome, Dosage compensation in *C. elegans*, *Drosophila* and Humans, Nature and mechanism of genomic imprinting, X- inactivation and imprinting, Sex specific imprinting	11
III	Genes in Pedigrees: Mendelian pedigree pattern, Inheritance of mitochondrial diseases, Complications to the basic pedigree patterns, non-Mendelian traits. Somatic Cell Genetics: Cell fusion and somatic cell hybrids – agents and mechanism of fusion, Heterokaryon – Cell lines and selection systems and chromosome segregation,	11
IV	Gene Mutations: Spontaneous mutations – Base pair substitution and frame shift mutations Induced mutations – Radiation, chemical and environmental, In –vitro site specific mutagenesis. Detection of mutagens – The Ames test and sister chromatid exchanges, Genetics of Cell Cycle: Genetic regulation of cell division in yeast and eukaryotes, Molecular basis of cellular check points.	11
Practical	1. Study of chiasma frequency and terminalization co-efficient. 2. Study of mitosis from hepatic caeca of suitable insects/ onion root tip. 3. Preparation of karyotype 4. Preparation of ideogram. 5. Demonstration of banding techniques (C, G and T). 6. Study of induced polyploidy in sperm/pollen. 7. Making preparations from salivary glands of Chironomus larvae / Drosophila larvae to study polytene chromosomes. 8. Preparation of human buccal smear to study sex chromatin. 9. Identification of meiotic and mitotic stages from permanent slides.	30

Learning Resources
1. Atherly, A.C., J.R. Girton and J.F. McDonald. The Science of Genetics. Sauders CollegePublishing, Harcort Brace College Publishers, NY. 2. Brooker, R.J. Genetics : Analysis and Principles. Benjamin/Cummings, Longman Inc. 3. Fairbanks, D.J. and W.R. Anderson. Genetics – The Continuity of Life. Brook/ColePublishing Company ITP, NY, Toronto. 4. Gardner, E.J., M.J. Simmons and D.P. Snustad. Principles of Genetics. John Wiley andSons. Inc., NY. 5. Griffiths, A.J.F., J.H. Miller, D.T. Suzuki, R.C. Lewontin and W.M. Gelbart. AnIntroduction to Genetic Analysis. W.H. Freeman and company, NY. 6. Lewin, B. Genes. VI. Oxford University Press, Oxford, New York, Tokyo. 7. Snustad, D.P. and M.J. Simmons. Principles of Genetics. John Wiley and Sons. Inc., NY. **8.** Watson, J.D., N.H. Hopkins, J.W. Roberts, J.A. Steitz and A.M. Weiner. MolecularBiology of Genes. The Benjamin/Cummings Publishing Company Inc., Tokyo. **9.** Tom Strachan & Read, A.P. Human Molecular Genetics 3rd edition, Garland Publishing2004, London.



ZOOLOGY: SEMESTER-II								
Course Code	**Course ID**	**Course Title**	**Credit**	**Contact Hours/Week**	**Internal Assessment marks**	**End Term Marks**	**Max. Marks**	**Exam Duration**
DSE-02	261/ZOO/DS-202	**Bioinformatics**	**2**	**2**	**15**	**35**	**50**	**3 hrs.**
		Practical	**1**	**2**	**5**	**20**	**25**	**2 hrs.**

Course Learning Outcomes (CLO)

1. Students will develop proficiency in using programming languages.
2. They will learn to analyze and interpret genomic and proteomic data
3. Students will deepen their knowledge of fundamental concepts in molecular biology and genetics.

Instructions for Paper-Setter

1. Seven questions will be set in all.
2. Question No. 1, which will be short answer type (14marks) covering the entire syllabus, will be compulsory.
3. The remaining six questions will be set unit wise selecting two questions from each Unit I to III.
4. The candidate will be required to attempt question No. 1 and three more questions selecting one question from each unit.

UNIT	TOPICS	CONTACT HOURS
I	Computers: An overview of computers, microcomputers, VDUs and printer; What is programming Algorithms; Languages and packages: Introduction to MS Office, MS Access, introduction to SQL (structured query language) Handling arrays, procedures. Introduction to PERL: Applications of PERL in Bioinformatics: Storing DNA sequence, DNA to RNA transcription, finding motifs, counting nucleotides, generating random numbers, simulating DNA mutation, generating random DNA, Analyzing DNA.	10
II	Biological Sequence Databases: Overview of various primary and secondary databases that deal with protein and nucleic acid sequences. Databases to be covered in detail are GenBank, EMBL, DDBJ, Swiss Prot, PIR, and MIPS for primary sequences. Preliminary ideas of query and analysis of sequence information. Sequence Comparison Methods: Method for the comparison of two sequences viz., Dot matrix plots, Needleman, Wusch&amp, SmithWaterman algorithms.	10
III	Database Search Algorithms: Methods for searching sequence databases like FASTA and BLAST algorithms. Statistical analysis and evaluation of BLAST results. Pattern Recognition Methods in Sequence Analysis: Concept of a sequence pattern, regular expression-based patterns. The use of pattern databases like PROSITE and PRINTS. Theory of profiles and their use with special reference to PSIBLAst. Markov chains and Markov models and their use in gene finding.	10
Practical	1. Retrieve Nucleotide sequences from NCBI serve. 2. Retrieve Protein sequences from PDB. 3. Analysis of sequences Similarity using BLAST/pBLAST/nrBLAST 4. To predict protein secondary structures by using iPred. 5. Perform phylogenetic analysis using PHYLIP. 6. Perform multiple sequence alignment by using ClustalW. 7. Primer design	30

Learning Resources

1. Jin Xiong (2006) Essential Bioinformatics. Cambridge publisher
2. ZhumurGhosh and BibekanandMallick (2008) Bionformatics: Principles and Applications. Oxford University Press publisher
3. Orpita Bosu and Simminder Kaur Thukral (2007). Bioinformatics. Oxford University Press publisher
4. M. Lesk (2002) Introduction to Bioinformatics. Oxford University Press publisher
5. Fundamental Concepts of Bioinformatics, Dan E. Krane, Michael L. Raymer, Michaeel
6. L. Raymer, Elaine NicponMarieb, 2002, Benjamin/Cummings
7. P. Rastogi and N. Mendiritta (2013) Bioinformatics: Methods and Applications: Genomics, Proteomics and Drug Discovery. Prentice-Hall of India Pvt. Ltd; 4th Revised edition
8. Mount and David W (2004) Bioinformatics: sequence and genome analysis. Cshl Press,2nd edition
9. Harisha S (2007) Fundamentals of Bioinformatics. I K International Publishing HousePvt. Ltd
10. Dan E. Krane (2003) Fundamentals concepts of bioinformatics. Dorling Kindersley (RS);First edition
11. David Edwards and Jason Stajich (2009) Bioinformatics: Tools and Applications. Published by Springer



ZOOLOGY: SEMESTER-II								
Course Code	**Course ID**	**Course Title**	**Credit**	**Contact Hours/Week**	**Internal Assessment marks**	**End Term Marks**	**Max. Marks**	**Exam Duration**
DSE-02	261/ZOO/DS-202	**Molecular Endocrinology & Neural Physiology**	**2**	**2**	**15**	**35**	**50**	**3 hrs.**
		Practical	**1**	**2**	**5**	**20**	**25**	**2 hrs.**

Course Learning Outcomes (CLO)

1. Essential for in depth understanding of the molecular synthesis, secretion and action of hormones respectively and other regulatory substances of animals.
2. Students will understand its relatedness to various hormone base disorders and its application to other fields of cell biology.
3. Students will understand the structure of brain and intricate network of nerve impulse conduction

Instructions for Paper-Setter

1. Seven questions will be set in all.
2. Question No. 1, which will be short answer type (14 marks), covering the entire syllabus, will be compulsory.
3. The remaining six questions will be set unit wise selecting two questions from each Unit I to III.
4. The candidate will be required to attempt question No. 1 and three more questions selecting one question from each unit.

UNIT	TOPICS	CONTACT HOURS
I	Introduction to endocrinology, hormones: Types, Chemical nature (amino acid, peptides, glycoproteins, steroid, prostaglandin). Biosynthesis, secretion, and mechanism of action of peptide and steroid hormones, Receptor for hormones and their molecular mechanism for signal transduction.	10
II	Structure and physiology of endocrine gland and their hormone (Pituitary, Pineal, Thyroid, Thymus, Pancras, Adrenal, Gonads and mucous membranes). Role of hypothalamus in hormonal control. Role of insulin and glucagon in carbohydrate metabolism, Endocrine control of food, fluid intake and obesity, endocrine regulation of calcium and phosphate in mammals, general hormonal disorders of mammals.	10
III	Neuronal physiology: Structure and classification of neurons and glial cells. Synaptic action, dendritic properties and functional operation of spinal cord, Brain stem, Neuroganglia interaction. Synaptic transmission: Ca2+ and transmitter release; post synaptic transmission mechanism, neurotransmitters.	10
Practical	1. To identify the stage of estrous cycle. 2. To show the endocrine glands in rat through charts/models/video clipping. 3. To study the histology of endocrine glands through permanent stained slides 4. To study the corrective measures for myopia, hypermetropia, astigmatism, cataract. 5. To study the structure of eye, ear and different types of neurons through charts/models.	30
	Learning Resources	
	1. *General Endocrinology* by **Turner, C.D. and Bagnars**, W.B. Saunders Company; 1976. 2. *Comparative Endocrinology of Invertebrates* by **Highnam, K.C.** and Hill, L. EnwaralArnold Ltd., London; 1981. 3. *Endocrinology* by Golds -**Worthy, G.J. Robinson, J. and Mordue**, W. John Wiley andSons, New York; 1981. 4. *An Introduction to Invertebrates Endocrinology* by **Tombes, A.S.** Academic Press, NewYork; 1970. 5. *Comparative Vertebrate Endocrinology* by **Bentley, P.J.** Cambridge Univ. Press; 1998. 6. *Endocrinology* (4 ed) by. **Hadley, M. E.** Prentice Hall; 1996.	

ZOOLOGY: SEMESTER-III								
Course Code	**Course ID**	**Course Title**	**Credit**	**Contact Hours/Week**	**Internal Assessment marks**	**End Term Marks**	**Max. Marks**	**Exam Duration**
CC-A07	261/ZOO/CC307	**Animal Physiology**	**3**	**3**	**25**	**50**	**75**	**3 hrs.**
		Practical	**1**	**2**	**5**	**20**	**25**	**2 hrs.**

Course Learning Outcomes (CLO2

1. The aim of this paper is to impart advanced knowledge about the principles of vertebrate physiology at both cellular and organismal levels.
2. Students would gain expertise in the physiology of different vertebrate classes and groups.
3. An appropriate understanding of the functioning of each physiological system in vertebrates, along with comparative analysis among different vertebrate groups, will be acquired.

Instructions for Paper-Setter

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

UNIT	TOPICS	CONTACT HOURS
I	Digestive system: Feeding mechanisms and regulation, Physiology of mammalian ingestion, digestion, absorption, assimilation and egestion, Energy balance and BMR, Dentition in mammals	11
II	Respiratory and Circulatory System: Organs and transport of gases, respiratory pigments, exchange of gases, neural and chemical regulation of respiration. Structure of heart and blood vessel; Composition and Functions of body fluids and their regulation; Blood volume, blood volume regulation. Heart Sounds, ECG – its principle and significance, Cardiac cycle, blood pressure, Blood coagulation.	11
III	Excretion and Osmoregulation: Patterns of nitrogen excretion among different animal groups. Physiology of excretion- renal regulation of acid balance, Mechanism of tubular reabsorption and urine formation, micturition, Influence of hormone in kidney functions. Osmoregulation in different mammalian groups.	11
IV	Muscle and Receptor physiology: Muscles: structure and function: neural control of muscle tone and posture; Neuromuscular transmission and nerve conduction, Gross neuro-anatomy of the brain and spinal cord, central and peripheral nervous system. Receptor physiology- Mechanoreceptor, Photoreception, Chemoreception, Equilibrium reception	11
Practical	1. To study Influence of temperature on insect development 2. To study effect of different anticoagulants on platelets count. 3. To identify different endocrine glands with the help of charts 4. To determine the concentration of glucose in the diabetic samples. 5. Determination of colour Index of blood. 6. Demonstration of the blood clotting time. 7. Demonstration of the erythrocyte sedimentation rate. 8. Observation of sex chromatin (Barr bodies) in buccal epithelium of Human female	30

Learning Resources

1. Alexander, R.M.N. Optima for animals. Princeton Univ. Press, Princeton, NJ.
2. Chatterjee C C , Human Physiology. 1992.
3. Guyton, Text book of Medical Physiology, 10th Ed. W B Saunders
4. Hoar, W.S. General and Comparative Physiology, Prentice Hall of India.
5. Louw, G.N. Physiological animal ecology. Longman Harloss, UK.
6. Newell, R.C. (ed.) 1976. Adaptation to environment. Essays on the physiology of marine animals. butterworths, London, UK, 539pp.
7. Prosser, C.L. Environmental and Metabolic Animal Physiology. Wiley-Liss Inc., New York.

8. Pummer, L. Practical Biochemistry, Tata McGraw-Hill.
9. Sastry K V and Shukla V. Text Book of Physiology and Biochemistry, Rastogi Publication, Meerut
10. Strand, F.L. Physiology: A regulatory Systems Approach. Macmillan Publishing Co., New York.
11. Townsend, C.R. and P. Calow. Physiological Ecology: An evolutionary approach to resource use. Blackwell Sci. Publ., Oxford, UK.
12. Willmer, P.G. Stone, and I. Johnston. Environmental Physiology. Blackwell Sci. Oxford, UK, 644pp.
13. Wood, D.W. Principles and Animal physiology ,1968.



ZOOLOGY: SEMESTER-III								
Course Code	**Course ID**	**Course Title**	**Credit**	**Contact Hours/Week**	**Internal Assessment marks**	**End Term Marks**	**Max. Marks**	**Exam Duration**
CC-A08	**261/ZOO/CC308**	**Developmental Biology**	**3**	**3**	**25**	**50**	**75**	**3 hrs.**
		Practical	**1**	**2**	**5**	**20**	**25**	**2 hrs.**

Course Learning Outcomes (CLO)

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

Instructions for Paper-Setter

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

UNIT	TOPICS	CONTACT HOURS
I	Introduction to animal development: Problems of developmental biology; Developmental patterns in metazoans; Development in unicellular eukaryotes; Development in Dictyostelium Creating multicellularity: Cleavage types and significance, Blastula, Fate maps, cell lineages; Comparative account of gastrulation Early vertebrate development: Neurulation and ectoderm; Mesoderm and endoderm	11
II	Cytoplasmic determinants and autonomous cell specification: Cell commitment and differentiation; Germ cell determinants; Germ cell migration; Progressive cell - Cell interaction and cell specification fate; Cell specification in nematodes Body pattern formation: Establishment of Body axis in mammals and birds; Proximate tissue interactions; Genetics of axis specification in Drosophila	11
III	Hormones as mediators of development: Amphibian metamorphosis; Insect metamorphosis Biology of sex determination: Chromosomal sex determination – Mammals, Drosophila and Nematodes; Testis determining genes; Secondary sex determination in mammals; Environmental sex determination. Cell death and cell renewal: Programmed cell death; Stem cells and the maintenance of adult tissues; Embryonic stem cells and therapeutic cloning	11
IV	Environmental evolution and animal development: Environmental cues and effects; Malformations and disruptions; Developmental constraints, Homeobox concept in different phylogenetic groups: Cell diversification in early animal embryo; Tetrapod limb development; Skeletal muscle regeneration.	11



Practical	1. To study the various developmental stages of life cycle of Caenorhabditis elegans with the help of Charts 2. To study the various developmental stages of embryogenesis and life cycle of Drosophila. 3. To study the various developmental stages of life cycle of Frog. 4. Preparation of whole mount of chick embryo 5. To study various developmental stages of chick embryo with the help of the permanent slides. 6. To dissect out Drosophila larvae and to take out the imaginal discs. 7. To study Influence of mutagens on insect development 8. To study Development and Preservation of chick Embryo. 9. Studies on vaginal smears during different stages of estrous cycle.	30

Learning Resources

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



ZOOLOGY: SEMESTER-III								
Course Code	**Course ID**	**Course Title**	**Credit**	**Contact Hours/Week**	**Internal Assessment marks**	**End Term Marks**	**Max. Marks**	**Exam Duration**
CC-A09	**261/ZOO/CC309**	**Immunology**	**3**	**3**	**25**	**50**	**75**	**3 hrs.**
		Practical	**1**	**2**	**5**	**20**	**25**	**2 hrs.**

Course Learning Outcomes (CLO)

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

Instructions for Paper-Setter

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

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

	8. To study permanent slides of Lymphoid and endocrine glands	

Learning Resources

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



ZOOLOGY: SEMESTER-III								
Course Code	**Course ID**	**Course Title**	**Credit**	**Contact Hours/Week**	**Internal Assessment marks**	**End Term Marks**	**Max. Marks**	**Exam Duration**
DSE-03	261/ZOO/DS303	**Animal Behavior and Wild-Life Conservation**	**2**	**2**	**15**	**35**	**50**	**3 hrs.**
		Practical	**1**	**2**	**5**	**20**	**25**	**2 hrs.**

Course Learning Outcomes (CLO)

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

Instructions for Paper-Setter

1. Seven questions will be set in all.
2. Question No. 1, which will be short answer type (14 marks) covering the entire syllabus, will be compulsory.
3. The remaining Six questions will be set unit wise selecting two questions from each Unit I to III.
4. The candidate will be required to attempt question No. 1 and three more questions selecting one question from each unit.

UNIT	TOPICS	CONTACT HOURS
I	Social behavior: Aggregations and society; Advantages of group living; Types of social organization in animals; Group selection, kin selection, altruism, reciprocal altruism. Territoriality and parental care; Behavior Ecology: Habitat selection, social behavior of termites, ants and primates. Various means of communication in animals: Chemical, Visual, auditory, touch etc.	10
II	Hormones and animal Behavior: Hormones important to behavioral regulation; Genetic basis of behavior, Aggressive behavior; sexual attraction and sexual behavior. Pheromones and animal behavior: types of pheromones, role of pheromones in animal behavior; pheromones of social insects, Human Ethology	10
III	Wildlife Census: Planning a wildlife census, understanding sample counts, Block count, Road side counts, Dung counts, Pugmark census, Water-hole census. Study of signs and symptoms: A practice of recording field observations, Bio-telemetry, Ageing and Sexing techniques. Wildlife Tourism: Definition scope and range. Poaching- definition and implications National Projects: Project Tiger, Project elephant, Project Rhinoceros, Project Crocodiles, Project Hangul, Manipur Brow Antlered Deer.	10
Practical	1. To study the effect of temperature on gill movement in fishes. 2. To study nesting behaviors of squirrels in different habitats vis., urban environment, grain- market-area, roadside plantations, orchards gardens etc. 3. Field study of burrowing behavior of common available rodent fauna of the region. 4. Study of morphological changes in common avian species during breeding season. 5. Preparation of charts of endangered amphibians, reptiles and mammals with	30

	ecological remarks. 6. Animal behavior patterns using Photostat sheets/ repertoire sheets 7. Analysis of standard pug marks of large sized wild mammals. 8. Study of Migratory Birds 9. Study of Diversity indices: use of software in calculating diversity indices 10. Study of beaks and claws of different bird species. 11. Field visit to a zoo or wildlife part/sanctuary and preparation of field report.	

Learning Resources

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



ZOOLOGY: SEMESTER-III								
Course Code	**Course ID**	**Course Title**	**Credit**	**Contact Hours/Week**	**Internal Assessment marks**	**End Term Marks**	**Max. Marks**	**Exam Duration**
DSE-03	261/ZOO/DS303	**Fish, Fisheries and Aquaculture**	**2**	**2**	**15**	**35**	**50**	**3 hrs.**
		Practical	**1**	**2**	**5**	**20**	**25**	**2 hrs.**

Course Learning Outcomes (CLO)

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

Instructions for Paper-Setter

1. Seven questions will be set in all.
2. Question No. 1, which will be short answer type (14 marks) covering the entire syllabus, will be compulsory.
3. The remaining six questions will be set unit wise selecting two questions from each Unit I to III.
4. The candidate will be required to attempt question No. 1 and three more questions selecting one question from each unit.

UNIT	TOPICS	CONTACT HOURS
I	Definition of fish & Aquaculture.; type, classification, estuarine, marine, riverine, wet land, fisheries and their exploitation. Methods of Fishing: Crafts and gear technology, Fish diseases and their control	10
II	Transgenesis, transgenes and application, Cryopreservation of gametes and embryo Fish-by products, Fish preservation process, Nutritive aspect of fish meat and oil.	10
III	Different systems for aquaculture: pond culture, cage culture, raceway culture. Culture of important fish species (Major carps, common carps, Chinese carps, cat fish culture and Tilapia culture). Integrated Aquaculture and waste water aquaculture, Pearl Culture, Prawn Culture-Fresh and brackish water	10
Practical	1. Fish Feed formulation and processing. 2. Proximate analysis of fish feed (Determination of moisture, protein, fat, ash carbohydrate, fiber and energy). 3. Taking out of pituitary gland, preservation and preparation of extract. 4. Estimation of primary productivity 5. Study of benthic macroinvertebrates in natural water bodies. 6. Identification of eggs, spawn, fry and fingerlings of cultivable fishes of India. 7. Determination of length weight relationship. 8. Determination of age of fish using hard parts 9. Analysis of fecundity, Gonado somatic index (GSI), Hepatosomatic index (HIS) in some fishes. 10. Study of crafts and gear and method of operation (Models can also be used) 11. Visit to fish farm and fish market and preparation of report 12. A small experimental project	30

Learning Resources

1. Bardach, JE, Ryther, JH & Mclarnely, OW (1972) Aquaculture. Wiley Interscience
2. Boyd, CE (1988) Water quality management for pond fish culture. Developments in Aquaculture and Fisheries Sciences. I. Elsevier Scientific Publishing Company, Amsterdam.
3. Delince, G (1992) The Ecology of the fish pond system. Kluwer Academic Publishers, Netherlands, 230 pp.
4. Handbook of Fisheries and Aquaculture, Indian Council of Agricultural Research, New Delhi. 755 pp.
5. Hepher, B (1975) Supplementary feeding in fish culture. In: Nutrition and Production of Fishes. Vol. 3 S. Karger, Basel : 183-198
6. Hoar, WS, Randall, DJ & Donaldson, ME (1983) Fish Physiology. Vol. IXA & IXB. Reproduction. Academic Press, London.
7. Jhingran, VG (1983) Fish and Fisheries of India. Hindustan Publishing Corporation (India) 954 pp
8. Ponniah, AG, Das, P & Verma SR (Ed.) (1998) Fish Genetics and Biodiversity Conservation. Nature Conservators, Muzaffarnagar, India 474pp.
9. Tandon, KK & Johal, MS (2006) Age and Growth in Indian Freshwater Fishes.Narendra Publishing House Delhi, 232 pp.



Zoology:
SEMESTER-IV

Course Type	Course Code	Name of the Course	Credit	Contact Hours/ Week	Internal Assessment marks	End Term Marks	Max. Marks
Dissertation	261/ZOO/DISSERTATION401	**Dissertation**	**20**	**40**	**100**	**400**	**500**

Course Learning Outcomes (CLO)

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

COURSE DESCRIPTION:

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

Internal Assessment:

- Synopsis
- One Mid-semester progress report/presentation

External Assessment:

- Final project report and viva-voce presentation.

Dissertation Report Submission Guidelines:

The dissertation report should be contained followings:

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

