Maa Shakumbhari University, Saharanpur

Syllabus of the Subject
Zoology

For Four Year Undergraduate Program (FYUP)

(As per guidelines of Common Minimum Syllabus by U.P. Government according to National Education Policy-2020 amended with GO-2090/70-3-2024-09(01) Dated: 02-09-2024)

20-02-25

20th Feb 25

Members, Board of Studies (Zoology)

S. No.	Name	Designation	College/University	Signature
1.	Prof. Garima Jain	Dean Science	D.A.V. (P.G). College, Muzaffarnagar	20/12/25
2.	Prof. Sandhya Jain	Convener	D.A.V. (P.G). College, Muzaffarnagar	
3.	Prof. Anju Panwar	Member	D.A.V.(P.G.) College, Muzaffarnagar	
4.	Dr. Yogendra Singh	Member	Vijay Singh Pathik Govt. P. G. College, Kairana, Shamli	
5.	Dr. Om Dutt	Member	M.S. College, Saharanpur	
6.	Prof. D. S. Malik	External expert	Gurukul Kangri University, Haridwar	
7.	Prof. Dinesh Kumar Sharma	External expert	Km. Mayawati Govt. Girls (PG)College, Baadalpur, Gautam Budhnagar	Joined Online
8.	Prof. A. K. Verma	External expert	Govt. College, Saidabad, PRG	Joined Online

Semester-wise Titles of Papers

Year	Sem.	Paper Code	Paper Title	Theory / Practical	Credits
I	I	**0120501**	Cytology, Genetics and Infectious Diseases	Theory	04
		0120580	Cell Biology and Cytogenetics Lab	Practical	02
	II	**0220501**	Biochemistry and Physiology	Theory	04
		0220580	Physiological, Biochemical & Hematology Lab	Practical	02
II	III	**0320501**	Molecular Biology, Bioinstrumentation & Biotechniques	Theory	04
		0320580	Bioinstrumentation & Molecular Biology Lab	Practical	02
	IV	**0420501**	Gene Technology, Immunology and Computational Biology	Theory	04
		0420580	Genetic Engineering and Counselling Lab	Practical	02
III	V	**0520501**	Diversity of Non-Chordates, Parasitology and Economic Zoology	Theory	04
		0520502	Diversity of Chordates and Comparative Anatomy	Theory	04
		0520580	Lab on Virtual Dissection, Anatomy, Economic Zoology and Parasitology	Practical	02
	VI	**0620501**	Evolutionary and Developmental Biology	Theory	04
		0620502	Ecology, Ethology, Environmental Science and Wildlife	Theory	04
		0620580	Lab on Environmental Science, Behavioural Ecology, Developmental Biology, Wildlife, Ethology	Practical	02
IV	VII	**0720501**	Biosystematics and Evolution	Theory	04
		0720502	Diversity of Invertebrates	Theory	04
		0720503	Biotechniques and Bioinstrumentation	Theory	04
		0720504	Cell and Molecular Biology	Theory	04
		0720580	Practical		04
	VIII	0720580	Genetics	Theory	04
		0820502	Biochemistry	Theory	04
		0820503	Biostatistics and Bioinformatics	Theory	04
		0820504	Physiology and Immunology	Theory	04
		0820580	Practical		04

Year wise Structure of UG Program in Zoology

Programme/Year	Semester	Paper Code	Course Codes	Paper Title	Credits	Teaching Hours
1 Certificate Course in Medical Diagnostics & Public Health	I	0120501	B050101T	Cytology, Genetics and Infectious Diseases	04	60
		0120580	B050102P	Cell Biology & Cytogenetics Lab	02	60
	II	0220501	B050201T	Biochemistry and Physiology	04	60
		0220580	B050202P/R	Physiological, Biochemical &Hematology Lab	02	60
2 Diploma in Molecular Diagnostics and Genetic Counselling	III	0320501	B050301T	Molecular Biology, Bioinstrumentation & Biotechniques	04	60
		0320580	B050302P	Bioinstrumentation & Molecular Biology Lab	02	60
	IV	0420501	B050401T	Gene Technology, Immunology and Computational Biology	04	60
		0420580	B050402P/R	Genetic Engineering and Counselling Lab	02	60
3 Degree in Bachelor of Science	V	0520501	B050501T	Diversity of Non-Chordates, Parasitology and Economic Zoology	04	60
		0520502	B050502T	Diversity of Chordates and Comparative Anatomy	04	60
		0520580	B050503P	Lab on Virtual Dissection, Anatomy, Economic Zoology and Parasitology	02	60
	VI	0620501	B050601T	Evolutionary and Developmental Biology	04	60
		0620502	B050602T	Ecology, Ethology, Environmental Science and Wildlife	04	60
		0620580	B050603P	Lab on Environmental Science, Behavioral Ecology, Developmental Biology, Wildlife, Ethology	02	60

Subject prerequisite

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

Programme Objectives (POs)

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

Certificate Course in Medical Diagnostics & Public Health

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

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

Degree in Bachelor of Science	
B.Sc III Programme Specific Outcomes (PSOs)	
PSO1	• This programme aims to introduce students to animal diversity of invertebrates and vertebrates. The students will be taught about invertebrates and vertebrates using observational strategies, museum specimens and field reports.
PSO 2	• A variety of interacting processes generate an organism's heterogeneous shapes, size, and structural features.
PSO 3	• Inclusion of ecology and environmental sciences will enrich students with our world which is crucial for human well-being and prosperity. This section will provide new knowledge of the interdependence between people and nature that is vital for food production, maintaining clean air and water, and

	sustaining biodiversity in a changing climate.
PSO 4	• Students will also come to know about the basic principle of life, how a cell divides leading to the growth of an organism and also reproduces to form new organisms.
PSO 5	• The basic concepts of biosystematics, evolutionary biology and biodiversity will enable students to solve the biological problems related to environment.
PSO 6	• At the end of the course the students will be capable enough to comprehend the reason behind such a huge diversity of animals and reason out why two animals are grouped together or remain separate due to similarities and differences which exist at many levels along with ecological, environmental and cellular inputs.
PSO 7	• **The Degree courses will enable students to go for higher studies like Masters and Ph.D in Zoology and Allied subjects.**

Detailed Syllabus- Zoology

4-Year UG Degree (Honours with Research) [FYUGSM] or First Year of M.Sc.

M. Sc. I (ZOOLOGY)

Programme/Class:	**Year:** First	**Semester:** First
Subject: Zoology		
Course code:0720501	**Course Title: Biosystematics and Evolution**	

Course outcome: Taxonomy also known as Systematic biology will help the students to have a broad knowledge of classification, cladogenesis and speciation. Phylogenetic taxonomy will aid in understanding and reconstruction of the phylogeny of life.
Evolution or evolutionary biology aims to impart the concept of evolutionary thoughts that lead to the evolution of the life on earth from most simple to complex forms along with the mechanism and function of various evolutionary factors and forces.

Credits: 4	**Core**
Max. Marks: (25+75)	**Min. Passing Marks: 40**

Total No. of Lecture-Tutorials-Practical (in hours per week):

Unit	Topics:	Total No. of Lectures (60)
I	Science of taxonomy- Concept, History, Scope and Applications of biosystematics, Taxonomy Vs Systematics, Principles of Zoological Classification and nomenclature, Theories, rules and principles of biological classification, Nomenclature and their history, hierarchies of categories and the higher taxa, Key v/s hierarchy. Evolutionary relationship among taxa.	
II	Modern trends in taxonomy- Behavioural taxonomy, Cladistic taxonomy, Chemotaxonomy, cytotaxonomy and molecular taxonomy, Bioinformatics and taxonomy (Bioinformatics tools for classification) Taxonomic collections, preservation, methods and data recording, methods of identification and problems encountered in identification, preparation of taxonomic publication and taxonomic paper.	
III	Origin of Life including aspects of pre-biotic environment. Abiotic and biotic Evolution. Emergence of Thoughts and Theories of Organic evolution. Evidences in favour of organic evolution. Evolutionary Bioinformatics Concept and evidences of molecular evolution, molecular divergence and molecular clocks: molecular tools in phylogeny: origin of new genes and proteins: gene duplication and divergence, in vitro molecular evolution.	
IV	Mechanism of Evolution- Elemental forces of evolution-Isolating Mechanism. Concept of Species, Species category, Intraspecific categories, Speciation: Allopatric and Sympatric, Convergent and Divergent evolution, Sexual Selection, Co-evolution, Natural Selection, Adaptation, Adaptive Radiation and Modifications, Coloration & Mimicry Fossil and Fossilization-Types of fossils, Zoological time scale.	

Recommended Books:

1. Barton, N.H., Briggs, D.E.G., Eisen, J.A. Goldstein, D.B. and Patel, N.H. (2007. Evolution. Cold Spring, Harbour Laboratory Press
2. Dobzhansky Th. et al. (1976): Evolution. Surjeet Publ. (34)
3. Futuyma D. J. (1998): Evolutionary Biology. Sinauer
4. Hall, B.K. and Hallgrimsson, B. (2008) Evolution, IV Edition. Jones and Barlett Publishers
5. Kimura M. (1984): The Neutral Theory of Molecular Evolution. Cambridge.
6. Li Wen-Hsiung and Dan Graur (1991): Fundamentals of Molecular Evolution. Sinauer
7. Ridley, M (2004). Evolution. III Edition. Blackwell publishing
8. Strickberger M. W. (2000): Evolution. Jones and Bartlett
9. White M. J. D. (1978): Modes of Speciation. Freeman
10. G.G.Simpson: Principle of animal taxonomy.
11. E.Mayer: Elements of Taxonomy

Programme/Class:	Year: First	Semester: First
Subject: Zoology		
Course code:0720502	Course Title: Diversity of Invertebrates	

Course outcome: Invertebrates are the numerous and widely diverse group of animals from protozoa to Echinodermata. The course will explain the diversity of invertebrates and comparison of various morphological, physiological phenomenon and adaptations in various phyla. This will help and enable the students to take up the research in life sciences.
In Economic zoology various types of economically important cultures have been given place to enable the students to be skilled in these and in future can start their own business. Along with-it various types of pest and pest management programmes are also included to impart the broad knowledge and to arm the students to deal with the menace of pests.

Credits: 4	Core:
Max. Marks: (25+75)	Min. Passing Marks: 40

Total No. of Lecture-Tutorials-Practical (in hours per week):

Unit	Topics:	
I	Protozoa, General characters and outline classification, locomotion and reproduction in protozoa. Porifera. General characters and outline classification, canal system, skeleton and regeneration in sponges Cnidaria: General characters and outline classification, polymorphism in cnidarians, gradation of metagenesis, coral and coral reefs.	**Totals No. of Lectures (60)**
II	General characters and outline classification of Platyhelminthes and nemathelminthes, Parasitic adaptations in helminths. Annelida: Important features, outline classification, segmentation and coelom, excretory system and regeneration. Onychophora: Outline classification, general organisation and affinities.	
III	Arthropoda. Important features, outline classification, Integumentary system, respiratory system and larval forms in crustacean Mollusca: Important features, outline classification, shell, root, and its modifications, torsions and detorsion in gastropoda. Echinodermata- Important features, outline classification, body wall and skeleton, larval forms and regeneration.	
IV	Minor non coelomate phyla: General organisation, classification and affinities of phylum rotifer and acanthocephalan. Minor coelomate phyla: General organization, classification and affinities of Phylum Chaetognatha, Pogonophora, Phoronida and Brachiopoda. Hemichordata: General organisation, classification and affinities.	

Recommended Books-

1. Barnes. Invertebrate Zoology (Holt-Saunders International, 4th edition, 1980)
2. Barnes et al (2009). The Invertebrates – A synthesis. Wiley Blackwell 17
3. Brusca and Brusca (2016) Invertebrates. Sinauer
4. Hunter. Life of Invertebrates, Collier Macmillan Pub. 1979
5. Jan Pechenik (2014) Biology of the Invertebrates. McGraw Hill
6. R.L. Kotpal Invertebrate series; Textbook of Invertebrates
7. Marshall. Parker & Haswell Text Book of Zoology, Vol. I, 7th edition, Macmillan, 1972

8. Moore: An Introduction to the Invertebrates, Cambridge University Press, 2001.

Programme/Class:	**Year:** First	**Semester:** First
Subject: Zoology		
Course:0720503	**Course Title: Biotechniques and Bioinstrumentation**	

Course outcome: The students at the end of course will have a deep insight into various biotechniques and enable them to apply these in their future researches. The course is expected to provide sufficient information to enable the students to select a technique that would be appropriate for a particular analysis and would help them to develop a valid and reliable analytical method. They will also able to start their own biotechniques research labs, a further step towards self-employment.

Credits: 4	**Core**
Max. Marks: (25+75)	**Min. Passing Marks: 40**

Total No. of Lecture-Tutorials-Practical (in hours per week):

Unit	**Topics:**	
I	Introduction to Microscopy, Resolving Power, Limit of Resolution and Magnification, Types of microscopes, Basic principles of Light, Electron, Fluorescence and Confocal Microscopy Chromatography and Centrifugation types.	**Totals No. of Lectures (60)**
II	Buffers, pH meter, Colorimetry, Spectrophotometry, UV/IR spectroscopy, mass spectroscopy, X-ray crystallography, N.M.R.	
III	Electrophoretic techniques: Agarose Gel Electrophoresis, Polyacrylami Electrophoresis (PAGE), Southern, Northern and Western blotting, Autoradiography Raising Polyclonal and Monoclonal Antibodies, Antigen-Antibody Int Immunodiffusion, ELISA, Radioimmunoassay	
IV	Cell culture and its basic requirements. Culture media-Nutrient and Non-nutrient, commonly used media for human cell lines. Sterilization of culture wares and media, Cell harvesting and Storage Methods, Autoclave and Laminar Air Flow, Safe laboratory practices.	

Books Recommended

1. Boyer: Modern Experimental Biochemistry and Molecular biology (2nd Ed.), Benjamin/Cumin, 1993
2. Clark and Switzer. Experimental Biochemistry. Freeman (2000)
3. Freifelder: Physical Biochemistry (2nd Ed.), Freeman and Company, 1982

4. Holme and Peck: Analytical Biochemistry (3rd Ed.), Tata McGraw Hill, 1998
5. Plumer: An Introduction to Practical Biochemistry (3rd Ed.), Tata-McGraw Hill, 1990
6. R.C. Dubey and D.K. Maheshwari: A textbook of Microbiology
7. S.V.S. Rana: Biotechniques Theory and Practice
8. Sambrook et. al. Molecular cloning Vols I, II, III. CSHL (2001)
9. Wilson and Walker: Practical Biochemistry (3rd Ed.), Cambridge Univ. Press, 2000.

Programme/Class:	**Year:** First	**Semester:** First
Subject: Zoology		
Course code: 0720504	**Course Title: Cell and Molecular Biology**	
Course outcome: Today cytology not only attracts the students from life sciences but also from other streams. Physicist have invented a lot of instruments and chemists provide the information of chemical composition and their processing along with synthesis of biomolecules. The course will attract the students to do their best in further advancement in the field of cytology and molecular biology. Advance topics related to molecular biology have been incorporated to enable the students to have a deep insight in the subject and prepare them for research.		
Credits: 4	**Core**	
Max. Marks: (25+75)	**Min. Passing Marks: 40**	
Total No. of Lecture-Tutorials-Practical (in hours per week):		

Unit	**Topics:**	**Total s No. of Lectures (60)**
I	Cell membrane- Structural organisation of bio-membrane. Functions of plasma membrane (transport. diffusion, pumps, uniports, symports and anti-ports). Cell organelles-origin. structure and function of nucleus, mitochondria, endoplasmic reticulum and ribosomes, Golgi complex, endosome, lysosomes, peroxisomes, centrosome	
II	Cytoskeleton, Organisation and dynamics of microtubules. actin filaments (micro-filaments), intermediate filaments, cilia & flagella. Cell communication cell- cell signalling, cell surface receptors, second messenger system, kinase pathways, signalling from plasma membrane to nucleus (signal trans-duction).	

III	Cell adhesion & cell junctions- Cellular affinity, cell adhesion molecules (CAMS), Ca++ dependent cell-cell adhesion, Ca++ independent cell-cell adhesion, cadherins, selectins, integrins, cell junctions. DNA replication, repair and recombination (Unit of replication, enzymes involved, replication origin and replication fork, fidelity of replication, extrachromosomal replicons, DNA damage and repair mechanisms.	
IV	Transcription in prokaryotes and eukaryotes, RNA processing, RNA editing, splicing, structure and function of different types of RNA, RNA transport Translation in prokaryotes and eukaryotes, Genetic code, Post-translation modification of proteins, protein targeting. Gene regulation, Lac operon, trp operon, Arabinose operon. Gene regulation in eukaryotes	

Book recommended

1. Alberts et al: Molecular Biology of the Cell (4th Ed.), Garland,2002
2. Lodish et al: Molecular Cell Biology (5th Ed.), Freeman, 2004
3. DeRobertis & DeRobertis: Cell & Molecular Biology, Lea & Febriger, 1987
4. Berg et al.: Biochemistry (5th Ed.), Freeman, 2002
5. Michael Jr.: Microbiology, Tata McGraw Hill, 1990s
6. P.K. Gupta: Cell and molecular biology
7. Karp: Cell and molecular biology: Wiley (2002).
8. Cooper: Cell. A Molecular approach: ASM Press (2000)

Practical Course Syllabus **Semester I** **Credit -4** **Time -4 Hrs**

- Virtual Dissection
- Major Dissection- Nervous system of Prawn, Pila, Unio, Sepia, Octopus
- Minor Dissection- Setae, nephridia, appendages of Prawn, statocyst, hastate plate, radula, Anatomy of Holothuri
- Mounting- Gemmules, spicules, Obelia colony, medusa of obelia, Pennatula, Crustacean larva
- Microtomy- Source tissue, fixing, dehydration, block making, section cutting and staining
- Slides and specimens of various invertebrate phyla
- Taxonomy- Cytotaxonomy, collection, identification, nomenclature and preservation of museum specimer Maintenance of museum
- Evolution- Preparation of coacervates, adaptive radiation in Darwin Finches through chart and models, Webe line, Wallace line through chart or model.
- Numerical based on gene pool and genetic drift. Demonstration/ photography of mimicry, protective coloration.
- Elementary knowledge about preparation of various reagents used in laboratory
- Microscopy- Light microscope, phase contrast, confocal microscope
- Flow cytometry, Centrifugation, Electrophoresis, chromatography
  Ag- Ab in tab str, Immunoprecipitation, ELISA, Demonstration / virtual demonstration of monoclonal antibodie
  Hybridoma Technology through chart,
  Western blot, DNA isolation and its quantification through stage of mitosis and meiosis, Squash technique
- Field study / visit and project (mandatory)

Distribution of Marks-

• Major Dissection	-	10
• Minor Dissection	-	05
• Mounting	-	$(2^{\overline{11}}x2)$
• Microtomy	-	10 (4+3+3) (Section cutting, stretching and staining)
• Spotting	-	10 (1x10)
• Evolution	-	5
• Techniques	-	10
• Cell Biology	-	10
• Mol. Biology	-	5
• Collection field visit	-	10
• Viva	-	10
• Record	-	10

Programme/Class:	Year: First	Semester: Second
Subject: Zoology		
Course code:0820501	**Course Title: Genetics**	

Course outcome: The course will enable the students to apply the skills of genetic technologies in various fields related to pharmaceuticals, biotechnology and diagnostic clinics. It will bring awareness on various genetic disorders, its inheritance patterns and to develop techniques of fighting against these disorders.

Credits:	Core:
Max. Marks: (25+75)	**Min. Passing Marks: 40**

Total No. of Lecture-Tutorials-Practical (in hours per week):

Unit	Topics:	Totals No. of Lectures (60)
I	Mendelian principles-Dominance, segregation, independent assortment, deviations from Mendelian inheritance. Methods of genetic transfer-Transformation, conjugation, transduction, bacteriophages-types, structure and morphology of T_4 phage.	
II	Chromosomes-Molecular anatomy of eukaryotic chromosomes, heterochromatin and euchromatin, Organisation of genetic material-packaging of DNA as nucleosomes in eukaryotes, repetitive and unique DNA sequences, split genes, overlapping genes and pseudogenes, giant chromosomes, polytene and lampbrush chromosomes, sex chromosomes Gene mapping-Concept of recombination, linkage map, cytogenetic map, physical map, molecular maps, levels of genome mapping, Genetic code-Properties of genetic code.	
IV	Genetic techniques- Cloning, PCR, DNA sequencing FISH, GISH, DNA fingerprinting. Chromosome walking, Applications of genetic engineering. Somatic cell genetics-cell fusion and hybrid –agents and mechanism of fusion, heterokaryon.	
V	Structural and numerical alteration of chromosomes Genetic disorders-chromosomal disorders, inborn errors of metabolism, Tay sachs disease, albinism, phenylketonuria, Lesch-Nyhan chromosome. Population genetics-Gene pool and gene frequencies, Hardy- Weinberg law of genetic equilibrium and changes in gene frequencies.	
	Books Recommended 1. Brooker: Genetics: Analysis and Principles (Addison-Wesley, 1999) 2. Gardner et al: Principles of Genetics (John Wiley, 1991) 3. Griffith et al: Modern Genetic Analysis (Freeman, 2002) 4. P.K. Gupta: Genetics 5. Lewin, Genes VIII (Wiley, 2004) 6. Russell: Genetics (Benjamin Cummings, 2002) 7. Snustad & Simmons: Principles of Genetics (John Wiley, 2003). 8. Benjamin A. Pierce: Genetics: a conceptual approach	

Programme/Class:	Year: First	Semester: Second
Subject: Zoology		
Course code: 0820502	**Course Title: Biochemistry**	
Course outcome: Biochemistry is regarded as the mother of all biological sciences disciplines as it unveils the chemical basis of life an all the living organisms from micro-organisms to plants and animals. Keeping in pace with the developing trends in various areas of biochemistry the subject course contains fundamental as well as latest and upcoming developments in the field of biochemistry.		
Credits:4	**Core**	
Max. Marks: (25+75)	**Min. Passing Marks: 40**	
Total No. of Lecture-Tutorials-Practical (in hours per week):		

Unit	Topics:	Total s No. of Lectures (60)
I	Structure of atoms, molecules and chemical bonds Composition, structure and function of biomolecules carbohydrates, lipids, proteins, Conformation of proteins (Ramachandran plot, secondary, tertiary and quaternary structure; domains; motif and folds) nucleic acids and vitamins. Principles of biophysical chemistry pH, buffer, reaction kinetics, thermodynamics, colligative properties.	
II	Enzymes, classification, enzyme kinetics, mechanism of enzyme catalysis, enzyme regulation, isozymes, coenzymes, Abzymes, ribozymes. Enzyme technology: engineering, immobilization, physical, adsorption, entrapment, covalent modifications. Bioenergetics, high energy rich biomolecules, phosphoryl transfer reactions, oxidation reduction reactions.	
III	Carbohydrate metabolism: glycolysis, gluconeogenesis, glycogenolysis, glycogenesis, pyruvate oxidation, TCA cycle, PPP pathway, oxidative phosphorylation. Lipid metabolism beta oxidation of fatty acid, steroid synthesis, cholesterol synthesis, fatty acid synthesis (SFA, UFA).	
IV	Protein metabolism (catabolism of carbon skeleton, nitrogen skeleton, urea cycle) Nucleic acid metabolism (Synthesis of purines and pyrimidines nucleotides and its catabolism).	

Books recommended:

1. Nelson et al: Lehninger Principles of Biochemistry (3rd Ed.), MacMillan Worth, 2000
2. Berg et al.: Biochemistry (5th Ed.), Freeman, 2002
3. J.L. Jain: Fundamental of Biochemistry
4. Mathews et al.: Biochemistry (3rd Ed.), Pearson, 2004 (37)
5. Zubay et al: Principles in Biochemistry (2nd Ed.), WCB, 1995
6. Murray et.al: Harper's Illustrated biochemistry: McGraw Hill (2003) Elliott and Elliott
7. Lubert Stryer: biochemistry
8. Voet & Voet. Biochemistry Vols I &2: Wiley (2004)

Programme/Class:	**Year:** First	**Semester: Second**
Subject: Zoology		
Course code:0820503	**Course Title: Biostatistics and Bioinformatics**	

Course outcome: The course will lead to comprehensive understanding of the principles and various practices of biotechnology. The aim will be to produce the responsible biotechnologists.
Bioinformatics is the emerging branch in the field of life science. The course covers the principles and computational methods used to search and compare the DNA, RNA and proteins cast as biological sequences. This will also help in the field of evolutionary biology to solve the mystery evolutionary relationship among different species.

Credits: 4	**Core:**
Max. Marks: (25+75)	**Min. Passing Marks: 40**

Total No. of Lecture-Tutorials-Practical (in hours per week):

Unit	**Topics:**	**Total No. of Lectures (60)**
I	Biostatistics – Basic concepts. Fundamentals of measurement. Qualitative & Quantitative Variables, Collection, Classification, Tabulation & Presentation of data Mean, Median, Mode, Dispersion, Standard Deviation and their merits & demerits.	
II	Chi-square test & 't' test. Analysis of variance, Probability Distribution and normal distribution (Gaussian Distribution) Correlation Analysis – Importance of Correlation Analysis. Types and measures of Correlation. Regression Analysis. Regression of Y on X and X on Y.	

III	Bioinformatics – Introduction. Components of Computer, Internet – Basics for Biologists (Electronic mail, Electronic Mail Servers, Downloading files with anonymous File Transfer Protocol, Gopher, WWW, Mosaic. Primary & Secondary Databases. Sequence Databases (European Molecular Biology Laboratory, Gene bank). DNA Data Base of Japan (DDBJ), SWISS-PORT, Protein Information Resource, TREMBL, Protein Family/Domain Databases (Prosite. Pfam & Prints).	
IV	Submitting sequence to Database and information retrieval through ENTREZ. Collecting & Storing Sequences, Local alignment, Global Alignment, BLAST (BLASTP, BLASTN, BLASTX, TBLASTN, TBLASTX). Phylogenetic Prediction, Gene Prediction & Analysis	

Recommended Books:

1) Bioinformatics for geneticists: Wiley (2003)
2) Lesk: Bioinformatics, Oxford (2003, Indian ed)
3) Westhead et al: Bioinformatics Instant Notes, Viva Books (2003, Indian ed)
4) Jerrold H. Zarr: Biostatistical Analysis (Fourth edition), Pearson Education Inc., Delhi
5) W.W. Daniel and C.L. Cross: Biostatistics (Tenth edition), Wiley
6) John E. Havel, Raymond, E. Hampton and Scott J Meiners: Introductory Biological Statistics (Fourth edition)
7) Satguru Prasad: Elements of Biostatistics
8) Pranab Kumar Banerjee: Introduction to Biostatistics

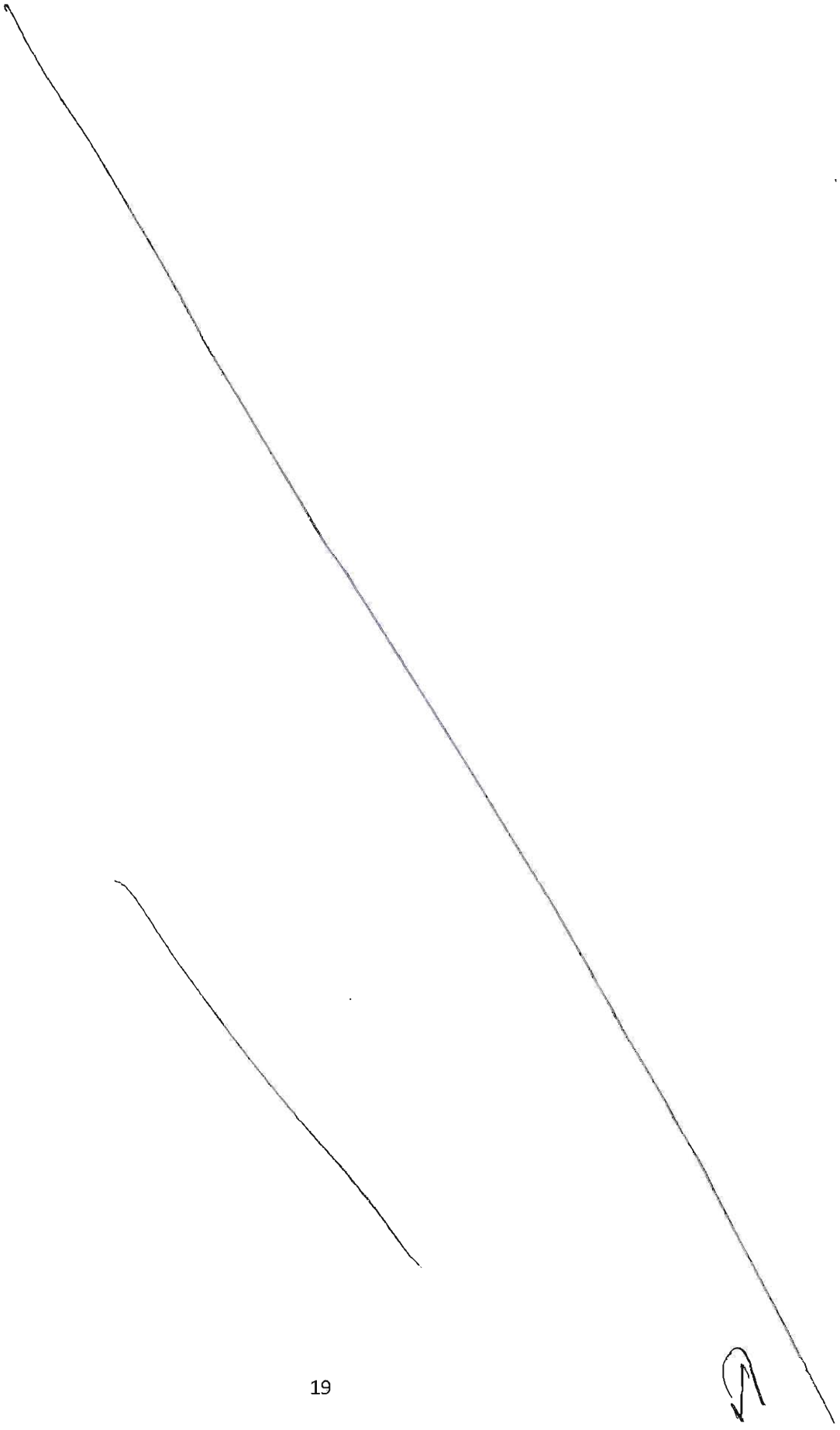
Programme/Class:	**Year:** First	**Semester:** Second
Subject: Zoology		
Course code:0820504	**Course Title: Physiology and Immunology**	
Course outcome: The course will enable students to understand the functions of important physiological systems, will allow the students to identify the glands, organs, tissues and cells that synthesize and secrete hormones, hormones precursors and associated compounds along with the regulation of hormones and their biological activities. The course will allow the students to have a deep insight into various concepts of immune system and its detail mechanism		
Credits: 4	**Elective**	
Max. Marks: (25+75)	**Min. Passing Marks: 40**	

Unit	**Topics:**	**Total**

I	Physiology of Neurons, Axonal and Synaptic transmission central and peripheral nervous system. Sense organs: Vision (Retinal components and photoreceptors), olfactory, hearing and tactile response.	**No. of Lecture s (60)**
II	Thermoregulation - Comfort zone, body temperature – physical, chemical, neural regulation, acclimatization. Stress and adaptation. Physiology of muscle, Sequence of events in contraction and relaxation of skeletal muscle, energetics of muscle contraction and its neural regulation.	
III	Concept, Objectives, Scope and Techniques in Endocrinology, Hormones classification. Autocrine/Paracrine signals. Miscellaneous regulatory substances (erythropoietin, somatomedin growth factors, eicosanoids etc). Neuroendocrine system. Harmone- genesis, transport, distribution. Mechanism of hormone action. Cell surface receptors and intracellular signalling. Hypothalamus. Pituitary, Pineal, thyroid, parathyroid, thymus, adrenal.	
IV	Lymphoid organs of the body, thymus, bone marrow, lymph nodes spleen, GALT, MALT, Types of immunity, Innate immunity, acquired immunity (Humoral and cell mediated immunity), Lymphoid cells (T-lymphocytes, B-lymphocytes), mononuclear cells, granulocytic cells, mast cells, basophils, dendritic cells, MHC molecules and compliments. Structure of immunoglobulins- IgG, IgM, IgA, IgE, monoclonal antibodies, Antigen antibody interactions, cross reactivity, precipitation reaction, agglutination reaction. Hypersensitivity, Autoimmunity, Transplantation, Immunodeficiency diseases, Passive immunization, active immunization, Vaccines, designing of vaccines.	

Recommended Books:

1. C.C. Chatterjee: Human physiology vol 1&2. 11th edition. CBS Publishers (2016)
2. Ganong: Review of Medical Physiology (21st Ed.), Lang Medical Publications, 2003
3. Guyton and Hall: Text Book of Medical Physiology. XI Edition. Hercourt Asia PTE Ltd./W.B. Saunders, 2006
4. Keel et al: Samson Wright's Applied Physiology (13th Ed.), Oxford Press, 1989
5. Vertebrate Endocrinology by Norris (Lea and Febigar)
6. Basic & Clinical Endocrinology by Greenspan and Strewler
7. Essentials of Immunology, David, Brostoff and Roitt, Mosby & Elsevier Publishing
8. Kuby Immunology by Glodsy, Kindt and Osborne
9. Cellular and Molecular Immunology by Abul K. Abbas, Andrew H. Lichtman, Shiv Pillai, Elsevier Publishing
10. Immuno Biology- The immune system in health and disease, Janeway, Travers, Walport and Shlomchik, Garland Science Publishing
11. Brooks and Marshall: Essentials of Endocrinology, Blackwell Science. 1995



Practical Course Syllabus **Semester II** **Credit -4** **Time -4 Hrs**

- Numerical related to deviation of Monohybrid and Dihybrid ratio.
- Numerical related to H & W law.
- Barr's Body, Karyotype, Idiotype
- Chromosome banding Pattern.
- Study of (case) of Genetic disorders- Demonstration.
- Pedigree analysis by chart / demonstration
- **Biostatistics**- Histogram, Bar chart, Pie diagram, Central tendency, standard deviation Chi square test, t-test,
- **Bio informatics**- BLAST, FASTA, Protein Data base, primer designing for gene amplification
  - Genomic annotation, using ORF (open reading Frame), construction of phylogenetic Tree, Software to study Protein structure.
- **Physiology**-
  - Histological slides – Pituitary, Thyroid, Parathyroid, Adrenal glands, Kidney, CNS, arteries, veins, Liver, Pancreas, Testes, Ovary.
  - RBC, WBC Count, Bleeding time, Clotting time,
  - Hb %, Haemin Crystals, ESR, Blood group determining test
  - B.P., Muscle twitch, Knee jerk, Reflex action
- **Biochemistry**-
  - Osmosis. pH, Buffers, Biochemistry test related to carbohydrate Protein lipid, Nucleic acid
  - Project report lab related to Bioinformatics and Biochemistry.

Marks Distribution-

• Genetics	1-Numerical	15
• Bio Stat	Numerical	15
• Bioinformatics	(Exp.)	10

Experiments

• Physiology-2/Endocrinology	10
• Bio chemistry -2	10
• Spotting	10
• Field/ Project report	10
• Viva	10
• Record	10

- *Students who want to opt 4- year UG Degree, Honours with research (and has secured 75% marks in the subject in all the three years) will choose any three of the above given theory papers (4 credits each) along with research project (4 credits each) in both VII & VIII Semester.
- *Under the Apprenticeship/Internship embedded UG degree programme the student should complete a Training Programme (1200 hrs. -40 credits) through NATS or from equivalent Organisation. The degree holder has to do 1- year PG Programme. It is purely optional for the University, to run and give this degree.