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 & Lab- I	241/ZOO/CC101	03	00	02	03	00	01	04	25	50	05	20	**100**
CC-A02	Molecular Biology & Lab- I	241/ZOO/CC102	03	00	02	03	00	01	04	25	50	05	20	**100**
CC-A03	Cell Biology & Lab- II	241/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 & Lab- II OR Genetic Engineering & Lab- II	241/ZOO/DS101	02	00	02	02	00	01	03	15	35	05	20	**75**
Multidisciplinary Course(s)														
MDC-01	One from the Pool	241/ZOO/MD101	02	00	02	02	00	01	03	15	35	05	20	**75**
Ability Enhancement Course(s)														
AEC-01	One from the Pool	241/ZOO/AE101	02	00	00	02	00	00	02	00	50	00	00	**50**
Value-added Course(s)														
VAC-01	One from the Pool	241/ZOO/VA101	02	00	00	02	00	00	02	00	50	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 & Lab-III	241/ZOO/CC204	03	00	02	03	00	01	04	25	50	05	20	**100**
CC-A05	Molecular Cytogenetics & Lab-III	241/ZOO/CC205	03	00	02	03	00	01	04	25	50	05	20	**100**
CC-A06	Biochemistry & Biotechniques & Lab- IV	241/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 & Lab- IV OR Molecular Endocrinology & Neural Physiology & Lab- IV	241/ZOO/DS202	02	00	02	02	00	01	03	15	35	05	20	**75**
Multidisciplinary Course(s)														
MDC-02	One from the Pool	241/ZOO/MD202	02	00	02	02	00	01	03	15	35	05	20	**75**
Ability Enhancement Course(s)														
AEC-02	One from the Pool	241/ZOO/AE202	02	00	00	02	00	00	02	00	50	00	00	**50**
Skill Enhancement Course(s)														
SEC-01	One from the Pool	241/ZOO/SE201	01	00	02	01	00	01	02	05	20	05	20	**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	T	P	L	T	P	Total Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
Core Course(s)														
CC-A07	Animal Physiology & Lab-V	241/ZOO/CC307	03	00	02	03	00	01	04	25	50	05	20	**100**
CC-A08	Developmental Biology & Lab-V	241/ZOO/CC308	03	00	02	03	00	01	04	25	50	05	20	**100**
CC-A09	Immunology & Lab- VI	241/ZOO/CC309	03	00	02	03	00	01	04	25	50	05	20	**100**
Discipline Specific Elective Courses (Select any one course from the following)														
DSE-03	Animal Behaviour and Wild-Life Conservation& Lab- VI OR Fish, Fisheries and Aquaculture& Lab- VI	241/ZOO/DS303	02	00	02	02	00	01	03	15	35	05	20	**75**
Multidisciplinary Course(s)														
MDC-03	One from the Pool	241/ZOO/MD303	02	00	02	02	00	01	03	15	35	05	20	**75**
Skill Enhancement Course(s)														
SEC-02	One from the Pool	241/ZOO/SE302	01	00	02	01	00	01	02	05	20	05	20	**50**
Value added Course(s)														
VAC-02	One from the Pool	241/ZOO/VA302	02	00	00	02	00	00	02	00	50	00	00	**50**
Seminars														
Seminar	Seminar	241/ZOO/SEMINAR301	02	00	00	02	00	00	02	00	50	00	00	**50**
Internship/Field Activity#														
INTRSP	Industrial Visit/ Field Work and Report Writing	241/ZOO/INTRSP301	02	00	00	02	00	00	04	00	50	00	00	**50**
Total Credits									**28**					**600**

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

Scheme A2: Semester 4th

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

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

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

Semester 1

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

Semester 2

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

Semester 3

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

Semester 4

Course Code	Course Title	Course ID	L	T	P	L	T	P	Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
MDC-04	Aquaculture-II & Practical	241ZOOMDC404	02	00	02	02	00	01	03	15	35	05	20	**75**

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

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

Semester 2

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

Semester 3

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

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

(These courses are offered by department of Indian and Foreign Languages for students of other departments/same department and leads to enhancement in the ability of learn Regional and foreign languages)

Semester 1

Course Code	Course Title	Course ID	L	T	P	L	T	P	Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
AEC-1	Language		02	00	00	02	00	00	02	00	50	00	00	50

Semester 2

Course Code	Course Title	Course ID	L	T	P	L	T	P	Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
AEC-2	Language		02	00	00	02	00	00	02	00	50	00	00	50

Semester 3

Course Code	Course Title	Course ID	L	T	P	L	T	P	Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
AEC-3	Language		02	00	00	02	00	00	02	00	50	00	00	50

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

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

Semester 1

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

Semester 3

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

ZOOLOGY: SEMESTER-I								
Course Type	**Course Code**	**Name of the Course**	**Credit**	**Contact Hours/Week**	**Internal Assessment marks**	**End Term Marks**	**Max. Marks**	**Exam Duration**
CC-A01	**241/ZOO/CC101**	**Diversity of Invertebrates**	**3**	**3**	**25**	**50**	**75**	**3 hrs.**
4 credit		**Practical**	**1**	**2**	**5**	**20**	**25**	**4 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. The remaining eight questions will be set unit wise selecting two questions from each Unit I to IV. The candidate will be required to attempt question No. 1 and four more questions selecting one question from each unit.

UNIT	TOPICS	CONTACT HOURS
I	Introduction to invertebrates with their general characters and classification up to class Level Minor Phyle,Concept and significance,Organization and general characters of Acoelomate, Pseudocoelomates and Coelomates minor phyla (with special emphasis on Ctenophora, Rotifera, Endoprocta, Ectoprocta, Phoronida, Sipunculida and Echiuroidea). Organization of coelom,Concept and structure of Acoelomate, Pseudocoelomates and Coelomates, Protostomia and Deuterostomia, Metamerism in Annelida, Pseudometamerism.	12
II	Locomotion, Flagella and ciliary movement in Protozoa,Hydrostatic movement in Coelenterata, Annelida and Echinodermata,Nutrition and Digestion,Patterns of feeding and digestion in lower metazoan, Filter-feeding in Polychaeta, Mollusca and Echinodermata, Respiration, Organs of respiration : Gills, lungs and trachea, Respiratory pigments, Mechanism of respiration	11
III	Excretion: Organs of excretion: Coelom, coelomoducts, Nephridia and Malpighian tubules. Mechanism of 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 of invertebrates, Introduction to insects, Mouthparts of Insects, How are insects able to fly? Mechanism of insect flight Metamorphosis in insects Hormonal control of moulting. Social life in insects, Integrated pest management.	11

V **Practical**	1. Live demonstration of Amoeboidal movements conjugation in paramecium and flaggelarmoments in euglena. 2. Slides and Museum specimens: (a) PROTOZOA: *Gregarina, Monocystis, Ceratium, Euplotes, Didinium, Noctiluca,Radiolaria, Stentor, Opalina*. (b) PORIFERA: Sectional view of Sycon (T.S., L.S.), *Grantia* (T.S.) *(c)* CNIDARIA: *Obelia* polyp and Medusa, *Pennaria,* (d) ANNELIDA: *Ozobranchus, Glossiphonia, Eunice, Chloea Flava, Polynoe,Terebella,Eurythoe*. (e) ARTHROPODA: *Cyclops, Daphnia, Chelifer*, section of *Peripatus, Balanus,Lepas,Palinurus, Uca, Pyna, Hippa, Gongylus, Bellostoma, Limulus, Squilla, Eupagurus*. *(f)* MOLLUSCA: Museum specimens of *Dolabella, Pteria, Nertie, Sanguinolaria, Chicoreus, Ficus, Lambis, Tridacna, Onchidium, Olcia, Murex, Turritella, Bulla, Cardium, Area.* *(g)* ECHINODERMATA: Museum specimen of *Linckia, Echinodiscus, Holothuria, Antedon.* *(h)* Study of Slides of *Bugula, Plumatella, Cristatella, Pectinatella* 3. Study of mouth parts of different insects. 4. Mounting: Trachea, Crustacean Larva, *Cyclops, Nauplius, Daphnia, Zoea, Mysis, Cercaria.* 5. Dissection of Loligo/Sepia, grass-hopper, Prawn, Cockroach, Earthwarm to expose varioussystems.	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 Type	**Course Code**	**Name of the Course**	**Credit**	**Contact Hours/Week**	**Internal Assessment marks**	**End Term Marks**	**Max. Marks**	**Exam Duration**
CC-A02	**241/ZOO/CC102**	**Molecular Biology**	**3**	**3**	**25**	**50**	**75**	**3 hrs.**
4 credit		**Practical**	**1**	**2**	**5**	**20**	**25**	**4 hrs.**

Course Learning Outcomes (CLO)

1. The youth will know 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. The remaining eight questions will be set unit wise selecting two questions from each Unit I to IV. The candidate will be required to attempt question No. 1 and four more questions selecting one question from each unit.

UNIT	TOPICS	CONTACT HOURS
I	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 exportof 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 desigining 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: Genomesizes, 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

V **Practical**	1. Isolation of Genomic DNA. 2. Isolation of RNA. 3. Quantitative analysis of 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 Type	**Course Code**	**Name of the Course**	**Credit**	**Contact Hours/Week**	**Internal Assessment marks**	**End Term Marks**	**Max. Marks**	**Exam Duration**
CC-A03	**241/ZOO/CC103**	**Cell Biology**	**3**	**3**	**25**	**50**	**75**	**3 hrs.**
4 credit		**Practical**	**1**	**2**	**5**	**20**	**25**	**4 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. The remaining eight questions will be set unit wise selecting two questions from each Unit I to IV. The candidate will be required to attempt question No. 1 and four more questions selecting one question from each unit.

UNIT	TOPICS	CONTACT HOURS
I	Biomembranes: Molecular composition and arrangement, functional consequences, membrane transportation; diffusion, active transport and pumps, uniports, symports and antiports, 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
V Practical	1. Preparation of mitotic and meiotic chromosomes. 2. Calculation of morphometric data and preparations of idiogram. 3. Determination of chiasma frequency and terminalization coefficient. 4. Preparation of polytene chromosomes and mapping. 5. Study of permanent slides of different types of cancer and their stages	30

Learning Resources

1. Molecular Cell, Biology, J. Darnell, H. Lodish and D. Baltimore Scientific AmericanBook, 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.

ZOOLOGY: SEMESTER-I

Course Type	Course Code	Name of the Course	Credit	Contact Hours/Week	Internal Assessment marks	End Term Marks	Max. Marks	Exam Duration
DSE-01 **4 credit**	**241/ZOO/DS101**	**Bio-statistical methods and Data Analysis**	**2**	**2**	**15**	**35**	**50**	**3 hrs.**
		Practical	**1**	**2**	**5**	**20**	**25**	**4 hrs.**

Course Learning Outcomes (CLO)

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

Instructions for Paper-Setter

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

UNIT	TOPICS	CONTACT HOURS
I	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.	8
II	Probability Theory: Concept and Approaches, Application of Additive and Multiplication Laws, Bay's Theorem, Mathematical Expectations. Probability Distribution: Binomial, Poisson, Normal.	7
III	Hypothesis Testing. Parametric tests: t-test and Analysis of Variance – one way classification,two way classification. Chi-Square test & its application.	7
IV	Non-Parametric Tests: The Runs test of randomness; tests of two-matched samples: Wilkoxson test, Signed Rank- Sum test; Test involving two independent samples: The Mann- Whitney U Test; Tests for K Related samples: The Kruskal Wallis H test, Friedman's test. Overview of Analytic Tools: Excel as analytic tool, SPSS, Data Visualization in Tableau, Elementary idea and Use of R Programming and Python in Analytics, Data Mining, Big Data.	8
V **Practical**	1. Descriptive statistics: Systemic tabular summarization of data (before analysis), measuresof central tendency, measures of dispersion (using calculators). 2. Tests of significance (Mean, Standard Deviation, proportion. 3. Chi Square Test of Goodness of fit, test of independence of attributes, 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 Type	**Course Code**	**Name of the Course**	**Credit**	**Contact Hours/Week**	**Internal Assessment marks**	**End Term Marks**	**Max. Marks**	**Exam Duration**
DSE-01	**241/ZOO/DS101**	**Genetic Engineering**	**2**	**2**	**15**	**35**	**50**	**3 hrs.**
4 credit		**Practical**	**1**	**2**	**5**	**20**	**25**	**4 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.

Instructions for Paper-Setter

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

UNIT	TOPICS	CONTACT HOURS
I	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.	7
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. Targeted gene replacement, chromosome engineering	7
III	Microarray, Site-directed Mutagenesis and Protein Engineering. DNA transfection, Northern blot, Primer extension, S1 mapping, RNase protection assay, Reporter assays Expression strategies for heterologous genes, Vector engineering and codon optimization, host engineering,in vitro transcription and translation, expression in bacteria expression in bacteria, yeast, insect cells, mammalian cells and in plants.	8
IV	Recombinant proteins: Purification and folding, characterization and stabilization. Phage Display, T-DNA and Transposon Tagging. Gene tagging and its role. Gene therapy: Vector engineering strategies of gene delivery, gene replacement/augmentation, gene correction, gene editing, gene regulation and silencing.	8
V Practical	1. Bacterial culture and antibiotic selection medias. Prepration of competent cells. 2. Isolation of plasmid DNA. 3. Isolation of lambda phage DNA. 4. Quantitation of nucleic acids. 5. Agarose gel electrophoresis and restriction mapping of DNA 6. Construction of restriction map of plasmid DNA. 7. Cloning plasmid/phagemid vectors. 8. Preparation of helper phage and its titration 9. Preparation of single stranded DNA template 10. DNA sequencing 11. Gene expression in E. coli and analysis of gene product 12. PCR and Reporter Gene assay (Gus/CAT/b-GAL) 13. Western Blotting	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,
12. Genetic Engineering. An Introduction to gene analysis and exploitation in eukaryotes (1998), S.M. Kingsman and A.J. Kingsman, Blackwell Scientific Publications, Oxford.

ZOOLOGY: SEMESTER-II

Course Type	Course Code	Name of the Course	Credit	Contact Hours/Week	Internal Assessment marks	End Term Marks	Max. Marks	Exam Duration
CC-A04	**241/ZOO/DS204**	**Diversity of Vertebrates**	**3**	**3**	**25**	**50**	**75**	**3 hrs.**
4 credit		**Practical**	**1**	**2**	**5**	**20**	**25**	**4 hrs.**

Course Learning Outcomes (CLO)

1. The youth will be able to understand the evolution of life forms from primitive tomost 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. The remaining eight questions will be set unit wise selecting two questions from each Unit I to IV. The candidate will be required to attempt question No. 1 and four more questions selecting one question from each unit.

UNIT	TOPICS	CONTACT HOURS
I	Origin of Chordates, Protochordata, hemichordate & urochordata Classification of Vertebrates upto orders, Vertebrate integument and its derivatives: Development, general structure and functions of skin and its derivatives, Glands, scales, horns, claws, nails, hoofs,feathers and hairs Skeletal system: Types, function, body size and skeletal elements of the body, Comparative accountof jaw suspensorium, Vertebral column, Limbs and girdles	12
II	Digestive system: Comparative account of Dentition, Stomach, Digestive organs & Glands Respiratory system: Characteristics of respiratory tissue, Internal and External Respiration, Comparative account of respiratory organs	11
III	General plan & types of circulation in various groups, Blood, Evolution of heart, Evolution of aortic arches, and Portal systems , Evolution of Urinogenital system in vertebrate series	11
IV	Nervous system, Comparative anatomy of nervous system in relation to its functions, Comparative anatomy of brain & spinal cord, Nerves-Cranial, Peripheral and Autonomous nervous systems, Sense organs, Simple receptors, Organs of Olfaction and taste, Lateral line system, Electroreception	11
V **Practical**	1. Museum specimens and slides : Chondrichthyes: Zygaena, Pristis, Narcine, Trygon, Rhinobatus, Chimaera. Actinopterygii: Polypterus, Acipenser, Lepidosteus, Muraena, Mystus, Catla. Hippocampus, Syngnathus, Exocoetus, Anabas, Diodon, Tetradon, Echeneis and Solea. Dipneusti (Dipnoi) : Protopterus (Lung fish) Amphibia: Uraeotyphlus, Necturus, Amphiuma, Ambystoma and its Axolotl larva. Triton,Salamandra, Hyla, Rhacophorus. Reptilia : Hemidactylus,,Calotes, Draco, Varanus, Phrynosoma,Chamaeleon. Typhlops, Python, Eryx, Ptyas, Bungarus, Naja, Hydrus, Vipera,Crocodilus, Gavialis, Chelone and Testudo. Aves: Casuarius, Ardea, Anas, Milvus, Pavo, Eudynamis, Tyto and Alcedo. Mammalia : Ornithorhynchus, Echidna, Didelphis, Macropus, Loris, Macaca,Manis, Hystrix, Funambulus, Panthera, Canis, Herpestes, Capra,Pteropus. 2. Demonstration of dissection of Labeo through video clipping/models/charts:Digestive and Reproductive systems Circulatory system: heart, afferent and	30

	efferent branchial arteries. Nervous system: cranial nerves and internal ear. 3. Study of the skeleton of Labeo, Rana, Varanus, Gallus & Oryctolagus. 4. Demonstration of dissection of chick and white rat through video clipping/models/charts.Chick : Digestive, arterial, venous and urinogenital systems. White rat : Digestive, arterial, venous and urinogenital systems. 5. Study of the histology of different organs of frog and rat/rabbit through permanent stainedslides. 6. Study of poison apparatus in snakes through charts.	

Learning Resources

1. Barrington, E.J.W. The Biology of Hemichordata and Protochordata. Oliver andBoyd,Edinbourgh.
2. Bourne, G.H. The structure and functions of nervous tissue. Academic Press, New York.
3. Carter, G.S. Structure and habit in vertebrate evolution - Sedgwick and Jackson, London.
4. Kingsley, J.S. Outlines of Comparative Autonomy of Vertebrates. Central Book Depot,Allahabad.
5. Kent, C.G. Comparative anatomy of vertebrates.
6. Milton Hilderbrand. Analysis of vertebrate structure. IV. Ed. John Wiley and Sons Inc.,New York.
7. Sedgwick, A. A Students Text Book of Zoology, Vol. II.
8. Torrey, T.W. Morphogenesis of vertebrates. John Wiley and Sons Inc., New York andLondon.
9. Walters, H.E. and Sayles, L.D. Biology of vertebrates. MacMillan & Co., New York.
10. Weichert, C.K. and Presch, W. Elements of chordate anatomy, 4th Edn. McGraw HallBook Co., New York.
11. Messers, H.M. An introduction of vertebrates anatomy.
12. Montagna, W. Comparative anatomy. John Wiley and Sons Inc.
13. Andrews, S.M. Problems in vertebrate evolution. Academic Press, New York.

ZOOLOGY: SEMESTER-II								
Course Type	**Course Code**	**Name of the Course**	**Credit**	**Contact Hours/Week**	**Internal Assessment marks**	**End Term Marks**	**Max. Marks**	**Exam Duration**
CC-A05	**241/ZOO/CC205**	**Molecular Cytogenetics**	**3**	**3**	**25**	**50**	**75**	**3 hrs.**
4 credit		**Practical**	**1**	**2**	**5**	**20**	**25**	**4 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 andits check points

Instructions for Paper-Setter

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

UNIT	TOPICS	CONTACT HOURS
I	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
V Practical	1. Making karyological preparations from testicular material of suitable insects by squash and air drying techniques to study the structure and behaviour of chromosomes during mitosis and meiosis. 2. Study of chiasma frequency and terminalisation co-efficient. 3. Study of mitosis from hepatic ceacae of suitable insects and preparation of karyotype andidiogram. 4. Demonstration of banding techniques (C, G and T). 5. Study of NORs in insect chromosomes. 6. Making preparations from salivary glands of Chironomus larvae / Drosophila larvae tostudy polytene chromosomes. 7. Effect of temperature on polytene chromosomes. 8. Preparation of human buccal smear to study sex chromatin. 9. Nuclear sexing from polymorphonuclear leucocytes.	30

	10. Identification of meiotic and mitotic stages from permanent slides. 11. Gel electrophoresis: Practical demonstration. 12. Isolation of genomic DNA. 13. PCR: Introduction and practical demonstration.	

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 Type	**Course Code**	**Name of the Course**	**Credit**	**Contact Hours/Week**	**Internal Assessment marks**	**End Term Marks**	**Max. Marks**	**Exam Duration**
CC-A06 **4 credit**	**241/ZOO/CC206**	**Biochemistry & Biotechniques**	**3**	**3**	**25**	**50**	**75**	**3 hrs.**
		Practical	**1**	**2**	**5**	**20**	**25**	**4 hrs.**

Course Learning Outcomes (CLO)

1. Students will be able to understand the general reactions of various metabolicpathways.
2. It will make the students to understand the structure and classification ofbiomolecules.
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 animalkindness.

Instructions for Paper-Setter

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

UNIT	TOPICS	CONTACT HOURS
I	Amino acids and peptides-classification, chemical reactions and physical, properties,Sugars - classification and reactions, metabolism of carbohydrate, Heterocyclic compounds-and secondary metabolites in living systems -nucleotides, pigments, isoprenoids, Separation techniques for different biomolecules. Bio-energetics and oxidative phosphorylation. Blood clotting – biochemistry, body fluids –pH and acid base balance and their importance in clinical biochemistry, muscle contraction. Techniques in the study of proteins, carbohydrates and lipids.	12
II	Lipids- classification, structure and functions Proteins-protein and protein legand interactions, end group analysis, hierarchy in structure, Ramachandran map. Conformational properties of polynucleotides, Polysaccharides - types, secondary and tertiary structural features, analysis- theoretical and experimental; Protein folding – biophysical and cellularaspects, enzymes coenzymes, in born errors of metabolism.	11
III	Microscopy: Principles and applications of light, phase contrast, fluorescence microscopes, scanningand transmission electron microscopes. Centrifuge technique: Principle, types of centrifuge, density gradient centrifuge in isolation of cell, cellorganelles and biomolecules. Chromatography: Principles and applications of gel filtration, ion-exchange, affinity, thin layer, gas chromatography and high pressure liquid chromatography (HPLC) and FPLC. Application of chromatographic technique in biology. Electrophoresis and centrifugation: Principles and applications of agarose and polyacrylamide gel electrophoresis; ultracentrifugation (velocity and buoyant density).	11
IV	Spectroscopy: Fluorescence, UV, visible, Infarad, Atomic absorption spectroscopy, NMR and ESR spectroscopy; Mass spectrometery (LC-MS, GC-MS), X-ray diffraction. Tracer Biology: Principles and applications of tracer techniques in biology; radioactive isotopes and half-life of isotopes; autoradiography. Application of different spectroscopic technique in biology. Nature and types of radiation, preparation of labelling biological sample, detection and measurement of radiation, GM counter, Scientillation counter. Flow cytometery. Safety measurement in handling radioisotopes, ELISA, RIA and non-radiolabelling.	11

V **Practical**	1. Titration of amino acids 2. Reactions of amino acids, sugars and lipids 3. Isolation of DNA and protein 4. Quantitation of Proteins and Sugars 5. UV, Visible, Fluorescence and IR spectroscopy, Absorption spectra 6. Demonstration of working of different types of microscopes. 7. Demonstration of Chromatography i.e. TLC, HPLC, GC. 8. To demonstrate the separation of proteins with the help of electrophoresis. 9. To study various molecular biology techniques i.e. PCR. 10. To demonstrate the use of spectrophotometer. 11. Purification of protein by column chromatography. 12. Visit of various laboratories in the university, preparation and submission of report.	30

Learning Resources

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 Type	**Course Code**	**Name of the Course**	**Credit**	**Contact Hours/Week**	**Internal Assessment marks**	**End Term Marks**	**Max. Marks**	**Exam Duration**
DSE-02	**241/ZOO/DS202**	**Bioinformatics**	**2**	**2**	**15**	**35**	**50**	**3 hrs.**
4 credit		**Practical**	**1**	**2**	**5**	**20**	**25**	**4 hrs.**

Course Learning Outcomes (CLO)

1. The youth will be able to understand the basics of various techniques
2. It will make the students to understand the applications of these techniques for animalkindness

Instructions for Paper-Setter

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

UNIT	TOPICS	CONTACT HOURS
I	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 querry language) Handling arrays, procedures. Colour, sound and graphics; Use of standard packages.	7
II	Introduction to PERL: Scalar variables, strings and numbers, Assignment statements, Arrays, Hashes, Operators, Input from file, Standard Input, Conditional and logical operators, loops, I/O, Input from file named in command line, Regular expression, Pattern matching, Pattern modifiers. 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	7
III	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, NeedlemanWusch&SmithWaterman algorithms. Analysis of computational complexities andthe relative merits and demerits of eachmethod.Theory of scoring matrices and their use for sequence comparison.	8
IV	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. Concept of position specific weight matrices and their use in sequence analysis. Theory of profiles and their use with special reference to PSIBLAst. Markov chains and Markov models and their use in gene finding. Concept of HMMS, the Forward backward and the Viterbi algorithm.The Baum Welch algorithm for training a HMM.Use of profile HMM for protein family classification.	8
	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.	

V Practical	5. Perform phylogenetic analysis using PHYLIP. 6. Perform multiple sequence alignment by using ClustalW. 7. Primer design 8. Computational modeling of genomic, transcriptomic and proteomic	30

Learning Resources

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

ZOOLOGY: SEMESTER-II

Course Type	Course Code	Name of the Course	Credit	Contact Hours/Week	Internal Assessment marks	End Term Marks	Max. Marks	Exam Duration
DSE-02 **4 credit**	**241/ZOO/DS202**	**Molecular Endocrinology & Neural Physiology**	**2**	**2**	**15**	**35**	**50**	**3 hrs.**
		Practical	**1**	**2**	**5**	**20**	**25**	**4 hrs.**

Course Learning Outcomes (CLO)

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

Instructions for Paper-Setter

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

UNIT	TOPICS	CONTACT HOURS
I	Overview: Glands, cellular secretions (autocrine, exocrine, endocrine), Secretory mechanism, ways of secretion **(**Autocrine, merocrine, holocrine) and regulation of glandular secretion. Hormones: Types, nature, synthesis, release and action action. Receptor, molecular mechanism and signal transduction.	8
II	Role of hypothalamus in hormonal control. Anterior pituitary hormones, posterior pituitary hormones; thyroid gland and thyroid hormones, pancreas (insulin and glucagon). Endocrine control of food and fluid intake/obesity calcium regulation, adrenal gland. Reproductive organs and their hormonal control in male and females; estrogen and androgen; Reproductive cycle, parturition and pathologies	8
III	Introduction to evolution and development of Nervous system. Structural and functional aspects of nervous system (CNS,PNS&ANS). Anatomy of brain and its cellular composition (types of neurons, glia and their functions). Neuroganglia interaction.	7
IV	. Structure of neuron, membrane proteins, channels (voltage gated and ligated), Na+, K+ pump, Na+, K+ ATPase. Bioelectricity, membrane excitability, nerve conduction. Neurohormones and neurotransmitters. Neuroendocrine regulations of physiological functions. Structure of synapse and synaptic transmission. Senses (vision, olfaction and touch).	7
V **Practical**	1. To identify the stage of oestrous 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* (4th ed) by. **Hadley, M. E.** Prentice Hall; 1996.

Multidisciplinary Course

ZOOLOGY: SEMESTER-I								
Course Type	**Course Code**	**Name of the Course**	**Credit**	**Contact Hours/Week**	**Internal Assessment marks**	**End Term Marks**	**Max. Marks**	**Exam Duration**
MDC-01 **3 credit**	**241/ZOOMD101**	**Population Genetics & Evolution-I**	**2**	**2**	**15**	**35**	**50**	**3 hrs.**
		Practical	**1**	**1**	**5**	**20**	**20**	

Course Learning Outcomes (CLO)

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

Instructions for Paper-Setter

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

UNIT	TOPICS	CONTACT HOURS
I	Concept of evolution: Darwinism and Neo-Darwinism, Hardy-Weinberg law of genetic equilibrium. A detailed account of destabilizing forces: (i) Natural selection, (ii) Mutation, (iii) Genetic drift, (iv)Migration (v) Meiotic drive.	12
II	Evolutionary time scale: eras, periods and epoch. Major events in evolutionary time scale: origins of unicellular and multicellular organisms.	11
III	Quantifying genetic variability: Genetic structure of natural populations, phenotypic variations, Models explaining changes in genetic structure of populations. Factors affecting human disease frequency Mendelian basis of transmission of disease	11
IV	. Molecular population genetics: Patterns of change in nucleotide and amino acid sequences Ecological significance of molecular variations Emergence of Non-Darwinism-Neutral Hypothesis	11

Learning Resources

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

ZOOLOGY: SEMESTER-II								
Course Type	**Course Code**	**Name of the Course**	**Credit**	**Contact Hours/Week**	**Internal Assessment marks**	**End Term Marks**	**Max. Marks**	**Exam Duration**
MDC-02 **3 credit**	**241/ZOO/MD202**	**Population Genetics & Evolution-II**	**2**	**2**	**15**	**35**	**50**	**3 hrs.**
		Practical	**1**	**1**	**05**	**20**	**25**	

Course Learning Outcomes (CLO)

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

Instructions for Paper-Setter

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

UNIT	TOPICS	CONTACT HOURS
I	Molecular evolution: molecular divergence and molecular clock. Patterns and mechanism of reproductive isolation, modes of speciation	12
II	Interrelationship among different phyla of Invertebrates and their evolutionary significance. Origin of Vertebrates: Pisces, Amphibia, Reptilia, Aves and Mammalia. Stages of primate evolution.	11
III	Genetics of quantitative traits in populations: Analysis of quantitative traits Quantitative traits and natural estimation of heritability	11
IV	. Genotype-environment interactions Inbreeding depression and heterosis Molecular analysis of quantitative traits, phenotypic plasticity	11

Learning Resources

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