



Ramakrishna Mission
Vivekananda Centenary College, Rahara

Department Of Zoology

Syllabi for M.Sc. in Zoology offered by the
Department Under
CHOICE BASED CREDIT SYSTEM

Session 2020-2021

The course of M.Sc. Zoology is modified under CBCS syllabus,
2020-2021 vide BOS resolution dated 29th November, 2020

Total Change= 100%

Pradyot Kumar Medda

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R. K. Mission V.C. College
Rahara, Kol-700118

After completion of the M.Sc. Degree programme, the students will be able to

PO No.	PROGRAMME OUTCOMES	Cognitive Level
PO 1	Outline and demonstrate the basic concepts by acquiring a comprehensive knowledge in the newer emerging field of knowledge.	R, U
PO 2	Perform experiments, analyse & interpret the obtained accurate results and thus gain the ability to solve problems.	Ap, An, E
PO 3	Apply and evaluate the basic ideas to their thoughts, actions, and interventions for the societal benefits through the development of entrepreneurship.	Ap, E
PO 4	Develop the ability to involve in critical, independent, and inventive thinking for the engagement in research and development on the emerging topics.	C

R= remembering, U = understanding, Ap = applying, An = analysing, E = evaluating, and C = creating

PROGRAMME SPECIFIC OUTCOMES

After completion of these programme the student would be able to

PSO No.	PROGRAMME OUTCOMES	Cognitive Level
PSO 1	Define, Demonstrate and apply the value of animal life's diversity and complexity as learn the various aspects on morphology, physiology, developmental biology, Neurobiology, cellular and molecular biology and biochemistry.	R, U, Ap
PSO 2	Demonstrate and apply the basic models in ecological and environmental sciences those may inculcate them to design sustainable management policies for global, regional or local ecosystem.	U, Ap, C
PSO 3	Illustrate, examine and evaluate the sophisticated scientific methodologies in practical and advanced zoological sciences by gaining cognitive and hands-on experience.	U, E
PSO 4	Apply, analyse and elaborate statistical methods, bioinformatics software, and biology-integrated technology on different scientific areas namely, immunology, endocrinology, biotechnology, microbiology and genetics to solve biological challenges	Ap, An, C
PSO 5	Apply and compile the varied range of subject based skills to various fields that provide a foundation for future career in disciplines such as Health Sciences, Agriculture, Environmental Management, Biotechnology, Teaching and Research	Ap, C

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POST GRADUATE COURSE IN ZOOLOGY

Semester - I		July - December			
	Paper Code	Topic	Marks	Credit	
	PGZOOCC 1.1	Diversity and biology of Nonchordates	50	4	
	PGZOOCC 1.2	Diversity and biology of Chordates	50	4	
	PGZOOCC 1.3	Cell biology & Instrumentations	50	4	
	PGZOOCC 1.4	Genetics	50	4	
	PGZOOCC 1.5	Structures & systems of organisms	50	4	
	PGZOOCC 1.6	Tools & techniques in biological study	50	4	
		Total	= 300	24	
	PGZOOSOC 1	Yoga	25	1	
Semester - II		January - June			
	Paper Code	Topic	Marks	Credit	
	PGZOOCC 2.1	Biochemistry & Metabolism	50	4	
	PGZOOCC 2.2	Molecular biology & Biotechnology	50	4	
	PGZOOCC 2.3	Ethology & chronobiology	50	4	
	PGZOOCC 2.4	Ecological sciences	50	4	
	PGZOOCC 2.5	Biochemical and molecular aspects of life	50	4	
	PGZOOCC 2.6	Ethology & Ecology	50	4	
		Total	= 300	24	
	PGZOOSOC 2	Communicative English	= 25	1	
Semester - III		July - December			
	Paper Code	Topic	Marks	Credit	
	PGZOOCC 3.1	Parasitology and Immunology	50	4	
	PGZOOCC 3.2	Developmental biology and Neurobiology	50	4	
	PGZOOCC 3.3	Endocrine physiology	50	4	
	PGZOOCC 3.1A/1B	Elective paper 1A (Entomology) / 1B (Cellular and Molecular Biology)	50	4	
	PGZOOCC 3.4	Immunology, Parasitology, Developmental biology & Endocrinology	50	4	
	PGZOOCC 3.2A/2B	Dissertation and practical of elective paper 2A/ 2B	50	4	
		Total	= 300	24	
	PGZOOSOC 3	Value Education and Indian Culture	= 25	1	
Semester - IV		January - June			
	Paper Code	Topic	Marks	Credit	
	PGZOOCC 4.1	Taxonomy and Biostatistics	50	4	
	PGZOOCC 4.2	Bioinformatics and Computational Biology	50	4	
	PGZOOCC 4.3	Bio python and LaTeX	50	4	
	PGZOOCC 4.1A/1B	Elective paper 1A (Entomology)/ 1B (Cellular and Molecular Biology)	50	4	
	PGZOOCC 4.4	Phylogenetics, Biostatistics and Bioinformatics	50	4	
	PGZOOCC 4.2A/2B	Submission of final dissertation and practical of elective paper 2A / 2B	50	4	
		Total	= 300	24	
	PGZOOSOC 4	Fundamentals of remote sensing and GIS	= 25	1	
		Total	= 1300	100	

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SEMESTER – I	
Course name	Diversity and Biology of Nonchordate
Course code	PGZOOCC 1.1
Course type	Theory
Number of lectures	60
Credits	4
Marks	50

Course Objectives:

After completion of this course the student will be able to

Sl. No.	Course Objectives:
1:	Remembers, understands and apply the protozoan reproduction, polymorphism in cnidarians, nervous system in molluscs and importance of sponges and various larvae
2:	Understand and evaluate the invertebrate defence and feeding mechanisms
3:	Understand and evaluate the adaptive radiation, evolution, affinities of a variety of invertebrates
4:	Understand and analyse the compound vision in arthropods, insect flight mechanism

PGZOOCC 1.1: Diversity and Biology of Nonchordates

Class: 60hrs

- ❖ Nucleus and reproduction of protozoa
- ❖ Biological and medicinal importance of sponges
- ❖ Polymorphism and regeneration of Cnidarians
- ❖ Adaptive radiation in polychaetes; Trochophore larva: structure and significance
- ❖ Mollusca: Nervous system; Modifications of foot
- ❖ Arthropoda: Affinities of trilobites; Crustacean larvae and their significance, compound vision, insect flight mechanism.
- ❖ Factors influencing respiration (body and size, activity, feeding, temperature, oxygen tension and salinity)
- ❖ Invertebrate defence against predators and parasites
- ❖ Evolution of metazoans; origin, radiations and extinction of invertebrate groups; evolution of and early organizer concept
- ❖ Types of invertebrate feedings.
- ❖ Salient features and affinities of: Ctenophora, Rotifera, Phoronida.

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Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes:	POs Addressed	PSOs Addressed	Cognitive Level
CO 1:	Describe and demonstrate the protozoan reproduction, polymorphism in cnidarians, nervous system in molluscs	PO 1	PSO 1	R, U
CO 2:	Apply the biological and medicinal importance of various larvae and sponges respectively	PO 3	PSO 1	Ap
CO 3:	Demonstrate the invertebrate defence and feeding mechanisms	PO 1	PSO 1	U
CO 4:	Analyse and discuss the adaptive radiation, evolution, affinities of a variety of invertebrates	PO 1	PSO 1, 5	An, C
CO 5:	Compare and apply the compound vision in arthropods, insect flight mechanism	PO 3	PSO 1, 5	E, Ap
CO 6:	Acquire skills in teaching about the structural and functional features of invertebrate animal life's diversity	PO 4	PSO 4, 5	Ap

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Books for Reference:

- Ahmed, N., Dawson, M., Smith, C. and Wood, Ed. (2006). Biology of Disease. Taylor and Francis.
- Ahsan, J. and Sinha S.P. (2010). A Handbook on Economic Zoology. S. Chand Company.
- Brusca, R.C. and Brusca, G.J. (2002). Invertebrates. 2nd edition, Sinauer Associates.
- De Sarkar, D. (1998). The Silk worm: Biology, Genetics and Breeding. Vikas Publishing House.
- Mayr, E. & Ashlock, P.D. (1991). Principles of Systematic Zoology. 2nd edition, McGraw-Hill, Inc.
- Meglitsch, P.A. and Schram, F.R. (1991). Invertebrate Zoology. 3rd edition, Oxford University Press.
- Parker, T.J. and Haswell, W.A., ed. By Marshall, A.J. and Williams, W.D. (1995). Text book of Zoology: Invertebrates. Vol. 1, 7th edition, Indian edition, A.I.T.B.S. Publishers.
- Pechenik, J. A. (2015). Biology of the Invertebrates. 7th edition, McGraw Hill Education.
- Ruppert, E. E. and Barnes, R.D. (1994). Invertebrate Zoology, 6th edition, Harcourt Publishers.
- Ruppert, E. E., Fox, R.S. and Barnes, R.D. (2004). Invertebrate Zoology, A functional Evolutionary Approach. 7th edition, Indian edition, Cengage Learning.
- Simpson, G.G. (1961). Principles of Animal Taxonomy. Columbia University Press, New York.

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SEMESTER – I	
Course name	Diversity and Biology of Chordates
Course code	PGZOOCC 1.2
Course type	Theory
Number of lectures	60
Credits	4
Marks	50

Course Objectives:

After completion of this course the student will be able to

Sl. No.	Course Objectives:
1:	Remembers and understands the characteristic features and affinities of Protochordata (Hemichordata Urochordata, Cephalochordata), Cyclostomes, Dipnoi
2:	Understand and evaluate the origin of birds and mammals
3:	Understand and evaluate the Skeletal system and its functional and evolutionary significance
4:	Understand, analyse and apply the Circulatory systems, Nervous system and Sense organ
5:	Understand and analyse Structural Adaptation of different vertebrates

PGZOOCC 1.2: Diversity and Biology of Chordate

Class: 60hrs

- ❖ Characteristic features and affinities of the following: Protochordata (Hemichordata Urochordata, Cephalochordata), Cyclostomes, Dipnoi
- ❖ Origin of the Birds and Mammals
- ❖ Skeletal system: Origin of jaw and modification of jaw bones and types; functional and evolutionary significance, Jaw kinetics in relation to feeding.
- ❖ Circulation: Heart and circulation in fetal and neonatal mammal, Evolution of portal system.
- ❖ Nervous system & Sense organ: Sensory receptors and classification, Organ of olfaction and taste.
- ❖ Structural Adaptation: Structural elements of body and their properties, Mechanics of support and movement, Swimming adaptation, Cursorial adaptation, Flying mechanism.
- ❖ Modification of beaks, feet and palate in birds
- ❖ Dentition and Stomach in mammals

Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes:	POs Addressed	PSOs Addressed	Cognitive Level
CO 1:	Describe the characteristic features and explain the affinities of Protochordata (Hemichordata Urochordata, Cephalochordata), Cyclostomes, Dipnoi	PO 1	PSO 1	R, U
CO 2:	Demonstrate and evaluate the origin of birds and mammals	PO 3	PSO 1, 2	U, E
CO 3:	Demonstrate and analyse the Skeletal system and its functional and evolutionary significance	PO 2, 3	PSO 1	U, An
CO 4:	Illustrate and apply the Circulatory systems, Nervous system and Sense organ	PO 3	PSO 1, 5	U, Ap
CO 5:	Analyse and discuss structural adaptation of different vertebrates	PO 4	PSO 1, 5	An, C

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Books for Reference:

- Banerjee, G.C. (1986). Poultry. 2nd edition, Oxford and IBH Publishing.
- Duellman, W.E. and Trueb, L. (1986). Biology of Amphibians. JHU Press.
- Hildebrand, M and Gaslow G.E. Analysis of Vertebrate Structure, John Wiley and Sons
- Jordan, E.L. and Verma, P.S. (2003). Chordate Zoology. S. Chand and Company.
- Kardong, K. V. (2015). Vertebrates: Comparative Anatomy, Function, Evolution. 7th edition, McGraw Hill Education.
- Kent, G. C. and Carr, R. K. (2001). Comparative Anatomy of the Vertebrates. 9th edition, McGraw Hill.
- Nelson, J.S., (2006). Fishes of the World, 4th edition, Wiley.
- Parker, T. J. and Haswell, W. (1972). Text Book of Zoology, Volume II: Marshall and William (Editors). 7th edition, Macmillan Press, London.
- Pough, F.H., Janis, C.M. and Heiser, J.B. (2013). Vertebrate life, 9th edition, Pearson.
- Romer, A. S. and Parsons, T. S. (1986). The vertebrate body. 6th edition, Saunders College Publishing.
- Sinha, K. S., Adhikari, S., Ganguly, B. B. and Goswami, B. (2001). Biology of Animals. Vol. II. New Central Book Agency (p) Ltd.
- Walter, H.E. and Sayles, L.P; Biology of Vertebrates, Khosla Publishing House
- Young, J. Z. (1981). The Life of Vertebrates. 3rd edition, Oxford University Press.

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SEMESTER – I	
Course name	Cell biology & Instrumentations
Course code	PGZOOCC 1.3
Course type	Theory
Number of lectures	60
Credits	4
Marks	50

Course Objectives:

After completion of this course the student will be able to

Sl. No.	Course Objectives:
1:	Understand, analyse and apply the buffer systems and its importance in biological science
2:	Acquire and apply various knowledge on tools and techniques in cell biology
3:	Remember and understand the structure and function of cell membrane and cell organelles
3:	Remember, understand, and apply the cellular communications mechanisms

PGZOOCC 1.3: Cell Biology and Instrumentations

Class: 60hrs

- ❖ Buffers: pH and its determination, Derivation of Henderson-Hasselbalch equation, Maintenance of pH in cells, Preparation of buffers and related calculations
- ❖ Centrifugation: Basic principles, Types of rotors, Clinical, high speed & ultracentrifuge
- ❖ Spectrophotometry: Beer-Lambert's law, molar extinction coefficient and calculation, Absorption spectrum, Colorimeter and UV- vis Spectrophotometer
- ❖ Electrophoresis: Agarose- and polyacrylamide gel, Two-dimensional, Isoelectrofocussing Chromatography: Paper and Thin layer chromatography, Column chromatography, Gel filtration Ion-exchange, Affinity, FPLC, HPLC
- ❖ Radio-tracer techniques: Unit of radioactivity and half life, Measurement of radioactivity (β and γ emission), Applications of radioisotopes, Safety measures
- ❖ Detection of nucleic acids and proteins: Southern blotting, Northern blotting, Western blotting, ELISA, PCR
- ❖ Types of microscopes and their biological applications: Bright-field microscope, numerical aperture, limit of resolution, types of objectives, ocular & stage micrometers, Dark-field microscope, Phase-contrast microscope, Fluorescence microscope, Confocal microscope, Atomic force microscope, Transmission and scanning electron microscopes, Photomicrography and image processing

- ❖ Cell Membrane: Lipid bi-layer, Membrane proteins & Fluid mosaic model; Transport: Diffusion, Osmosis and measurement of osmotic pressure, Active transport: Mechanism and related calculations; Targetting and sorting of proteins: Processing through endomembrane system, Targetting of cytosolic proteins
- ❖ Mitochondria: Structure; Assemblies of respiratory chain & Fo-F1 ATPase, Oxidative phosphorylation, ATP and other high energy phosphate compounds
- ❖ Cytoskeleton: Organization of Microtubules, Microfilaments and Intermediary filaments; Extracellular matrix
- ❖ Nucleolus: Structure and biogenesis of ribosomes
- ❖ Cell Signalling: Cell-cell interaction, Chemical mediators, Cell surface and intracellular receptors, Cell death, Apoptosis

Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes:	POs Addressed	PSOs Addressed	Cognitive Level
CO 1:	Explain, analyse and apply the buffer systems	PO 2	PSO 1	U, Ap, An
CO 2:	Define, explain and apply centrifugation, spectrophotometry, electrophoresis & blotting and microscopy.	PO 1, 3	PSO 3, 4	R, U, Ap
CO 3:	Demonstrate the cell membrane and demonstrate and evaluate cell transport mechanisms.	PO 1	PSO 1, 3	U, E
CO 4:	Define and demonstrate the structure and function of cellular organelles	PO 1	PSO 1	R, U
CO 5:	Demonstrate, apply and discuss the cell signalling system.	PO 4	PSO 1, 5	U, Ap, C

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Books for Reference:

- Alberts, B., Johnson, A., Lewis, J., Morgan, D., Raff, M., Roberts, K. and Walter, P. (2015). Molecular Biology of the Cell. 6th edition, Garland Science, New York and London.
- Casey, E. J. (1962). Biophysics - Concepts and Mechanisms. East West Press Pvt. Ltd. New Delhi.
- Cassimeris, L., Lingappa, V.R. and Plopper, G., editors (2011). Lewin's Cells. 2nd edition, Jones and Bartlett Publishers, Massachusetts.

- Cooper, G.M. and Hausman, R.E. (2009). The Cell: A Molecular Approach. 5th edition, ASM Press, Washington D.C. and Sinauer Associates, INC. Sunderland, Massachusetts.
- Daniel, M. (2005). Basic Biophysics for Biologist. Agro Botanical Publishers, Bihaner, India.
- De Robertis, E.D.P. and De Robertis, E.M.F., Jr. (2001). Cell and Molecular Biology. 8th edition, WoltersKluwer/Lippincott Williams and Wilkins.
- Karp, G. (2010). Cell Biology. 6th edition, International Student Version, John Wiley and Sons, INC.
- Keith Wilson and John Walker (2010) Principles and techniques of Biochemistry and Molecular Biology Latest Ed. Cambridge University Press, New York
- Lodish, H., Berk, A., Kaiser, C.A., Krieger, M., Bretscher, A., Ploegh, H., Amon, A. and Scott, M.P. (2013). Molecular Cell Biology. 7th edition, W.H. Freeman and Company, New York.
- Narayanan, P. (2007). Essentials of Biophysics. New Age International (P) Ltd. Publishers.
- Plummer, T.D. (1978). An introduction to Practical Biochemistry. Tata McGraw Hill Publishing Company Limited, New Delhi.
- Rodney, C. (2004). Biophysics An Introduction. John Wiley & Sons Ltd.
- Skoog, A. D. and James, J. L. (1992). Principles of Instrumental Analysis. Saunders Golden Sunburst Series.
- Upadhyay, A., Upadhyay, K. and Nirmalendu, N. (2002) Biophysical chemistry. Himalayan Publishing House, Mumbai.
- Vasanthan, P. and Gautham, N. (2002). Biophysics. Narosa Publishing House, New Delhi.

SEMESTER – I	
Course name	Genetics
Course code	PGZOOCC 1.4
Course type	Theory
Number of lectures	60
Credits	4
Marks	50

Course Objectives:

After completion of this course the student will be able to

Sl. No.	Course Objectives:
1:	Understand the fine structure and function of chromatin and chromosomes and their metabolic pathways
2:	Understand, analyse and apply the concept of crossing over & linkage to construct gene map
3:	Understand and evaluate the mechanism of gene mutation and DNA repair
4:	Remember, understand and analyse human karyotyping and chromosomal disorders

PGZOOCC 1.4: Genetics

Class: 60hrs

- ❖ Eukaryotic chromatin structure and chromosome organization: Classes of DNA, Chromosomal proteins- histones and their modifications, non-histone proteins, scaffold/matrix proteins, Levels of chromatin condensation at interphase and metaphase stages, Nuclear matrix and organization of interphase nucleus, Centromere, kinetochore and telomere, Metaphase chromosome bandings; Giant chromosomes: models for studies on chromosome organization and gene expression
- ❖ Cell division: Mitosis (Role of maturation promoting factor, Chromosomal movement, Exit from mitosis); Cytokinesis; Meiosis (Chromosome pairing and recombination Genetic regulation of meiosis)
- ❖ Mendel's laws and their chromosomal basis; Extensions of Mendelism (Dominance relationships, Epistasis, Pleiotropy, Expressivity and penetrance)
- ❖ Methods of gene mapping: point test cross in Drosophila; Gene mapping in human by linkage analysis in pedigrees; Tetrad analysis in Neurospora; Gene mapping in bacteria by conjugation, transformation and transduction
- ❖ Gene Mutation and DNA repair: Types of gene mutations; Methods for detection of induced mutations; P-element insertional mutagenesis in Drosophila; DNA damage and repair
- ❖ Epigenetics and epigenetic modifications

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- ❖ Human cytogenetics: Mitochondrial inheritance; Complexities associated with inheritance (penetrance and expressivity, new mutations, anticipation, co-dominance, pseudo-dominance, genetic heterogeneity, Lyonisation, mosaicism and chimerism); Chromosome anomalies and disease- Common syndromes caused by aneuploidy, mosaicism, deletion and duplication; Chromosomal anomalies in malignancy (chronic myeloid leukemia, Burkitt's lymphoma, retinoblastoma and Wilms' tumour); Fragile site and X-linked mental retardation; Complex traits (Oligogenic trait, Polygenic trait, Multifactorial trait, Threshold trait) Pharmacogenetics and Ecogenetics

Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes:	POs Addressed	PSOs Addressed	Cognitive Level
CO 1:	Define and explain the chromosome structure and its metabolic pathways	PO 1	PSO 1, 5	R, U
CO 2:	Demonstrate and apply the concept of crossing over & linkage to construct gene map	PO 3	PSO 5	U, Ap, C
CO 3:	Demonstrate and evaluate the mechanism of gene mutation and DNA repair	PO 3	PSO 1, 5	U, E
CO 4:	Explain and discuss cause of epigenetic modifications	PO 2	PSO 1, 4, 5	U, C
CO 5:	Define, demonstrate and analyse human karyotyping and chromosomal disorders	PO 1, 4	PSO 1, 5	R, U, An

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Books for Reference:

- Brooker, R.J. (2012). Genetics: Analysis and Principles. 4th edition. , McGraw Hill Education.
- Brown, T. (2012). Introduction to Genetics: A molecular Approach. Garland Science.
- Hartl, D.L. and Ruvolo, M. (2012). Genetics : Analysis of Genes and Genomes. 8th edition, Jones and Bartlett.
- Klug, W.S., Cummings, M.R., Spencer, C.A. and Palladino, M.A. (2012). Concepts of Genetics. 10th edition, International edition, Pearson Benjamin Cummings.
- Russell, P.J. (2010). iGenetics : A Molecular Approach. 3rd edition, Pearson Benjamin Cummings.
- Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. 5th edition, International Student Version, John Wiley and Sons, Inc.
- Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R. (2008). Molecular Biology of the Gene. 6th edition, Pearson International Edition, Pearson Benjamin Cummings.

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SEMESTER – I	
Course name	Structures & systems of organisms
Course code	PGZOOCC 1.5
Course type	Practical
Number of lectures	90
Credits	4
Marks	50

Course Objectives:

After completion of this course the student will be able to

Sl. No.	Course Objectives:
1:	Relate and evaluate various organ and systems in selected invertebrates and vertebrates and correlate the structure and function of organs in animals
2:	Demonstrate and apply the knowledge of hypophysation technique
3:	Acquire, apply and evaluate knowledge on aquaculture firm operation.
3:	Obtain knowledge on collection, preservation and identification of museum specimens

PGZOOCC 1.5: Structures and Systems of Organisms (practical course)

Class: 90hrs

- ❖ Practical exposure to a zoological museum and collection, preservation and identification of museum specimens
- ❖ Stomatogastric nervous system of Cockroach (major)
- ❖ Closed blood vascular system of Earthworm (major)/ Reproductive system of Earthworm (major)
- ❖ Sting, ovipositor and pollenbasket of honey bee (minor)/ Mouth parts dissection and comparison of *Anopheles*, *Culex* and *Aedes* (minor)
- ❖ Hypophysation techniques exploiting platybasic and leptobasic pituitary glands (demonstration)
- ❖ Hydrostatic organ, auditory apparatus and weberian ossicles dissection (major)/ urinogenital system of a major carp and minor carp (major)
- ❖ Comparison of ctenoid vs cycloid scales (minor)
- ❖ Visit to any aquaculture firm in West Bengal

Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes:	POs Addressed	PSOs Addressed	Cognitive Level
CO 1:	Develop knowledge on dissection of various organ and systems in animals and analyse the correlation	PO 1	PSO 1, 3	Ap, An
CO 2:	Demonstrate, apply and design the hypophysation technique	PO 2, 3, 4	PSO 1, 3, 5	U, Ap, C
CO 3:	Explain, evaluate and design the aquaculture firm operation.	PO 3, 4	PSO 1, 3, 5	U, E, C
CO 4:	Define and explain the process of collection, preservation and identification of museum specimens	PO 1	PSO 1, 2, 3	R, E

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SEMESTER – I	
Course name	Tools & techniques in biological study
Course code	PGZOOCC 1.6
Course type	Practical
Number of lectures	90
Credits	4
Marks	50

Course Objectives:

After completion of this course the student will be able to

Sl. No.	Course Objectives:
1:	Apply the knowledge of spectrophotometric techniques to estimate protein and nucleic acids
2:	Analyse the adulteration and estimate the insulin applying the knowledge on HPLC and ELISA respectively
3:	Apply the knowledge of chromosome structure in man and drosophila
4:	Apply the knowledge on survey of Mendelian traits, analyse the pedigree
5:	Apply the knowledge of Hardy Weinberg law of population genetics
6:	Apply the knowledge on preparation, purification and gel electrophoresis of extrachromosomal DNA

PGZOOCC 1.6: Tools and Techniques in Biological Study (practical course) Class: 90hrs

- ❖ Preparation of buffer with the aid of a pH meter
- ❖ Lowry vs Bradford protein estimation
- ❖ Spectrophotometric comparison of nucleic acid vs protein
- ❖ Horizontal vs vertical electrophoresis
- ❖ Adulteration checking by HPLC
- ❖ Prokaryotic culture maintenance
- ❖ Estimation of insulin by ELISA
- ❖ PCR analysis from a zooplankton study
- ❖ Chromosome preparations from human blood
- ❖ Polytene chromosome study of Drosophila
- ❖ Case studies of pedigree
- ❖ Case studies of genetic crosses
- ❖ Population genetics: Hardy Weinberg dynamics study of case vs control samples
- ❖ Preparation, purification and extrachromosomal DNA gel electrophoresis

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Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes:	POs Addressed	PSOs Addressed	Cognitive Level
CO 1:	Analyse and estimate protein and nucleic acids using spectrophotometric techniques	PO 2	PSO 3, 5	An, E
CO 2:	Analyse the adulteration and estimate the insulin using HPLC and ELISA respectively	PO 2	PSO 3, 5	An, E
CO 3:	Discuss and compare chromosome structure in man and drosophila	PO 2, 4	PSO 3, 5	E, C
CO 4:	Analyse, evaluate and construct the pedigree	PO 2, 4	PSO 3	An, E, C
CO 5:	Apply and estimate the Hardy Weinberg law in population dynamics study	PO 2, 3	PSO 3	Ap, C
CO 6:	Evaluate and estimate the extrachromosomal DNA through DNA preparation, purification and gel electrophoresis.	PO 3	PSO 3, 5	E, C

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SEMESTER – I	
Course name	Yoga
Course code	PGZOOSOC 1
Course type	Soft Skill
Number of lectures	15
Credits	1
Marks	25

Course Objectives:

After completion of this course the student will be able to

Sl. No.	Course Objectives:
1:	Attain general awareness about health
2:	Manage life style of students' life
3:	Increase of concentration
4:	Improve the decision-making capacity
5:	Build up confidence in their life

PGZOOSOC 1: Yoga

Class: 15hrs

PART I

Unit – I: INTRODUCTION TO YOGA AND YOGA PRACTICES.

2 class.

- 1.1 Introduction to Yoga: Its meaning, definitions, aim, objective and misconceptions.
- 1.2 Schools of Yoga and their relevance in modern social life.
- 1.3 Yogic Practices and Principles for healthy living, Practice simple asana

Unit – II: BASIC PRINCIPLES AND PHYSIOLOGY OF YOGIC PRACTICES

2 class.

- 2.1 Basic principles and physiology of Shat-karma
- 2.2 Basic principles and physiology of Yogasana
- 2.3 Basic principles and physiology of Pranayama and Dhyana
- 2.4 Some complex asana

Unit – III: DIET, HEALTH AND HYGIENE

2 class.

- 3.1 Introduction to Diet and Nutrition : Yogic Concept of Diet
- 3.2 Health and Disease : Role of Yoga in prevention of disease and promotion of Health.
- 3.3 Role and importance of Swasthavrita, Dinacharya, Ritucharya and Sadvrita in Health and Hygiene
- 3.4 Practice of different Pranayama

Unit – IV: YOGA FOR WELLNESS

2 class.

- 4.1 Concept of Wellness : Ashtanga Yoga of Patanjali for Wellness
- 4.2 Yogic attitudes (Maitri, Karuna, Mudita and Upeksha) and practices for Mental Wellbeing
- 4.3 Psycho-social environment : Its role and importance for wellness
- 4.4 Some demonstrations of Bandha & Mudra

PART-II: PRACTICAL TRAINING IN YOGA

7 class

UNIT – I: Lecture cum demonstration o Yoga for Wellness

UNIT – II: Loosening practices, Selected Yogic Sukshma Vyayama OR Yogic Surya Namaskara

UNIT – III: Yogic Shatkarma / Yogic cleaning practices:3.1 Kapalabhati

UNIT – IV Yogasana

- 4.1 Sukhasana, Padamasana, Vajrasana
- 4.2 Tadasana, Urdhvahastottanasana, Katichakrasana
- 4.3 Mandukasana, Kurmasana
- 4.4. Vakrasana / Ardha
- 4.5 Ustrasana, Gomukhasana
- 4.6 Bhujangasana, Shalabhasana, Dhanurasana
- 4.7 Ardha Halasana, Halasana
- 4.8 Pawanmuktasana and its variations

UNIT – V Pranayama

- 5.1 Mechanism of correct breathing, Yogic deep breathing, Concept of Puraka, Rechaka and Kumbhaka
- 5.2 Nadi Shodhana Pranayama, Bhramari Pranayama (Without Kumbhaka)

UNIT – VI Concepts and demonstrations of Bandha & Mudra

- 6.1 **Bandha:** Jalandhara Bandha, Uddiyana Bandha, Mula Bandha
- 6.2 **Mudra:** Shanmukhi Mudra, Viparitanakrani Mudra

Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes:	POs Addressed	PSOs Addressed	Cognitive Level
CO 1:	Define, demonstrate and apply general awareness about health	PO 1, 4	PSO 1, 5	R, U, Ap
CO 2:	Learn and apply how to manage life style of students' life	PO 3	PSO 5	R, Ap
CO 3:	Discover and apply how to increase concentration	PO 1	PSO 5	An, Ap
CO 4:	Demonstrate and improve the decision-making capacity	PO 4	PSO 5	U, C
CO 5:	Build up confidence in their life	PO 4	PSO 5	C

R= remembering, U = understanding, Ap = applying, An = analysing, E = evaluating, and C = creating

SEMESTER – II	
Course name	Biochemistry & Metabolism
Course code	PGZOOCC 2.1
Course type	Theory
Number of lectures	60
Credits	4
Marks	50

Course Objectives:

After completion of this course the student will be able to

Sl. No.	Course Objectives:
1:	Define, Understand and evaluate the structure and function of biomolecules
2:	Understand and apply the principles of biophysical chemistry
3:	Explain and evaluate different metabolic pathways
4:	Understand the process of fatty acids and nucleic acids synthesis

PGZOOCC 2.1: Biochemistry & Metabolism

Class: 60hrs

- ❖ Structure of atoms, molecules and chemical bonds; Stabilizing interactions (Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction, etc.)
- ❖ Principles of biophysical chemistry (pH, buffer, reaction kinetics, colligative properties)
- ❖ Thermodynamics: Second law and its application; Concept of free energy and calculations based on free energy change
- ❖ Composition, structure and function of biomolecules (carbohydrates, lipids, nucleic acids and vitamins)
- ❖ Protein structure: Primary structure (peptide bond); Secondary structure(α helix, β pleated sheet & bends); Prediction of secondary structure; Ramachandran plot; Tertiary structure(Forces stabilizing tertiary structure, Domains and motifs); Quaternary structure
- ❖ Enzymes and enzyme kinetics; enzyme regulation, mechanism of enzyme catalysis, isozymes; Abzyme
- ❖ Metabolism: Concept of metabolic pathways of carbohydrates, lipids, amino acids, nucleotides and vitamins, mechanism of energy conservation
- ❖ Synthesis of fatty acids
- ❖ Nucleic acids: Conformation of nucleic acids (helix (A, B, Z), t-RNA, micro-RNA); Synthesis and stability of nucleic acids

- ❖ Instrumentations for qualitative and quantitative characterization of biochemical molecules

Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes:	POs Addressed	PSOs Addressed	Cognitive Level
CO 1:	Define, explain and evaluate the molecular conformations and interactions of carbohydrates, proteins, lipids and nucleic acids	PO 1	PSO 1, 4	R, U, E
CO 2:	Demonstrate and apply the law of thermodynamics in biophysical chemistry	PO 1, 2	PSO 1, 3	U, Ap
CO 3:	Demonstrate, evaluate and analyse the different metabolic pathways	PO 3	PSO 1, 4	U, E, An
CO 4:	Demonstrate, apply and discuss the synthesis of fatty acids and nucleic acids	PO 4	PSO 1, 5	U, Ap, C

R= remembering, U = understanding, Ap = applying, An = analysing, E = evaluating, and C = creating

Books for Reference:

- Jain, J.L., Sunjay Jain and Nitin Jain (2007). Fundamentals of Biochemistry, S. Chand & Company Ltd., New Delhi.
- Lehninger, A. L., Nelson, D. K., and Cox, M. M. (1993). Principles of Biochemistry. CBS Publishers and distributors, New Delhi.
- Murray, R. K., Granner, D. K., Mayes, P. A., Rodwell, V. W. (2000) Harper's Biochemistry. Prentice Hall International Inc.
- Satyanarayanan, U (2004). Essentials of Biochemistry, Uppala Author – Publisher Interlinks, Vijayawada
- Stryer, L. (1988) Biochemistry. W. H. Freeman and Company, New York.
- Voet, D., Judith, G. Voet, Charlotte W. Pratt. (1999). Fundamentals of Biochemistry. John Wiley & Sons Inc. New York.

SEMESTER – II	
Course name	Molecular Biology & Biotechnology
Course code	PGZOOCC 2.2
Course type	Theory
Number of lectures	60
Credits	4
Marks	50

Course Objectives:

After completion of this course the student will be able to

Sl. No.	Course Objectives:
1:	Define, demonstrate and evaluate the central dogma concept
2:	Understand and apply the gene regulation mechanism and role of non-coding RNAs
3:	Remember, understand the transposable elements and microbial genetics
4:	Explain, evaluate and apply different genetic engineering tools
5:	Understand the mechanism of cancer biology

PGZOOCC 2.2: Molecular Biology & Biotechnology

Class: 60hrs

- ❖ DNA replication: DNA polymerases, ARS and initiation in yeast, eukaryotic chromatin replication, regulation; DNA repair and recombination, Human genome: mapping and characteristics
- ❖ Transcription and transcriptome: RNA polymerases in eukaryotes, general and specific transcription factors, assembly of pre-initiation complex, enhanceosomes, elongation factors and elongation; Promoter analysis and characterization: Deletion mapping, Transient/stable expression system, S1/RNase mapping, EMSA, DNase I Footprinting; Types of introns and mechanism of splicing; RNA editing, catalytic RNA; Regulation of initiation of transcription, post-transcriptional
- ❖ Molecular biology of translations; post translational modifications.
- ❖ Transposable genetic elements; types, characteristics, functions; use of transposable genetic elements
- ❖ Regulation of genes; gene silencing, RNA interference.
- ❖ Genetic map of bacteria; plasmids, characteristics, types & biological importance of plasmids; resistance plasmids; molecular biology of transformation & transduction; conjugation, F particles, Hfr strains & use of Hfr in genetic crosses.
- ❖ Genetic engineering Tools: Restriction enzymes and other enzymes for DNA manipulation, cloning vectors, oligonucleotide synthesis; Cloning strategies (cDNA and genomic libraries, expression

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- and interaction based cloning, positional cloning; Screening of clones: Preparation of probes, hybridization, immuno-screening; Characterization of clones: Sequencing of clones and genomes
- ❖ Microarray; PCR and its applications; Application: Transgenic organisms (GMOs), Animal cloning, Site-directed mutagenesis, Generation of knock-out animals, Gene therapy, DNA drugs, Ethical and social issues
 - ❖ History of Cancer; Genetic Pathways in Cancer: Tumor Suppressor, Oncogenes, Proto-oncogenes and their cellular functions; Cancer Stem cells; Metastasis and Angiogenesis; Cancer immunology; Carcinogens & carcinogenic air pollutants; Biomarkers of ambient air pollution & lung cancer; Future of Cancer Research.
 - ❖ Noncoding RNAs; types, biogenesis & associated proteins; biological functions; miRNA expressions and interactions; Differences in time dependent microRNA expression in cancer cells; Roles of miRNA & lncRNAs in hematopoietic stem cell differentiation; Functional varieties of noncoding RNAs in rRNA regulation; Integrated networks of noncoding RNAs; Applications & anticancer drug development
 - ❖ Molecular genetics of human congenital malformations; molecular biology of common diseases (Type I diabetes mellitus, coronary heart disease, asthma, osteoporosis); impact of molecular biology on clinical genetics

Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes:	POs Addressed	PSOs Addressed	Cognitive Level
CO 1:	Define, demonstrate and analyse the mechanisms and regulation of replication, transcription and translation	PO 1	PSO 1, 3	R, U, An
CO 2:	Demonstrate and apply the gene regulation, gene silencing and non-coding RNAs interference for drug development	PO 1, 3	PSO 1, 3	U, Ap, C
CO 3:	Demonstrate, evaluate and discuss the importance of transposable elements and microbial genetics	PO 1, 3	PSO 1, 3, 5	U, E, C
CO 4:	Explain, adapt and apply different genetic engineering tools	PO 1, 3	PSO 1, 3	U, C, Ap
CO 5:	Demonstrate the mechanism of cancer formation and access the role of carcinogens	PO 1	PSO 1, 3	U, E
CO 6:	Demonstrate and apply the transgenic organism's production and ethical issues	PO 1, 4	PSO 1, 2, 3	U, A, C

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Books for Reference:

- Babiuk, L.A., John, P. Philips and Murray Moo Young (1989). Animal Biotechnology, Pergamon Press, Oxford.
- Balasubramanian, D., Bryce, C.F.A., Dharmalingam, K., Green, J. and Kunthala Jayaraman (2004). Concepts in Biotechnology, XIV edition, University Press
- Glick, B.R. and Pasterick Jack, J., (2001) Molecular Biotechnology. ASM Press, London.
- GorDardand Lucessen, E. (1993) In-vitro Culture of Animal Cells. Butterworth – Heinemann Publications.
- Higgins, I. J., Best, D.J. and Jones, J., (1988) Biotechnology - Principles and Applications. Blackwell Scientific Publications, Oxford.
- Kannan.S.Krishnan.M.R., Thirumurugan.S.Achiraman (2012) Methods in Molecular Biology.
- Marx, J.L., (1989) A revolution in Biotechnology. Cambridge University Press.
- Old, R. W. and Primrose, S.B., (1991) Principles of Gene Manipulation. Blackwell Scientific Publications.
- Primrose SB and R.M.Twyman (2006) Principles of Gene Manipulation and Genomics Blackwell Publishing
- Primrose, S.B., (1999) Molecular Biotechnology. Panima Publications, New Delhi.
- Smith John, E., (1990) Biotechnology New Revolution. Orbis, London
- VandanMohod, (1999) Biotechnology - Recent development. Book enclave, Jaipur.
- Watson, J.D., Michael Gilman, Jan Witkowski and Mark Zoller., (1999) Recombinant DNA. Scientific American Books W. H. Freeman & Company, New York.

SEMESTER – II	
Course name	Ethology & Chronobiology
Course code	PGZOOCC 2.3
Course type	Theory
Number of lectures	60
Credits	4
Marks	50

Course Objectives:

After completion of this course the student will be able to

Sl. No.	Course Objectives:
1:	Define, demonstrate and analyse the social organization and the communications in animals
2:	Define and understand the learning behaviours in animals
3:	Learn and demonstrate the migration and defence systems in animals
4:	Learn, understand and apply the biological rhythms and chronobiology
5:	Understand and evaluate the development of behaviour in animals

PGZOOCC 2.3: Ethology & Chronobiology

Class: 60hrs

- ❖ Social organization: altruistic behavior and concept of inclusive fitness; evolution of helpful behavior; evolution of eusocial behaviours
- ❖ Exploitation of resources: Decision making; Foraging models
- ❖ Communication and animal signals: Communication; Evolution of animal signals
- ❖ Learning; learning & memory; basic models of learning; social learning & play
- ❖ Movement; search, navigation, migration & dispersal; source of navigational information; migration of fish
- ❖ Self defense; camouflage; vigilance and alarm; mimicry; predator deterrence; pathogen avoidance
- ❖ Biological rhythms: Types of rhythms, Methods of measurement, Properties (Entrainment, Re-entrainment, Phase angle difference, Freerun, Phase shift, Phase response curve, Arrhythmia), Factors influencing biological rhythms (environmental and other zeitgebers), Centres of biological clock (Suprachiasmatic nuclei, Pineal gland, Optic lobes); Molecular bases of circadian rhythms (Clock genes in Drosophila and mouse)
- ❖ Development of behavior: Genetic basis of behavior; Hormone-brain relationship; Bird song development; Neural basis of behaviour

- ❖ **Applied Chronobiology:** Human circadian rhythms; Applications of circadian rhythm principles (Jet-lag/shift work; Depression and sleep disorders ; Chronopharmacology and Chronotherapy)
- ❖ **Sexual selection;** history of sexual selection studies, , types of sexual selection, intra & inter sexual selection, runaway selection, evolution of sexual dimorphism, direct and indirect benefits; handicap principle, paradox of good genes; sperm competition and cryptic female choice; sexual conflicts

Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes:	POs Addressed	PSOs Addressed	Cognitive Level
CO 1:	Define, demonstrate and analyse the various types of social organization in animals	PO 1, 3	PSO 1, 2	R, U, An
CO 2:	Demonstrate and apply the animal's communications system in resource exploration and discuss the significance	PO 1, 3	PSO 1, 2, 5	U, Ap, C
CO 3:	Demonstrate, analyse and apply the learning behaviours in animals	PO 3	PSO 1, 5	U, An, Ap
CO 4:	Demonstrate and evaluate the migration and defence systems in animals	PO 1, 3	PSO 1, 2	D, E
CO 5:	Demonstrate, analyse and discuss the development of behaviour and biological rhythms and chronobiology in animals and human	PO 1, 4	PSO 1, 5	U, An, C

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Books for Reference:

- Alcock, J. (2013). Animal Behavior: An Evolutionary Approach, 10th ed., Sinauer Associates Inc.
- Davies, N.B., Krebs, J.R. and , West, S.A. (2012). An Introduction to Behavioural Ecology. 4th edition, Wiley-Blackwell.
- Drickamer, L.C., Vessey, S.H. and Jacob, E.M. (2002). Animal Behaviour: Mechanisms, Ecology and Evolution. 5th edition, McGraw Hill.
- Dugatkin, L.A. (2014). Principles of Animal Behaviour. 3rd edition, W.W. Norton and Company.
- Dunlap, J.C., Loros, J.J. and Patricia, J. DeCoursey (editors). (2004). Chronobiology Biological Time keeping. Sinauer Associates, Inc. Publishers.

- Kumar, V. (2002). Biological Rhythms. Springer.
- Manning, A. and Dawkins, M.S. (2016). An Introduction to Animal Behaviour. 6th edition, Cambridge University Press.
- Saunders, D.S., editors : Steel, C.G.H., Vafopoulou, X. and Lewis, R.D. (2002). Insect Clocks. 3rd edition, Elsevier Science.
- Sherman, P.W. and Alcock, J. (Editors) (2013). Exploring Animal Behaviour : Readings from American Scientist. 6th edition, Sinauer Associate Inc.

SEMESTER – II	
Course name	Ecological Sciences
Course code	PGZOOCC 2.4
Course type	Theory
Number of lectures	60
Credits	4
Marks	50

Course Objectives:

After completion of this course the student will be able to

Sl. No.	Course Objectives:
1:	Define, understand and analyse the population and community ecology
2:	Remember, understand and apply the ecosystem concepts
3:	Learn, demonstrate and evaluate the riverine ecosystem and its importance
4:	Understand, apply and formulate the riverine ecosystem management
5:	Understand, evaluate and adapt the wetland ecosystem management

PGZOOCC 2.4: Ecological Sciences

Class: 60hrs

- ❖ Population Ecology: Population characteristics and population dynamics; Meta-population study
- ❖ Ecological Communities: Species abundance models; Niche and competition theories; Meta-community and Island Biogeography models; Prey-Predator Models
- ❖ Ecosystem ecology: Energy law & Energy flow within ecosystem; concepts of Productivity & productivity models of different ecosystems; Food chains & food webs; Ecosystem & Biodiversity; desert ecosystem & tropical rain forest
- ❖ River ecosystem: Biotic community; Trophic relationships; Community interactions within rivers(case studies); Chemical communications among riverine biotic communities (case studies); Riverine guilds (case studies); Riverine hydrological regulators; Heterotrophic energy sources; Role of fish assemblages in stream communities (metapopulation & meta community studies); Impacts of modifications on river ecosystem (construction of dams; ecological fragmentation); Effects of invasive alien species in rivers (case studies); Restoration strategies for conservation of river ecosystem.
- ❖ Rivers of India; importance of rivers; river pollution in India; National Mission for clean Ganga; Namami Ganges; Water pollution in global perspective (case studies); surface water pollution; Arsenic pollution in West Bengal.

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- ❖ Wetland ecosystem: physical & ecological characteristics of wetlands; types of wetlands; natural & artificial wetlands; wetlands in India; wetland biodiversity; planktonic communities; wetlands as bird's habitat; importance of wetlands; productivity of wetlands; ecosystem services of wetlands (special reference to East Calcutta Wetland); fisheries in wetlands (Indian perspective); pollution in wetlands; conservation of biodiversity within wetlands; wetland restoration strategies; instruments used in wetland studies (brief account); future prospects in wetland research

Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes:	POs Addressed	PSOs Addressed	Cognitive Level
CO 1:	Demonstrate, analyse and design models in the population and community ecology	PO 1, 4	PSO 2, 5	U, An, C
CO 2:	Define, demonstrate, and apply the ecosystem concepts and theory in different ecosystems	PO 1, 3	PSO 2, 5	R, U, Ap
CO 3:	Explain, evaluate and apply the riverine ecosystem composition, interactions and impact	PO 1, 3, 4	PSO 2, 5	U, E, Ap
CO 4:	Demonstrate, apply and formulate the riverine ecosystem pollution management strategy	PO 1, 4	PSO 2, 5	U, Ap, C
CO 5:	Demonstrate, evaluate and adapt the wetland biodiversity and pollution management	PO 1, 4	PSO 2, 5	U, E, C

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Books for Reference:

- Asthana, D. K., and Meera, A. (2001) Environment– Problems and solution. S. Chand & Company LTD, NewDelhi.
- Cunningham, P. W. and Saigo, W.B.(1999). Environmental Science. V Ed. McGraw Hill, New York.
- Dhawan,N.G. and Khan,A.S.(2014). Disaster Management and Preparedness. (Based on the syllabus prescribed by UGC for Disaster Management Education). CBS Publishers. New Delhi.
- Edward, I. N. (1996).Applied Ecology & Environmental Management.Wiley Blackwell; 2 edition
- Goel, P.K. (1997). Water Pollution - Causes, Effects and Control. New Age International (P) Limited Publishers
- Kudesia, V.P. (1986). Air Pollution. PragatiPrakashan, Meerut. Nobel, J., Richard, T. Wright, S. (1996) Environmental Sciences. V Edition.
- Odum,E.P. (2001) Fundamentals of Ecology. IV Edition. Saundercompany, Philadelphia, London. Toppan Company, Ltd. Tokyo, Japan.
- Shah, S.A. (1988) Forestry for People, Indian Council of Agricultural Research - KrishiAnusandhuBhavan, Pusa, New Delhi.
- Sharma, B.K. (2005). Environmental chemistry.Goel Publishing House, Meerut, 11 t h Edition.
- Sharma, B.K. and Kaur, H. (1997) An Introductionto Environmental Pollution. Goel Publishing House, Meerut.
- Sinha, R,K. (1996) Biodiversity - Global Concerns. Common Wealth Publishers.

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SEMESTER – II	
Course name	Biochemical and molecular aspects of life
Course code	PGZOOCC 2.5
Course type	Practical
Number of lectures	90
Credits	4
Marks	50

Course Objectives:

After completion of this course the student will be able to

Sl. No.	Course Objectives:
1:	Estimate glucose, lipids and lipid peroxidation products
2:	Quantification of oxidative stress enzymes and redox cycle enzymes
3:	Apply the knowledge of Spectrofluorimetric technique on quaternary haemoglobin protein
4:	Apply the knowledge of gene cloning and gene expression
5:	Apply the knowledge of cell culture lab protocols
6:	Apply the knowledge DNA sequencing

PGZOOCC 2.5: Practical Course for Biochemical and molecular aspects of life Class: 90hrs

- ❖ Estimation of glucose
- ❖ Estimation of lipids
- ❖ Quantification of oxidative stress enzymes / Quantification of redox cycle enzymes
- ❖ Estimation of lipid peroxidation products
- ❖ Spectrofluorimetric studies on quaternary haemoglobin protein
- ❖ Gene cloning
- ❖ Gene expression study by RTPCR
- ❖ Immunoblotting studies on proteins
- ❖ Cell culture lab protocols and essentials,
- ❖ Monolayer and suspension cell culture
- ❖ Sanger gene sequencing study
- ❖ Visit to R&D laboratory

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Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes:	POs Addressed	PSOs Addressed	Cognitive Level
CO 1:	Analyse, evaluate and estimate glucose, lipids and lipid peroxidation products	PO 2	PSO 4, 5	An, E, C
CO 2:	Evaluate and examine of oxidative stress enzymes and redox cycle enzymes	PO 2	PSO 4, 5	An, E
CO 3:	Identify and evaluate the quaternary haemoglobin protein	PO 2	PSO 4	Ap, E
CO 4:	Construct the gene clone and evaluate gene expression	PO 2, 4	PSO 4, 5	C, E
CO 5:	Apply the cell culture lab protocols and maintain cell culture	PO 2, 4	PSO 4, 5	Ap
CO 6:	Identify, analyse and solve DNA sequence	PO 2, 4	PSO 4, 5	Ap, An, C

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SEMESTER – II	
Course name	Ethological & Ecological studies
Course code	PGZOOCC 2.6
Course type	Practical
Number of lectures	90
Credits	4
Marks	50

Course Objectives:

After completion of this course the student will be able to

Sl. No.	Course Objectives:
1:	Analyse and evaluate the nesting behaviour of birds
2:	Analyse and evaluate the FAP and aggressive behaviour in fishes and birds
3:	Prepare report and documentary on field visit
4:	Perform toxicity test,
5:	Analyse and evaluate physicochemical parameters of water and soil
6:	Apply the knowledge of population ecology

PGZOOCC 2.6: Practical Course for Ethology & Ecology

Class: 90hrs

- ❖ Nesting behavior of birds / Studies on habituation vs learning in case specimens
- ❖ Studies on fixed action pattern of a fish or bird / Analysis of the aggressive behavior of fish or bird
- ❖ Visit to a national park and preparation of a report and documentary on animal behavior studies / Visit to wetlands and biosphere reserve of WB
- ❖ Vermicomposting technique (Demonstration)
- ❖ LD₅₀ vs LC₅₀ measurement / Ecotoxicological case study / Pharmacotoxicological analysis on prokaryotic vs eukaryotic specimens
- ❖ Sampling techniques in population biology/ Mark recapture method of sampling
- ❖ Estimation of productivity (light & dark bottles method)
- ❖ Estimation of hydrological parameters (hardness, salinity, alkalinity, nitrate, phosphate, sulphate)
- ❖ Estimation of organic carbon from soil samples
- ❖ Population growth study

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Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes:	POs Addressed	PSOs Addressed	Cognitive Level
CO 1:	Analyse, evaluate and apply the nesting behaviour of birds	PO 3	PSO 2, 3	Ap, An, E
CO 2:	Demonstrate, analyse and evaluate the FAP and aggressive behaviour in fishes and birds	PO 1, 3	PSO 2, 3	U, An, E
CO 3:	Analyse and prepare report and documentary on field visit	PO 3, 4	PSO 2, 5	An, C
CO 4:	Perform toxicity test, physicochemical parameters of water and soil	PO 2, 3	PSO 2, 5	Ap, An, E
CO 5:	Apply, analyse and adapt the knowledge of population ecology to solve ecological problems	PO 2, 3, 4	PSO 2, 5	Ap, An, C

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SEMESTER – II	
Course name	Communicative English
Course code	PGZOOSOC 2
Course type	Theory
Number of lectures	15
Credits	1
Marks	50

Course Objectives:

After completion of this course the student will be able to

Sl. No.	Course Objectives:
1:	Demonstrate mastery of the discipline by detailing the development and current practices of Listening, Speaking, Reading and Writing as Language skills.
2:	Conduct research that engages and responds to diverse audiences of scholars, students, and community members.
3:	Demonstrate values and ethics in all activities

PGZOOSOC 2: Communicative English

Class: 15 hrs

Unit I: Introduction to Communication

- Process of Communication
- Levels of Communication
- Flow of Communication
- Verbal and Non-Verbal Communication
- Barriers to Communication

Unit II: Listening and Speaking Skills

- Introduction to English Phonetic Symbols: Consonants and Vowels with illustrations in use.
- Dialogue
- Group Discussion
- Presentation
- Interview Technique.

Unit III: Reading and Writing Skills

- Techniques of Reading
- Types of Reading
- Email Writing
- Report Writing

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Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes:	POs Addressed	PSOs Addressed	Cognitive Level
CO 1:	Enhance their English language proficiency in the aspects of reading, writing, listening and speaking.	PO 3	PSO 5	U, A
CO 2:	Develop academic literacy required for undergraduate learning, further studies and research	PO 3	PSO 5	C
CO 3:	Apply the requisite communicative skills and strategies to future careers	PO 3	PSO 5	Ap
CO 4:	Gain an insight into cultural literacy and cross-cultural awareness and engage in self-directed English language learning	PO 3	PSO 5	Ap, C
CO 5:	Be responsible and ethical English users	PO 3	PSO 5	Ap

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Books for Reference:

1. Vibrant English (New Delhi: Orient Black Swan)
2. Speak Well (New Delhi: Orient Black Swan) a compulsory supplementary Work Book for exercises on Interactions, dialogue, presentation skills, Group discussions, debates and Interviews.

Recommended Readings for advanced learning:

1. Advanced Skills in English. eds E Suresh Kumar et al..
2. Practising Writing Skills, Work Book
3. Enhancing English and Employability Skills
4. Business Communication,
5. English for Fluency
6. English Language Practice
7. Basics of Academic English- 1 and 2
8. Practising English- all these are Orient Black Swan publications

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SEMESTER – III	
Course name	Parasitology and Immunology
Course code	PGZOOCC 3.1
Course type	Theory
Number of lectures	60
Credits	4
Marks	50

Course Objectives:

After completion of this course the student will be able to

Sl. No.	Course Objectives:
1:	Understand and apply parasitology, host parasite interactions
2:	Learn and understand the mechanisms of innate immunity
3:	Extend their knowledge on immunogens, antigens, cytokines, immunoglobulins and different immune cells and their functions
4:	Understand the hypersensitivity reactions, Immunological tolerance, autoimmunity and diseases
5:	Explain and apply the immunological mechanisms of infectious and noncommunicable disease formation
6:	Learn the basic idea about organ transplantation and vaccination

PGZOOCC 3.1: PARASITOLOGY AND IMMUNOLOGY

Class: 60 hrs

- Human clinical and veterinary parasitology- detection, diagnosis, prophylaxis, treatment and pharmacology (emergent parasites)
- Host parasite interaction- immunological nuances in vertebrates and invertebrates and epidemiological surveillance tools.
- Vector biology with special reference to Malaria and Kala-azar.
- Innate immunity – molecular patterns and their recognition, infection induced innate response – role of TLR and other PRR, Complement system
- Immunogens and Antigens – definition, properties, types; haptens, adjuvants and their importance in research methodology and vaccine development, Concept of APC, MHC processing and presentation, MHC gene clusters, origin & evolution of MHC gene diversity
- Cytokines – properties, classification, functions, isolation, purification and assay

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- Immunoglobulins – types, structure, variety, Genetics of immunoglobulin diversity, purification and assay; Immunoglobulins of non-mammalian vertebrates
- B cell biology – production, maturation, activation, signaling, functions
- T cell biology – production, maturation, activation, signaling, functions
- Cross talks in adaptive immunity – B cell T cell interaction
- Neutrophil and Macrophage Function. Defense mechanism to Infection (Migration, Inflammation and Phagocytosis). Function of NK cell. Cross-talk with Adaptive Immune system
- Hypersensitivity reactions; Type I, II, III, IV and V
- Immunological tolerance; autoimmunity and diseases (viral & metabolic)
- Disease immunology – Malaria, Tuberculosis, AIDS; special note – Immunology in COVID19
- Tumor immunology; anti tumor immune response; immunotherapy for cancer
- Basis of Transplantation; Acute, Hyperacute and chronic Graft rejection; Modern techniques of transplantation (e.g BMT, liver, cornea, etc)
- Immunoprophylaxis; types of vaccines; efficacy; clinical trials; Community medicine and Vaccination programmes in India

Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes:	POs Addressed	PSOs Addressed	Cognitive Level
CO 1:	Define, explain and analyse the parasites detection, diagnosis, prophylaxis and host parasite interactions	PO 1, 3	PSO 4	R, U, An
CO 2:	Demonstrate and apply the mechanisms of innate immunity	PO 1, 3	PSO 4, 5	U, Ap
CO 3:	Illustrate, analyse and discuss the importance of immunogens, antigens, cytokines, immunoglobulins and different immune cells and their functions	PO 1, 4	PSO 4, 5	U, An, C
CO 4:	Demonstrate and apply the hypersensitivity reactions, Immunological tolerance, autoimmunity and diseases	PO 1	PSO 4	U, Ap
CO 5:	Explain and apply the knowledge on immunological mechanisms of infectious and noncommunicable disease formation	PO 1, 3	PSO 4, 5	Ap, E
CO 6:	Demonstrate and explain the basic idea about organ transplantation and vaccination	PO 1	PSO 4	U, E

R= remembering, U = understanding, Ap = applying, An = analysing, E = evaluating, and C = creating

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Books for Reference:

- Abbas, A.K., Lichtman, A.H. and Pillai, S. (2017). Cellular and Molecular Biology. 9th edition, Elsevier.
- Ahmed, N., Dawson, M., Smith, C. and Wood, Ed. (2006). Biology of Disease. Taylor and Francis.
- Arora, D. R and Arora, B.B. (2012). Medical Parasitology. 3rd edition. CBS Publishers.
- Bogitsh, B.J., Carter, C.E. and Oeltmann, T.N., 2013, Human Parasitology, 4th Edition, Elsevier Inc.
- Bose, M. (2016). Parasitoses and Zoonoses. New Central Book Agency.
- Chatterjee, K.D. (1952). Human Parasites and Parasitic Diseases. Published by author.
- Chatterjee, K.D. (2009). Parasitology : Protozoology and Helminthology. 13th edition, CBS Publishers and Distributors.
- Cheng, T.C. (1986). General Parasitology. 2nd edition, Elsevier.
- Dailey, M.D. (1996). Meyer, Olsen and Schmidt's Essentials of Parasitology. 6th edition, McGraw-Hill Science.
- David, M., Jonathan, B., David, R.B. and Ivan, R. (2012). Immunology. 8th edition, Elsevier
- Ichhupani, R.L. and Bhatia, R. (2003). Medical Parasitology. 3rd edition, Jaypee Brothers.
- Kindt, T.J., Goldsby, R.A. and Osborne, B.A. (2007). Kuby Immunology. 6th edition, W.H. Freeman and company.
- Kuby, J. (1992). Immunology. 3rd edition, W.H. Freeman and Company.
- Loker, E.S. and Hofkin, B.V. (2015). Parasitology : A Conceptual Approach. Garland Science.
- Noble, E.R. and Noble, G.A. (1982). Parasitology: The Biology of Animal Parasites. 5th edition, Lippincott Williams and Wilkins.
- Owen, J.A., Punt, J., Stranford, S.A. and Jones, P.P. (2009). Kuby Immunology. 7th edition, Macmillan Higher Education.
- Parija, S. C. (2013). Textbook of Medical Parasitology, Protozoology and Helminthology (Text and Colour Atlas), 4th edition, All India Publishers & Distributors.
- Roberts, L.S., Janovy, J. (Jr) and Nadler, S. (2013). Gerald D. Schmidt and Larry S. Roberts' Foundations of Parasitology. 9th edition, McGraw Hill.

SEMESTER – III	
Course name	Developmental biology and Neurobiology
Course code	PGZOOCC 3.2
Course type	Theory
Number of lectures	60
Credits	4
Marks	50

Course Objectives:

After completion of this course the student will be able to

Sl. No.	Course Objectives:
1:	Acquire knowledge on the early developmental processes and morphogenetic movements
2:	Develop a deep knowledge on the cellular and molecular aspects of regenerative biology and stem cell
3:	Develop a knowledge of nervous system organization and brain structure through imaging
4:	Understand the nerve impulse transmission
5:	Demonstrate the brain aging and various neuropathological diseases

PGZOOCC 3.2: Developmental biology and Neurobiology

Class: 60 hrs

- Potency, commitment, specification, induction, competence, Determination and Differentiation; morphogenetic gradient, cell fate and cell lineages, Cell to cell communication during early development.
- Axes, compartment and pattern formation, HOX gene and their regulation in *Drosophila*; Early development and vulva formation in *Caenorhabditis elegans*; Cell movement and signal during early development, Patterning, polarity and regionalization of nervous system in *Danio rario*; Limb development in vertebrate.
- Cellular and molecular aspects of regenerative biology; Genomic equivalence and cytoplasmic determinants; animal models in Development and Regeneration
- Stem cells and their applications
- Plasticity of brain and neurogenesis
- Organization of nervous system; Brain structure; Neurons and glia; Cerebrospinal fluid; Blood brain barrier; Autonomic nervous system

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- Axonal and synaptic transmission; Membrane potential and action potential; Excitatory and inhibitory post-synaptic potential; Chemical transmission, neurotransmitters (acetylcholine, catecholamines, serotonin and GABA), neuropeptides
- Brain imaging: CAT, PET and MRI
- Brain aging and Neuropathology; Strokes; Epilepsy; Alzheimer disease; Huntington disease; Parkinson disease

Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes:	POs Addressed	PSOs Addressed	Cognitive Level
CO 1:	Define, demonstrate and analyse the mechanisms of early developmental processes and morphogenetic movements	PO 1, 2	PSO 1, 4	R, U, An
CO 2:	Demonstrate and analyse the cellular and molecular aspects of regenerative biology and stem cell	PO 1, 2	PSO 1, 4	U, An
CO 3:	Demonstrate and explain the nervous system organization and brain structure through imaging	PO 1	PSO 1, 4	U, E
CO 4:	Demonstrate, apply and explain the nerve impulse transmission	PO 1, 2, 3	PSO 1, 4	U, Ap, E
CO 5:	Demonstrate and explain the brain aging and various neuropathological diseases	PO 1	PSO 1, 4, 5	U, E

R= remembering, U = understanding, Ap = applying, An = analysing, E = evaluating, and C = creating

Books for Reference:

- Balinsky, B.I. (1981). An Introduction to Embriology. 5th edition, Thomson Learning.
- Carlson, R. F. Patten's Foundations of Embryology
- Gilbert, S.F. (2014). Developmental Biology. 10th edition, Sinauer Associates.
- Slack, J.M.W. (2012). Essential Developmental Biology. 3rd edition, Wiley-Blackwell.
- Wolpert, L. and Tickle, C. (2011). PrinciplesofDevelopment. 4th edition, Oxford University Press.

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SEMESTER – III	
Course name	Endocrine physiology
Course code	PGZOOCC 3.3
Course type	Theory
Number of lectures	60
Credits	4
Marks	50

Course Objectives:

After completion of this course the student will be able to

Sl. No.	Course Objectives:
1:	Demonstrate the molecular mechanisms of hormone action
2:	Explain the role of hormone in cancers, endocrine disorders, stress and obesity disorders
3:	Analyse the hormonal regulation of male & female reproductive systems.
4:	Demonstrate the structure and functions of melatonin and Prostaglandins
5:	Illustrate the reproductive disorders endocrine disruptions

PGZOOCC 3.3: ENDOCRINE PHYSIOLOGY

Class: 60 hrs

- Molecular mechanisms of hormone actions; receptors and signaling pathways, hormonal cross talks and feedback systems, hormonal resistance
- Hormones and cancers; Endocrine disorders
- Pheromones: classification, structure and uses
- GI tract hormones; source, composition and functions
- Role of hormones in stress, obesity and eating disorder
- Pineal gland and melatonin; structure, biosynthesis and functions
- Prostaglandins: Source, chemical nature, structure, functions, physiological significance and clinical implications.
- Female reproductive system; hormonal regulation of ovulation, gestation, parturition and lactation
- Male reproductive system; hormonal regulation of spermatogenesis
- Development of male and female contraceptives
- Hormones and reproductive disorders
- Endocrine disruption; classification of disruptors, sources and effects on reproduction

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Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes:	POs Addressed	PSOs Addressed	Cognitive Level
CO 1:	Define, demonstrate and explain the role of receptors and signalling pathways and feedback mechanisms in hormone action	PO 1	PSO 5	R, U, E
CO 2:	Explain and evaluate the role of hormone in cancers, endocrine disorders, stress and obesity disorders	PO 1, 4	PSO 5	U, E
CO 3:	Demonstrate, apply and discuss the hormonal regulation of male & female reproductive systems.	PO 1	PSO 1, 5	U, Ap, C
CO 4:	Explain the structure, biosynthesis and functions of melatonin and Prostaglandins	PO 1	PSO 5	E
CO 5:	Illustrate and discuss the reproductive disorders endocrine disruptions	PO 1, 4	PSO 1, 5	U, C

R= remembering, U = understanding, Ap = applying, An = analysing, E = evaluating, and C = creating

Books for Reference:

- Barrington, E.J.W. (1985). An introduction to general and comparative endocrinology Clarendon Press Oxford.
- Bentley, P.J. (1985). Comparative vertebrate endocrinology, Second Edition, Cambridge University Press, Cambridge.
- Haris, G.W. and. Donovan, B.T (1968). The Pituitary Gland. S. Chand and Co.
- Ingleton, P.M. and Bangara, J.T. (1986). Fundamentals of comparative vertebrate endocrinology. Kluwer Academic Publishers. Mac Hadley (1992). Endocrinology, 3rd Edition. Prentice - Hall Inc. A Simon & Schuster Company, Englewood Cliffs, New Jersey, USA.
- Turner, C.D. and Bangara, J.T. (1986) General endocrinology. Saunders International Student edition. Toppan Company Limited, Tokyo.

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SEMESTER – III	
Course name	Elective paper-Entomology
Course code	PGZOOEC 3.1A
Course type	Theory
Number of lectures	60
Credits	4
Marks	50

Course Objectives:

After completion of this course the student will be able to

Sl. No.	Course Objectives:
1:	Attain a solid foundation in insect biology, including general entomology, basic systematics, morphology, physiology, and biodiversity
2:	Understand insect reproduction, development and hormonal regulation
3:	Understand evolution and biodiversity generation
4:	Demonstrate the application of social insects

PGZOOEC 3.1A: Entomology

Class: 60 hrs

1. SYSTEMATICS, TAXONOMY AND CLASSIFICATION OF INSECTS:

i) Definition of Biological Systematics, taxonomy and Nomenclature, ii) History of insect classification and Classification of Insects (Old & Modern), iv) Distinguishing characters of the major orders.

2. INSECT MORPHOLOGY:

i) General body plan, ii) **Morphology of Head** (antennae, eyes, mouth parts), **Morphology of Thorax** (thoracic appendages), **Morphology of Abdomen** (abdominal appendages), iii) **The Cuticle** (structure, chemistry, cuticular appendages, cuticular glands, moulting), Formation (Proecdysis, Ecdysis, Postecdysis), Segmentation & Tagmosis. iv) Special features on the morphological characters (order-wise).

3. INTERNAL ANATOMY & PHYSIOLOGY:

i) **Insect Muscles & locomotion:** Structure, Muscle contraction, Physiology of muscles, flight muscles – speciality. ii) **Respiratory system & Functions:** Diversity in structure and functions, direct respiration, convection respiratory pattern. Respiratory pigments and respiratory proteins, haemoglobin in insects, Insect ventilation and its control, respiration in aquatic insects iii) **Circulatory system & Functions:** Haemolymph –composition and function, structure and functions

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of haemocytes. , iv) **Digestive System:** The gut & digestive organs, Food, feeding and digestion, Importance of microbial association in digestion, importance of Trophobiosis and Trophallaxis in nutrition, v) **Excretion and water balance:** Formation of primary urine, Modification of urine in different insects, water balance in aquatic insects, vi) **Nervous system:** Stomodaeal Nervous System. Sensory receptors, vision & acoustics. Vision and colour perception in insects. Sense organs in insects. Chordotonal Organs. Central nervous system, Visceral nervous system, Physiology of Neural Integration, vii) **Endocrine and exocrine system in insects:** Semiochemicals: nature, diversity, functional significance, role in insect plant interaction. Retinue behaviour in relation to QMP. Insect hormones- with reference to metamorphosis & reproduction. Insect Pheromones: variations and functions.

4. WINGS AND FLIGHT:

Evolution of winged insects, v) Origin & evolution of wings, Structural Basis, Aerodynamic Considerations, Mechanics of Wing Movements, Flight Metabolism.

5. INSECT SENSE ORGANS: PERCEPTION OF ENVIRONMENT

i) **Vision:** eyes, photoreception and colour vision ii) **Sensory system:** Mechanoreceptor, sensory hairs, proprioceptors, signal detection, Sound Reception: Johnston's Organ, Tympanal Organs, iii) **Chemoreception:** Chemosensory sensilla, Physiology of Chemoreception iv) **Humidity Perception,** v) **Temperature Perception,**

6. INSECT REPRODUCTION, DEVELOPMENT

Reproduction – Sex determination in insects. Structure and Function of the Reproductive System, Types of reproduction, significance. reproductive interference - causes and consequences. development and metamorphosis – types. Hormonal regulation of metamorphosis and diapause. moulting - neurohormonal control, life cycle diversity. Significance of parthenogenesis in social insects. Paedogenesis in Insects. Arrhenotoky and Thelytoky in eusocial insects. Thelytokous Parthenogenesis in Eusocial Insects.

7. CO-EVOLUTION IN INSECTS AND PLANTS.

Insect plant interaction with reference to Gall formation, Pollination, Herbivory.

8. SOCIAL INSECTS –

Evolution of eusociality. Eusociality in insects. Social structure, organization and behaviour in honey bee, ants, termites. Behavioural epigenetics in social insects, Evolution of castes, hormonal control of caste differentiation.

9. MODERN TOOLS IN INSECT CLASSIFICATION:

DNA barcoding in taxonomy of insects.

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Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes:	POs Addressed	PSOs Addressed	Cognitive Level
CO 1:	Define, demonstrate, and explain insect biology, including general entomology, basic systematics, morphology, physiology, and biodiversity	PO 1, 2	PSO 1, 2, 5	R, U, E
CO 2:	Demonstrate, apply and explain the insect reproduction, development and hormonal regulation	PO 1, 3	PSO 1, 2, 3	U, Ap, E
CO 3:	Demonstrate, apply and adapt the significance of parthenogenesis Paedogenesis in social insects	PO 1, 3	PSO 1, 5	U, Ap, C
CO 4:	Demonstrate, apply and explain the evolution and biodiversity generation	PO 1, 4	PSO 1, 2, 5	U, Ap, E
CO 5:	Demonstrate, evaluate, and discuss the application of social insects	PO 1, 4	PSO 1, 5	U, E, C

R= remembering, U = understanding, Ap = applying, An = analysing, E = evaluating, and C = creating

Books for Reference:

- Barrett, K.E., Barman, S.M., Boitano, S. and Brooks, H.L. (2016). Ganong's Review of Medical Physiology. 25th edition, Indian edition, McGraw Hill Education.
- Brobeck, J.R. (1973). Best and Taylors physiological basis of Medical practice. IX Edn. William n Wilkins Company.
- Copenhaver, W.M., Kelly, D.E. and Wood, R.L. (1978). Bailey's Textbook of Histology. 17th edition, Williams and Wilkins Company.
- Cormack, D.H. (1987). Ham's Histology. 9th edition, J.B. Lippincott Company.
- Eckers, R. & Randal, D. (1987) Animal Physiology. CBS Publishers and Distributors.
- Eroschenko, V.P. (2013). diFiore's Atlas of Histology with Functional Correlations. 12th edition, Lippincott Williams and Wilkins.
- Gordon, M. S., Bartholomew, G. A., Grinnel, A. D., Jorgensen, C. B. White, F.N., (1971) Animal Function - Principles and Adaptations. Macmillan Co. London.
- Hadley, M. and Levine, J. (2007). Endocrinology. 6th edition, Pearson Education.
- Hall, J.E. (2016). Guyton and Hall Text book of Medical Physiology. 13th edition, Elsevier.
- Hoar, W.S., (1987) General and Comparative Animal Physiology. Prentice Hall.
- Kronenberg, H. and Williams, R.H. (2008). Williams Text Book of Endocrinology. 11th edition, Saunders/Elsevier.
- Lehninger, A. L., Nelson, D.L. and Cox, M.M., (1993) Principles of Biochemistry. CBS Publishers and Distributors.
- Marieb, E. (1998). Human Anatomy and Physiology. 4th edition, Addison-Wesley.
- Marieb, E.N. (2007) Essentials of Human Anatomy and Physiology. Published by Dorling Kindersley (India) Pvt. Ltd.
- Nelson, S, K. (1985) Animal Physiology - Adaptation and Environment. Cambridge University Press.

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- Norris, D. O. and Carr, J.A. (2013). Vertebrate Endocrinology. 5th edition, Academic Press.
- Prakash, G. (2012). Lab Manual on Blood Analysis and Medical Diagnostics. S. Chand and Company.
- Prosser, C.L. and Brown (1985) Comparative Animal Physiology III Ed. W.B. Saunders Company, Philadelphia
- Randall, D., Burggren, W. and French, K. (2001). Eckert Animal Physiology: Mechanisms and adaptations. 5th edition, W. H. Freeman.
- Rastogi, S.C. (2005) Essentials of Animal Physiology IV Edn. Published by New Age International (P) Ltd.
- Ross, M.H., Kaye, G.I. and Pawlina, W. (2003). Histology : A Text and Atlas. 4th edition, Lippincott Williams and Wilkins.
- Silverthorn, D.U. (with Johnson, B.R. and Ober, W.C.) (2010). Human Physiology : An Integrated Approach. 5th edition, PHI Learning Pvt Ltd.
- Tortora, G.J. & Derrickson, B.H. (2009). Principles of Anatomy and Physiology. 12th edition, John Wiley & sons.
- Vander A, Sherman J. and Luciano D. (2014). Vander's Human Physiology: The Mechanism of Body Function. 13th edition, McGraw Hills.

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SEMESTER – III	
Course name	Elective paper -Cellular and Molecular Biology
Course code	PGZOOEC 3.1B
Course type	Theory (Elective)
Number of lectures	60
Credits	4
Marks	50

Course Objectives:

After completion of this course the student will be able to

Sl. No.	Course Objectives:
1:	Remember and understand advanced issues related to structure and metabolism of Carbohydrates, Amino acids, Lipids, and nucleic acids
2:	Demonstrate the diagnostic aspect of enzymology
3:	Remember, understand the cellular organization, cell division and cell cycle
4:	Understand and compare some essentials ideas of molecular biology
5:	Demonstrate the applications of some tools and techniques in molecular biology
6:	Elaborate the application of tools for genetic engineering

PGZOOEC 3.1B: Cellular and Molecular Biology

Class: 60 hrs

STRUCTURE, FUNCTION AND METABOLISM OF BIOMOLECULES

Class: 15

Carbohydrates: Homopolysaccharides & heteropolysaccharides; homopolysaccharide folding; glycosaminoglycans, its molecular properties and functions; carbohydrates as informational molecules

Amino acids and proteins: Ionic properties of amino acids and proteins; protein purification and fractioning methods; protein structure determination (X-ray crystallography, NMR Spectroscopy, SDS-PAGE, Mass Spectroscopy, Amino acid analysis, Edman degradation, Protein cleavage & peptide production, disulphide linkage, hydrophobicity profile); monitoring of protein interactions (Surface Plasmon Resonance, DNA foot printing), glycoproteins and their molecular characteristics; proteomics and protein function.

Lipids: The lipid composition of human and animal biological membrane (phospholipid, cholesterol and glycolipids); structure, molecular and biochemical properties, isolation techniques; functions and related disorders. Turnover of membrane lipids; flow cytometry in membrane study.

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Diagnostic enzymology: Serum-specific enzymes, non-serum-specific enzymes, secreted enzymes; ischaemic heart disease & myocardial infarction (creatine kinase, aspartate aminotransferase and lactate dehydrogenase activities); liver diseases (hepatitis, cirrhosis and malignancy).

Nucleic acids: Unusual structure of DNA (palindrome, inverted repeats, cruciform, mirror repeat, Hoogsteen position & pairing, G tetraplex); ultraviolet absorption spectra of DNA, Denaturation & Renaturation of DNA & RNA; nucleic acid hybrids; non enzymatic transformation of nucleotides & nucleic acids; DNA bending (Wedge model & Junction model); DNA supercoiling (supercoiled forms, DNA knots & Catenanes, Superhelical density & specific linking difference); triplex DNA.

CELLULAR ORGANIZATION, CELL DIVISION AND CELL CYCLE Class: 10

Structural organization and function of Cell Membrane and intracellular organelles Structure of model membrane, lipid bilayer and membrane protein diffusion, osmosis, ion channels, active transport, membrane pumps, regulation of intracellular transport, electrical properties of membranes.

Nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, structure & function of cytoskeleton and its role in motility.

Genome Structure and Gene family:

Chromatin organization and remodeling, chromosome, centromere, telomere.

Gene families, clusters, Pseudogenes, super-families

Organelle genomes. C-value paradox and genome size, Cot curves, repetitive and non-repetitive DNA sequences, Cot $\frac{1}{2}$ and Rot $\frac{1}{2}$ values, satellite DNA, DNA melting and buoyant density.

Cell Division and Cell Cycle

Mitosis and meiosis, their regulation, steps in cell cycle, regulation and control of cell cycle

Programmed Cell Death, Aging and Senescence

ESSENTIALS OF MOLECULAR BIOLOGY

Class: 12

Mechanism of Replication: Eukaryotic DNA polymerases and mechanism of replication. Telomere synthesis-telomerases. Replication of viral DNA, rolling circle model. Inhibitors of replication.

Recombination Homologous and site-specific recombination: Models for homologous recombination-Holliday junction, NHEJ, Proteins involved in recombination- RecA, RuvA, B, C, Gene conversion

DNA damage and Repair: DNA damage- alkylation, deamination, oxidation, UV radiation. Repair mechanisms- photoreactivation, excision repair, post replication repair, mismatch repair and SOS repair

Gene Expression in Eukaryotes: Mechanism of Transcription, Eukaryotic RNA polymerases-transcription factors, mechanism of transcription and regulation.

Post transcriptional modifications of mRNA: Capping, poly adenylation, mechanism of splicing, Group I, II and III, spliceosome assembly, splicing editing, Group IV splicing Processing of tRNA and rRNA. Inhibitors of transcription.

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Regulation of gene expression in eukaryotes: transcriptional control, cis control elements, promoters, enhancers, transacting factors, homeobox in the control of developments in insects and vertebrates. DNA binding motifs of transcription factors, posttranscriptional control.

Protein synthesis and processing : Ribosome, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, genetic code, aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase, and translational proof-reading, translational inhibitors, Post- translational modification of proteins).

Co- and post-translational modifications of proteins: Control of translation in eukaryotes (Antisense RNA, Heme and interferon). Role of chromatin in gene expression and gene silencing.

TOOLS AND TECHNIQUES IN MOLECULAR BIOLOGY

Class: 13

PCR primers: Types of PCR primers, primer designing and its application: Universal and random primers, allele-specific PCR primer, SNP primers, primer designing tools and software

Principles of different PCR types: DNA finger printing (RFLP, RAPD, AFLP), Conventional PCR, Multiplex PCR, Nested PCR, High Fidelity PCR, Fast PCR, Hot Start PCR, touchdown PCR, GC-Rich PCR, Long-range PCR, Arbitrary Primed PCR, Cold PCR, Inverse PCR, Reverse-Transcriptase (RT-PCR),

Real-time PCR and its application: Gene Expression Analysis, microRNA & Noncoding RNA Analysis, Disease diagnosis, Genetic Variation Analysis, Biomarker Analysis, mutation detection

BIOTECHNOLOGY

Class: 10

Introduction and tools for genetic engineering

General requirements for performing a genetic engineering experiment; restriction endonucleases and methylases; DNA ligase, Klenow enzyme, T4 DNA polymerase, polynucleotide kinase, alkaline phosphatase; cohesive and blunt end ligation; linkers; adaptors; homopolymeric tailing; labelling of DNA: nick translation, random priming, radioactive and non-radioactive probes, hybridization techniques: northern, southern, south-western and far-western and colony hybridization, fluorescence in situ hybridization.

Different types of vectors

Plasmids; Bacteriophages; M13 mp vectors; PUC19 and Bluescript vectors, phagemids; Lambda vectors; Insertion and Replacement vectors; Cosmids; Artificial chromosome vectors (YACs; BACs); Expression vectors: pMal; GST; pET-based vectors; mammalian expression and replicating vectors; Baculovirus and Pichia vectors system, yeast vectors, shuttle vectors, Intein-based vectors

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Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes:	POs Addressed	PSOs Addressed	Cognitive Level
CO 1:	Define and demonstrate advanced issues related to structure and metabolism of Carbohydrates, Amino acids, Lipids, and nucleic acids	PO 1	PSO 1	R, U
CO 2:	Demonstrate, apply and elaborate the role of various enzymes in disease formation and disease diagnosis	PO 1, 2	PSO 1, 4	U, Ap, C
CO 3:	Define, demonstrate the cellular organization, cell division and cell cycle	PO 1	PSO 1	R, U
CO 4:	Demonstrate, evaluate and compare the central dogma, its regulation and modifications	PO 1, 4	PSO 1, 4	U, An, E
CO 5:	Demonstrate, apply and discuss the tools and techniques in molecular biology	PO 1, 3, 4	PSO 1,5	U, Ap, C
CO 6:	Demonstrate and elaborate the application of tools for genetic engineering	PO 1, 3, 4	PSO 1, 5	U, C

R= remembering, U = understanding, Ap = applying, An = analysing, E = evaluating, and C = creating

Books for Reference:

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- Brooker, R.J. (2012). Genetics : Analysis and Principles. 4th edition. , McGraw Hill Education.
- Brown, T. (2012). Introduction to Genetics : A molecular Approach. Garland Science.
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- Cooper, G.M. and Hausman, R.E. (2009). The Cell: A Molecular Approach. 5th edition, ASM Press, Washington D.C. and Sinauer Associates, INC. Sunderland, Massachusetts.
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- Nelson, D.L. and Cox, M.M. (2013). Lehninger Principles of Biochemistry. 6th edition, International edition, Macmillan Higher Education, W.H. Freeman and Company, New York.
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SEMESTER – III	
Course name	Immunology, Parasitology, Developmental Biology and Endocrinology
Course code	PGZOOCC 3.4
Course type	Practical
Number of lectures	90
Credits	4
Marks	50

Course Objectives:

After completion of this course the student will be able to

SI No.	Course Objectives:
1:	Apply the knowledge of dissection or surgical procedure of various endocrine organs and microtome procedure
2:	Analyse the bioassays of hormones like insulin and TSH
3:	Quantify the glycogen/cholesterol/ascorbic and/fructose in given endocrine tissue
4:	Apply the knowledge of chick embryo, mounting and stage identification
5:	Apply the knowledge of preparation of stains, fixatives, culture media for parasites, and their spot identifications and blood smear examination
6:	Apply the knowledge on preparation and gel electrophoresis of blood sera

PGZOOCC 3.4: Practical Course for Immunology, Parasitology, Developmental Biology and Endocrinology

Class: 90 hrs

- Dissection or surgical procedure of various endocrine organs
- Exercise on bioassays of hormones like insulin and TSH
- Quantitative estimation of glycogen/cholesterol/ascorbic and/fructose in given endocrine tissue
- Microtomy procedure
- Exercise on living embryos/ teratological experiments
- Chick embryo mounting and stage identifications of slides
- Explant culture experiments
- Metamorphosis and regeneration experiments
- Preparation of stains, fixatives, culture media for parasites, and their spot identifications
- Blood smear examination for malarial parasites
- Spleen and thymus dissection, histology and staining
- Analyze the immune components of human sera by electrophoresis

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- A Blood bank visit

Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes:	POs Addressed	PSOs Addressed	Cognitive Level
CO 1:	Demonstrate and apply the knowledge of dissection or surgical procedure of various endocrine organs and microtome procedure	PO 1, 3	PSO 1, 3	U, Ap
CO 2:	Analyse and evaluate the bioassays of hormones like insulin and TSH	PO 2	PSO 3, 4	An, E
CO 3:	Analyse and estimate the glycogen/ cholesterol/ ascorbic and/fructose in given endocrine tissue	PO 2	PSO 4	An, C
CO 4:	Demonstrate and apply the knowledge of chick embryo, mounting and stage identification	PO 1, 2	PSO 1, 3	U, Ap
CO 5:	Demonstrate, apply and explain the knowledge of preparation of stains, fixatives, culture media for parasites, and their spot identifications and blood smear examination	PO 1, 2, 3	PSO 1, 3	U, Ap, E
CO 6:	Demonstrate and apply the knowledge on preparation and gel electrophoresis of blood sera	PO 2, 4	PSO 4, 5	U, Ap

R= remembering, U = understanding, Ap = applying, An = analysing, E = evaluating, and C = creating

SEMESTER – III	
Course name	Dissertation and practical of elective paper-Entomology
Course code	PGZOOEC 3.2A
Course type	Practical (Elective)
Number of lectures	90
Credits	4
Marks	50

Course Objectives:

After completion of this course the student will be able to

Sl. No.	Course Objectives:
1:	Apply the knowledge of Collection, Preservation, Curation, Identification and Classification of Major Insect Orders
2:	Demonstrate the Dissection of Mouth parts, antenna and genitalia dissection of some major order of insects
3:	Design and perform original research work in Entomology

PGZOOEC 3.2A: Practical of Entomology

Class: 90 hrs

METHODS IN ENTOMOLOGY: Collection, Preservation, Curation, Identification and Classification of Major Insect Orders (Preparation of Taxonomic Keys)

Dissection: Mouth parts, antenna and genitalia dissection of some major order of insects.

Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes:	POs Addressed	PSOs Addressed	Cognitive Level
CO 1:	Demonstrate, explain and apply the knowledge of Collection, Preservation, Curation, Identification and Classification of Major Insect Orders	PO 1, 2, 3	PSO 2, 3	U, Ap, E
CO 2:	Demonstrate and evaluate the of Mouth parts, antenna and genitalia dissection of some major order of insects through dissection	PO 1, 2	PSO 3	U, E
CO 3:	Design and perform original research work in entomology	PO 4	PSO 3, 5	C

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SEMESTER – III	
Course name	Dissertation and practical of elective paper-Cellular and Molecular Biology
Course code	PGZOOEC 3.2B
Course type	Practicals (Elective)
Number of lectures	90
Credits	4
Marks	50

Course Objectives:

After completion of this course the student will be able to

Sl. No.	Course Objectives:
1:	Apply the knowledge of DNA and protein isolation and visualization
2:	Apply the knowledge of bacterial culture and plasmid DNA preparation
3:	Apply the knowledge of PCR primer designing
4:	Design and perform original research work using molecular biology techniques

PGZOOEC 3.2B: Practical of Cellular and Molecular Biology

Class: 90 hrs

- DNA isolation, Protein isolation, Electrophoresis of DNA and Protein
- Bacterial culture preparation, Plasmid DNA preparation
- Primer designing
- Dissertation works

Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes:	POs Addressed	PSOs Addressed	Cognitive Level
CO 1:	Demonstrate, and apply the knowledge of DNA and protein isolation and evaluate the DNA quality through visualization	PO 1, 2	PSO 3, 4	U, Ap, E
CO 2:	Demonstrate perform and explain the bacterial culture and plasmid DNA preparation	PO 1, 2	PSO 3, 4	U, Ap, E
CO 3:	Demonstrate and design the PCR primer	PO 1, 2	PSO 3, 4	U, C
CO 4:	Design and perform original research work using molecular biology techniques	PO 2, 3, 4	PSO 3, 5	C

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SEMESTER – III	
Course name	Value Education and Indian Culture
Course code	PGZOOSOC 3
Course type	Soft Skill
Number of lectures	15
Credits	1
Marks	25

Course Objectives:

After completion of this course the student will be able to

Sl. No.	Course Objectives:
1:	Attain awareness about daily routine, self-evaluation & Integral Personality Development
2:	Understand the educational needs, the Power of thoughts and the Science of Peace
3:	Understand the relation: Values and enlightened citizenship
4:	Attain awareness about the Indian Practice and Culture
5:	Demonstrate the importance of Four Yogas
6:	Acquire idea about Modern India: her hopes, challenges and Swami Vivekananda

PGZOOSOC 3: Value Education and Indian Culture

Class: 15 hrs

Unit1: Daily Routine:

1 class

- A suggested daily routine
- The daily routine & the concept of Biological clock: key to a healthy and productive life
- Necessity for an all-round daily routine
- Combining Rest and Activity, Hardships and Joy in a daily routine
- The scope of developing the power of concentration and detachment through a daily routine
- Daily Routine disciplines the system but confers conviction on oneself

Unit2: Self Evaluation & Integral Personality Development:

2 classes

- Why is Self-Evaluation important? Because if you win yourself, you win the world
- Quantitative Self Evaluation for a qualitative change: A method
- Traits to track Personality Development: Academic Excellence, Social Compatibility, Participation in Group events, Sense of Responsibility, Role as a Consumer, Scientific Temperament, Aesthetic taste and creativity, Leisure time Activities, Concern for others, Spiritual values.
- Close and Constant Self Evaluation : a stitch in time saves nine
- The world *is* as we *are* : A minor inner change may nullify a major outer perturbation

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2 classes

Unit3: Our Educational Needs

- The need of a correct blend of inner and outer well-being in education
- Man-making, Character building education : growing from within , a surer foundation of progress
- The outer crust and the inner core of our personality: "What you are shouts so loudly in my ears that I cannot hear what you say."
- A 5-point training in Discipline, Cleanliness, Behaviour, Manners and Ambition
- Sharpening the sword of will: controlling its expression, a basic educational need
- How to study effectively?

1 class

Unit4: The Power of thoughts and the Science of Peace

- Shanti Mantras: Peace can be radiated from and reflected back upon ourselves
- You can create an ambience and others can enjoy it, can be benefitted by it.
- How to create a positive, peaceful and inspiring ambience?- the aggressive exertion and the unquestioning sacrifice involved in it

1 class

Unit5: Subhashita: The Well said

- Bringing home high thoughts in nuggets of wisdom
- Pearls of Wisdom and flames of fire: simple parables and anecdotes from the great ones.

Unit6: Values and Enlightened Citizenship

2 classes

- Intrinsic and Instrumental Values
- What makes a man great? A powerful will to do good born out of self-control and self-sacrifice
- Learning the art of inter-personal relations: Not I but You
- The combination of the Head, Heart and Hand: a valuable value for Enlightened Citizenship

Unit7: Indian Practice and Culture

2 classes

- The idea of sacredness & its necessity
- Every aspect of life is sacred in India
- Renunciation and service the twin ideals for India
- My freedom from Nature helps me to serve nature and the world better
- I never say I am the body, I always say this body is mine : I as a master of the body-mind complex
- Weakness is death: in search of real strength of self-knowledge, reliance on God and unselfish service
- Meditation, Concentration and the silent Indian path for becoming a dynamo of power
- The Indian concept of Unity in diversity: Harmony of Religions

Unit8: Four Yogas

2 classes

- The Real and Apparent Man, the science of knowing myself: Jnana Yoga
- Taming the mighty current of emotions and giving them their right food: Bhakti Yoga

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- The Science of working wisely: Karma Yoga
- The Process of making my mind mine: Raja Yoga
- Selected portions from Swami Vivekananda's Karma Yoga
- Harmony of 4 Yogas: a needed balance for the modern man

Unit9: Modern India: her hopes, challenges and Swami Vivekananda

2 classes

- Swami Vivekananda's method of combining the best of the East & the West: where Indian values and Western workmanship join hands
- Invigorating rationality in the field of the Indian search for the supreme joy : erasing the misconception of dogmatism
- Rousing a sense of pride in the age-long Indian discoveries in the field of inner truths as opposed to an inferiority complex posed by Western material supremacy.
- Do you feel: Service, Swami Vivekananda's acid test for modern science and traditional spirituality.

Unit10: Students' Presentations/Project: (may be in groups)

Project on Service, Teaching and Cleanliness

Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes:	POs Addressed	PSOs Addressed	Cognitive Level
CO 1:	Define, demonstrate and apply the daily routine, self-evaluation & Integral Personality Development	PO 1	PSO 5	R, U, Ap
CO 2:	Learn, and apply the Power of thoughts & the Science of Peace	PO 4	PSO 2, 5	U, Ap
CO 3:	Demonstrate and explain the relation: Values and enlightened citizenship	PO 4	PSO 5	U
CO 4:	Discuss the awareness about the Indian Practice and Culture	PO 4	PSO 5	C
CO 5:	Demonstrate and practice the Four Yogas	PO 1	PSO 5	U, Ap
CO 6:	Explain and analyse the idea about Modern India: her hopes, challenges and Swami Vivekananda	PO 3, 4	PSO 2, 5	U, An

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Books for Reference:

- 1) Jivan Sopan, Published by Ramakrishna Mission Vivekananda Centenary College, Rahara, Kolkata
- 2) Swami Vivekananda : His Call to the Nation, Advaita Ashrama
- 3) Thoughts of Power: Swami Vivekananda, Advaita Ashrama
- 4) Swami Vivekananda, The Friend of all, Ramakrishna Mission Institute of Culture, Golpark, Kolkata
- 5) Gems, Ramakrishna Mission Institute of Culture, Golpark, Kolkata

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SEMESTER – IV	
Course name	Taxonomy and Biostatistics
Course code	PGZOOCC 4.1
Course type	Theory
Number of lectures	60
Credits	4
Marks	50

Course Objectives:

After completion of this course the student will be able to

Sl. No.	Course Objectives:
1:	Understand, apply and analyse the basic concepts in taxonomy & phylogenetics and biostatistics
2:	Analyse and evaluate the descriptive statistics and diagrammatic representation of data
3:	Understand and apply research methodologies in future research
4:	Understand, evaluate and apply the biological data analysis tools and techniques
5:	Understand, analyse and apply the machine learning in biological data analysis and representation

PGZOOCC 4.1: TAXONOMY AND BIOSTATISTICS

Class: 60 hrs

Taxonomy & Phylogeny

- Concepts of taxonomy and systematics
- Characters; plesiomorphous & apomorphous characters; homoplasy;
- Character state transitions; unordered, ordered; irreversible; dollo; polymorphism
- Phylogenetic groups; monophyly; polyphyly; paraphyly
- Species concepts; OTU; biological species concept; phylogenetic species concept; evolutionary species concept
- Cladistics and cladograms; parsimony analysis
- Phenetic methods in taxonomy; phenograms
- Keys and identification

Basic Statistics:

- Types of Variables and measurements along with measurement scales
- Descriptive statistics Measures of Central tendency and dispersal
- Probability Distribution (Binomial, Poisson and Normal)

- Graphical Representation by types of data
- Central Tendency: Mean Deviation, Variance,
- Standard Deviation, Coefficient of Variation

Sampling Techniques and Design:

- Concepts of Sampling
- Population and Sample
- Random sampling
- Stratified Sampling
- Systematic Sampling
- Cluster Sampling

Statistical Inference:

- Concept of a Statistic and Sampling Distribution,
- Point and Interval Estimate of a Parameter,
- Standard errors, Null and Alternative Hypotheses,
- Statistical Tests and Distributions,
- Concepts of Type I & II Errors,
- p- values
- Chi-square tests, t – test, Z-test and F-test.

Research Methodology:

- Concepts and definitions of Research,
- Formulation of objectives,
- Expected Outcome/s and Statistical Analysis,
- Methods of data collection,

Introduction to data analytics

- Data representation, management, and visualization
- Hypothesis Testing
- Correlation and Linear Models
- Logistic Regression
- Clustering, K-means clustering
- Principal Components Analysis (PCA)
- Hierarchical clustering

Introduction to Machine learning

- Linear Regression
- Logistic Regression

- K Nearest Neighbors
- Decision Trees and Random Forests
- Support Vector Machines
- K-Means Clustering
- Natural Language Processing
- Neural Nets.
- Model testing and evaluation techniques

Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes:	POs Addressed	PSOs Addressed	Cognitive Level
CO 1:	Define and explain the basic statistical concepts.	PO 1	PSO 3, 4	R, E
CO 2:	Demonstrates, apply and analyse the descriptive statistics and construct skills in diagrammatic representations	PO 1, 2	PSO 3, 4	U, An, Ap, C
CO 3:	Apply various sampling techniques and statistical inference to solve various problems	PO 2, 3	PSO 3, 4	Ap, C
CO 4:	Formulate research objectives and research methodologies respectively	PO 3, 4	PSO 5	C
CO 5	Apply machine learning tools to construct decisions	PO 3, 4	PSO 4	Ap, C

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Books for Reference:

- Antonisamy, B., Christopher, S. and Samuel, P.P. (2010). Biostatistics : Principles and Practice. Tata McGraw Hill Education.
- Banerjee, P.K. (2011). Introduction to Biostatistics. S. Chand Publishing
- Pagana, M. and Gavreau, K. (2000). Principles of Biostatistics. Duxberry Press.
- Zar, J.H. (2010). Biostatistical Analysis. 5th edition, Pearson Education.
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- Futuyma, D.J. (2013). Evolution. 3rd edition, Sinauer Associates.
- Hall, B.K. and Hallgrimsson, B. (2008). Strickberger's Evolution. 4th edition, Jones and Bartlett Publishers.
- Herron, J.C. and Freeman, S. (2013). Evolutionary Analysis. 5th edition, Pearson.
- Ridley, M. (2004). Evolution. 3rd edition, Blackwell Publishing.

SEMESTER – IV	
Course name	Bioinformatics & Computational biology
Course code	PGZOOCC 4.2
Course type	Theory
Number of lectures	60
Credits	4
Marks	50

Course Objectives:

After completion of this course the student will be able to

Sl. No.	Course Objectives:
1:	Understand the basic concepts in Bioinformatics/Computational biology and its applications in various fields
2:	Understand, analyse and apply biological databases available online
3:	Understand and apply algorithms for the sequence alignment and computational calculations used in bioinformatics tools
4:	Understand, evaluate and apply the computational techniques in genomics, transcriptomics and proteomics

PGZOOCC 4.2: Bioinformatics & Computational Biology

Class: 60 hrs

Introduction to Computational Biology and Bioinformatics:

Nature and scope of Computational Biology and Bioinformatics, Basic algorithms in Computational Biology, Introduction to sequence alignment (only general ideas) - Local and global, pair wise and multiple, BLAST.

Bioinformatics databases:

Type of databases, Nucleotide sequence databases, Primary nucleotide sequence databases-EMBL, Gene Bank, DDBJ; Secondary nucleotide sequence databases. Specialized database, Protein sequence databases-SwissProt/ TrEMBL, PIR, Sequence motif databases - Pfam, PROSITE, Protein structure databases, Protein Data Bank-SCOP, CATH, KEGG, ChEMBL, Sequence, structure and function relationship.

Sequence alignment:

Pair-wise sequence alignment, Need of Scoring schemes- Penalizing gaps – Linear and Affine gap penalty; Effect of scoring schemes, Scoring matrices for amino acid sequence alignment, PAM Probability matrix- Log odds matrix; BLOSUM; Dot-plot visualization; Smith –Waterman algorithm for local alignment, Needleman-Wunsch algorithm, Statistics of Sequence alignment score: E- values, bit scores and sensitivity,

specificity; BLAST and FASTA. Need for MSA, SP measure- n dimensional dynamic programming- Heuristics algorithm for multiple sequence alignment - Progressive alignment, Iterative alignment - Tools for local, global and MSA: Muscle, T-Coffee, and ClustalW.

Genomics –

Definition of genome and genome sequencing, genome map; types of genome maps and their uses, map repositories; GDB – Genome database, NCBI- Entrez human genome map viewer, OMIM- Online Mendelian inheritance in man. Structural annotation (Locating coding regions and other structural elements of the gene). Various approaches in gene prediction: ORF Prediction, gene prediction in prokaryotes, gene prediction in eukaryotes. Interpretation of gene maps of selected organism.

Transcriptomics:

Concept of Transcriptome, transcriptome analysis and Gene Expression-An Overview-introduction to microarrays; Types of non-coding RNA's- lncRNAs, miRNAs, piRNAs, siRNAs ceRNAs etc., RNA databases, RNA interference, RNA structure prediction tools, RNA sequence analysis, RNA regulatory networks; Transcriptome assembly, Comparative transcriptomics; short ORFs, encode project.

Proteomics

Proteome and proteomics –Proteins as workhorse molecules of life, Interatomic forces and protein structure; Protein databases: UniProtKB/ Swiss-Prot, Interpro, PIR, PDB, SCOP & CATH, ProDom, PFAM; Protein visualization tools- Swiss PDB Viewer, Pymol. Expasy proteomic tools: AA CompIdent, MultiDent, Peptide Mass etc. Protein structure prediction (basic idea), Drug Discovery and Drug Design through Computational approaches (basic idea).

Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes:	POs Addressed	PSOs Addressed	Cognitive Level
CO 1:	Describe and explain various database used for nucleotides and proteins	PO 1	PSO 4	R, E
CO 2:	Demonstrate apply and discuss various algorithms for sequence analysis and molecular interactions	PO 1, 2	PSO 4	U, Ap, C
CO 3:	Analyses nucleotide and protein sequences using various databases and software tools	PO 2	PSO 4	An
CO 4:	Evaluate RNA interference and RNA regulatory networks.	PO 3	PSO 4, 5	E
CO 5:	Predict gene, ORF, protein structure and their functional role.	PO 4	PSO 4 & 5	C

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- Bergeron, B. P. (2003). Bioinformatics computing. Prentice Hall Professional.
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- Dan. E. Krane, & Raymer, M. L. (2003). Fundamental Concepts of Bioinformatics. Pearson Education International.
- Deonier, R. C., Tavaré, S., & Waterman, M. (2005). Computational genome analysis: an introduction. Springer.
- Gautham, N. (2006). Bioinformatics: Databases and Algorithms. Alpha Science Int'l Ltd.
- Gopal, S., Price, R., Tymann, P., & Haake, A., (2000). Bioinformatics with Fundamentals of Genomics and Proteomics. Tata McGraw Hill Education Pvt. Ltd.
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- Pevsner, J. (2009). Bioinformatics and functional genomics. John Wiley & Sons
- Ramsden, J. (2009). Bioinformatics: an introduction (Vol. 10). Springer.
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- Salemi, M., Lemey, P., & Vandamme, A. M. (Eds.). (2009). The phylogenetic handbook: a practical approach to phylogenetic analysis and hypothesis testing. Cambridge University Press
- Setubal, J. C., Meidanis, J., & Setubal-Meidanis. (1997). Introduction to computational molecular biology. PWS Pub.
- Xiong, J. (2006). Essential bioinformatics. Cambridge University Press
- Zvelebil, M. J., & Baum, J. O. (2008). Understanding bioinformatics. Garland Science.
- Ghosh, Z. and Mallick, B. (2008). Bioinformatics : Principles and Applications. Oxford University Press.
- Zvelebil, M. and Baum, J.O. (2007). Understanding Bioinformatics. Garland Science.

SEMESTER – IV	
Course name	Bio python And LaTeX
Course code	PGZOOCC 4.3
Course type	Theory
Number of lectures	60
Credits	4
Marks	50

Course Objectives:

After completion of this course the student will be able to

Sl. No.	Course Objectives:
1:	Learn the handling and analysis of nucleotide, protein sequences and databases.
2:	Create neural networks and learn genetic algorithms.
3:	Create and design documents in LaTeX.
4:	Prepare presentations in Beamer with confidence.

PGZOOCC 4.3: Bio python And LaTeX

Class: 60 hrs

Bio python

2 credit, Class: 30 hrs

Will be conducted by IIT Bombay through Spoken tutorial

LaTeX

2 credit, Class: 30 hrs

Will be conducted by IIT Bombay through Spoken tutorial

Topic 1: Introduction

This topic introduces the learner to LaTeX, its installation, and different IDEs. The learner creates the first document using LaTeX, organizes content into sections using articles and book class of LaTeX.

Topic 2: Styling Pages

In this topic, the session starts by reviewing different paper sizes, examines packages, formats the page by setting margins, customizing header and footer, changing the page orientation, dividing the document into multiple columns. The topic ends with reading different types of error messages.

Topic 3: Formatting Content

This topic concentrates on formatting text (styles, size, alignment), adding colors to text and entire page, and adding bullets and numbered items. It concludes by explaining the process of writing complex mathematics.

Topic 4: Tables and Images

The topic starts by creating basic tables, adding simple and dashed borders, merging rows and columns, and handling situations where a table exceeds the size of a page. The sessions then continue to add an image, explore different properties like rotate, scale, etc..

Topic 5: Referencing and Indexing

In this topic, the learner learns to add cross-referencing (refer to sections, table, images), add bibliography (references), and create back index.

Topic 6: Presentation using Beamer

Introduction to creating slides, adding frames, dividing the slide into multiple columns, adding different blocks, etc..

Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes:	PSOs Addressed	PSOs Addressed	Cognitive Level
CO 1:	Demonstrate, evaluate and apply the handling and analysis of nucleotide, protein sequences and databases.	PO 1, 2, 3	PSO 1, 4	R, E, Ap
CO 2:	Demonstrate, analyse and create neural networks and learn genetic algorithms.	PO 1, 2, 4	PSO 1, 4, 5	U, An, C
CO 3:	Organize documents into different sections, subsections, etc., Formatting pages (margins, header, footer, orientation), Formatting text, create presentations using Beamer	PO 1	PSO 4, 5	Ap, C
CO 4:	Write complex mathematical formulae, Include tables and images, Cross-referencing, bibliography, and Indexing	PO 1, 3	PSO 4, 5	Ap, C

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SEMESTER – IV	
Course name	Elective paper (Entomology)
Course code	PGZOOEC 4.1A
Course type	Theory (Elective)
Number of lectures	60
Credits	4
Marks	50

Course Objectives:

After completion of this course the student will be able to

Sl. No.	Course Objectives:
1:	Understand the application of insect biology in the field of agriculture, forest ecology, vector biology and forensic science
2:	Demonstrate the application of insect apiculture, sericulture, and lac culture
3:	Understand the global environmental impact on insects
4:	Demonstrate the various aspect of Insect Ecology

PGZOOEC 4.1A: ENTOMOLOGY

Class: 60 hrs

1. Agricultural Entomology

Introduction to Agricultural entomology, **Crop pests** (Cash crops), **Toxicology** (conventional, non-conventional insecticides, and nano-insecticides, application success and limitations, Pheromone trap, Sterile insect technique), **Insect pathology** (Vectors of Plant Viruses, and other Pathogens).

2. Forest Ecology and Entomology

Introduction (Environment and Forest Types, Ecosystem Services by Plants and Animals), **Plant phenology** (Importance of phenology in IPM), **Insect Herbivory and Pests** (Major Ecological Roles; Concept of Pest, Herbivory of Leaves, Leaf Galls, Flower Pollen and Nectar Robbers, Seed Predation), **Plant Pests**: Defoliators, Seed Pests, Nursery Pests, wood Borers, **Plant Defences**: Types of Defences, Mechanical Defences, Chemical Defences, **Sampling methodology** (Concept of Gradient Sampling and Insect assemblages; Prominent Environmental gradients for Insects & How to determine their effect) **Survey & Monitoring** (How to do Long-term Studies)

3. Medical Entomology:

Introduction (Importance in human society) **Vector biology** (medical importance, and management of the medically important insects; **Modes of transmission** (arthropod borne communicable diseases; Epidemiology of Vector-Borne diseases through Parasites and Pathogens of Public Health Importance-

Occurrence, causative agents, transmission and control of protozoan, bacterial, rickettsia and viral diseases. e.g Malaria, Leishmaniasis, Sleeping sickness, Filariasis, Plague, Japanese Encephalitis, Yellow fever, Dengue, Chikungunya; Ecto- & endoparasites- of skin, Internal Insect Parasites (myiasis causing insects).

4. Forensic entomology:

Introduction (Definition, History, importance and application) **Application & case study** (importance of medico legal forensic entomology, stages of death; importance of insects in medico criminal investigation; estimation of time of death using insects; common arthropods associated with dead body; application and case study).

5. Commercial entomology

Introduction (Provide information on productive insects and their products)

Apiculture (Bee diversity, Bee plant relationship, Bee keeping- General colony management during different seasons. Seasonal management. Managing colonies for honey production and pollination. Artificial queen rearing. Pests and diseases of honeybees. Production and marketing of quality honey and value-added honey products. Establishment and maintenance of apiaries.

Sericulture Indigenous races, pure races and commercial races of mulberry silk moth, pests and diseases of silkworms, rearing and management of silkworms. Rearing of mulberry silk moth, Alternate host plants in Sericulture. Study of different species of silkworms, characteristic features, moriculture, silk and its uses, pests, and diseases of silkworms, rearing and management of silkworms.

Lac culture (History, definition & composition, life cycle and natural enemies of lac insects and their management, Lac cultivation).

6. Global environmental impact on insects

Impact of global climatic changes on insects, effects on insect pollinators. Insects as Bioindicators to pollution. Global Insect decline in Anthropocene.

7. Basics of Insect Ecology

Concept of Abundance, Diversity & Distribution & their Relationship; Estimates and Causal factors of Diversity; Relative distribution of Insects; Assessment of diversity. Basic principles of Abiotic Factors and their generalised action on insects; Seasonality in Insects; Evolution of Predator Evasion: Mimicry, Colouration, Echo-Jamming, concept of predator satiation; evolution of life history strategies

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Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes:	POs Addressed	PSOs Addressed	Cognitive Level
CO 1:	Demonstrate, evaluate, analyse and apply the insect biology and its diversity in the field of agriculture, forest ecology, vector biology and forensic science	PO 1, 2, 3	PSO 1, 2, 5	U, E, An, Ap
CO 2:	Define, Demonstrate and apply the knowledge of insect biology in apiculture, sericulture, and lac culture	PO 1, 3	PSO 1, 2, 5	R, U, Ap
CO 3:	Demonstrate, access and apply the insect diversity in environment monitoring and the global environmental impact on insects	PO 1, 2, 3	PSO 1, 2, 5	U, E, Ap
CO 4:	Demonstrate, apply and discuss the various aspect of Insect Ecology	PO 1, 4	PSO 1, 2, 5	U, Ap, C

R= remembering, U = understanding, Ap = applying, An = analysing, E = evaluating, and C = creating

Books for Reference:

- IMMS' TEXT BOOK OF ENTOMOLOGY- BY O. W. RICHARDS AND R. G. DAVIES, (METHUEN &CC., LONDON,), VOLS. I & II.
- THE INSECTS: STRUCTURE, FUNCTION & BIODIVERSITY—DUNSTONE. P. AMBROSE
- PRINCIPLES OF INSECT MORPHOLOGY- BY R. E. SNODGRASS, (TATA, MCGRAW-HILL, BOMBAY.
- THE INSECT: STRUCTURE & FUNCTION- BY R.F. CHAPMAN (E. L.B.S., & E.U.P. LONDON,).
- A TEXTBOOK OF ENTOMOLOGY' BY H. H. ROSS (JOHN WILEY AND SONS, INS. NEW YORK,).
- INSECT MORPHOLOGY AND PHYLOGENY- ROLF G. BEUTEL, FRANK FRIEDRICH, SI-QIN GE, XING-KE YANG
- MAYR, E. 1969. PRINCIPLES OF SYSTEMATIC ZOOLOGY, MCGRAW-HILL, INC, NEW YORK.
- KAPOOR, V. C. 1998. THEORY AND PRACTICE OF ANIMAL TAXONOMY (4TH EDITION) 247 PP. OXFORD& IBH PUBLISHING CO. PVT. LTD. NEW DELHI.
- SPIDERS OF INDIA BY P. A. SEBASTIAN AND K V PET
- ENTOMOLOGY -- CEDRIC GILLOT

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- THE INSECTS AN OUTLINE OF ENTOMOLOGY--- P.J. GULLAN AND P.S. CRANSTON
- INTRODUCTION OF COMPARATIVE ENTOMOLOGY- BY R. M. FOX & J. W. FOX, (REINHOLD, NEW YORK,).
- A TEXT BOOK OF INSECT ENDOCRINOLOGY AND PHYSIOLOGY- TEMBHARE D.B.- S.CHAND PUBLICATION
- INSECT ENDOCRINOLOGY—LAWRENCE.I. GILBERT
- INSECT DIAPYCNSE- DAVID.L. DENLINGER
- FUNDAMENTALS OF INSECT PHYSIOLOGY, BLUM N.S., JOHN WILEY AND SONS,NY.
- AN INTRODUCTION TO INSECT PHYSIOLOGY, BURSELL, E. ACADEMIC PRESS, NY
- COMPREHENSIVE INSECT PHYSIOLOGY, BIOCHEMISTRY AND PHARMACOLOGY, KERKUR G.A AND GILBERT L.I., VOL 1 TO 13 PERGAMON PRESS, OXFORD, NY
- ADVANCED INSECT PHYSIOLOGY. BY RUSSEL JURENKA. INSECT PHYSIOLOGY BY WIGGLESWORTH.
- INSECT PHYSIOLOGY AND BIOCHEMISTRY ---JAMES L. NATION, SR
- INSECT BIOCHEMISTRY AND FUNCTION D.J. AND KILBY D.A. CHAPMAN AND HALL, LONDON.
- INSECT ECOLOGY --AN ECOSYSTEM APPROACH--- TIMOTHY D. SCHOWALTER
- CHEMICAL ECOLOGY OF INSECTS APPLICATIONS AND ASSOCIATIONS WITH PLANTS AND MICROBES---- ed: JUN TABATA NATIONAL AGRICULTURE AND FOOD RESEARCH ORGANIZATION TSUKUBA JAPAN
- MEDICAL AND VETENARY ENTOMOLOGY BY GARY R. MULLER, LANCE BURDEN.
- MEDICAL AND VETERINARY ENTOMOLOGY - D S KETTLE
- . GENERAL & APPLIED ENTOMOLOGY- BY K.K. NAYAR, T.N. ANATHAKRISHNAN & B.V.DAVID, (TATA,MCGRAW-HILL, NEW DEHLI,).
- A TEXT BOOK OF FOREST ENTOMOLOGY—T.V.SATHE
- ELEMENTS OF ECONOMIC ENTOMOLOGY—B. VASANTHARAJ DAVID & V.V.RAMAMURTHY
- A TEXTBOOK OF AGRICULTURAL ENTOMOLOGY—DAVID VALFORD
- COMPHREHENSIVE MOLECULAR INSECT SCIENCE---KOSTAS LATROU & SARJEET S.GILL
- NATURE'S DICTIONARY OF ENTOMOLOGY---R.BABU & P. GIRISH KUMAR, NBI
- A DICTIONARY OF ENTOMOLOGY—GORDON GORDH & DAVID HEADRICK

SEMESTER – IV	
Course name	Elective paper 2B (Cellular and Molecular Biology)
Course code	PGZOOEC 4.1B
Course type	Theory (Elective)
Number of lectures	60
Credits	4
Marks	50

Course Objectives:

After completion of this course the student will be able to

SL. No.	Course Objectives:
1:	Remember and understand cellular metabolic disorders
2:	Understand and evaluate the mendelian principles related to cell biology
3:	Remember, understand and apply the gene transfer and gene manipulation methodologies
4:	Understand, design and apply the tools and techniques in molecular biology viz. PCR, Cloning,
5:	Understand, analyse and apply various nucleotide sequencing techniques

PGZOOEC 4.1B: Elective paper 2B (Cellular and Molecular Biology)

Class: 60 hrs

Cellular metabolic disorders: Purine and Pyrimidine biosynthesis- denovo and salvage pathway, Urea cycle and Amino Acid Metabolism Disorders, Carbohydrate Metabolism Disorders - Type 1 and Type 2 diabetes, G6PD Deficiency, Hemochromatosis - hepatotoxicity, Lipid Metabolism Disorders - Gaucher Disease, Reactive oxygen species (ROS) – damage of DNA, protein and lipids, Mechanism of heavy metal toxicity. Tay-Sachs disease, Respiratory distress syndrome, Maple Syrup Urine Disease, Phenyl Ketonuria, Albinism, Alkaptonuria, hypercholesterolemia, jaundice, Hepatitis, Cardiac hypertension, Malaria, Dengue, Parkinson's disease, Alzheimer's disease, Multiple Sclerosis, Amyotopic Lateral Sclerosis (ALS), Stroke etc.

Class: 10 hrs.

Mendelian principles: Dominance, segregation, independent assortment, Analytical problems Codominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, penetrance and expressivity, phenocopy, linkage and crossing over, sex linkage, sex limited and sex influenced characters, Pedigree Analysis.

Class: 5 hrs

Extra chromosomal inheritance: Inheritance of Mitochondrial and chloroplast genes, maternal inheritance, Different experiments and their inferences

Class: 3 hrs

Gene Concept: Allele, multiple alleles, pseudoallele, complementation tests

Class: 2 hrs

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Microbial genetics: Methods of genetic transfers – transformation, conjugation, transduction and sex-duction, mapping genes by interrupted mating. Los score, Karyotype, Genetic Disorder. Class: 5

Gene silencing and genome editing technologies Class: 8

Gene silencing techniques, introduction to siRNA; siRNA technology; Micro RNA; construction of siRNA vectors; principle and application of gene silencing; gene knockouts, Genome editing by CRISPR-CAS with examples.

Genetic diseases-Detection and Diagnosis, Gene therapy – ex vivo, in vivo, gene delivery systems, viral and non-viral. DNA marker technology in plants, DNA fingerprinting, genetically engineered biotherapeutics and vaccines and their manufacturing, Transgenic animals and Bio-pharming.

Gene manipulation and protein-DNA interaction Class: 7

Insertion of foreign DNA into host cells; transformation, electroporation, transfection; construction of libraries; isolation of mRNA and total RNA; reverse transcriptase and cDNA synthesis; cDNA and genomic libraries; construction of microarrays – genomic arrays, cDNA arrays and oligo arrays; study of protein-DNA interactions: electrophoretic mobility shift assay; DNasefootprinting; methyl interference assay, chromatin immunoprecipitation.

Tools and techniques in Molecular biology

Application of different PCR types: Fidelity of thermostable enzymes; DNA polymerases; cloning of PCR products; chemical synthesis of oligonucleotides, PCR based site specific mutagenesis; PCR in molecular diagnostics for viral and bacterial detection Class: 3

Loop-Mediated Isothermal Amplification (LAMP): Emergence as an Alternative Technology for infectious disease diagnosis Class: 2

Sequencing methods: Maxam–Gilbert's chemical cleavage method of DNA sequencing. Sanger sequencing, automated DNA sequencing; RNA sequencing; Next Generation sequencing - NGS Platforms: High throughput pyrosequencing, Sequencing by ligation, Illumina, Ion Torrent, Complete Genomics Technology, Third Generation Sequencing (3GS): PacBio and Oxford Nanopore, NGS Strategies for Family Based Genetic Analysis - Family Based Genome Wide Association Studies, Target Specific Sequencing, Panel Gene Sequencing (PGS), Whole-Exome Sequencing (WES), Whole Genome Sequencing (WGS). 5 classes

DNA sequence analysis: Principles of Sequence Similarity Searches, Algorithms for Sequence Alignment and Similarity Search, Sequence database search algorithms, Algorithms and software tools for gene identification, NGS data analysis pipe-line 5 classes

Application of various Sequencing methods: Sequence variation in mitochondrial (mt) DNA, Variation in the tandemly repeated DNA sequences, Single nucleotide polymorphisms (SNPs) in the nuclear genome, 16S rDNA Sequencing, Metagenomic and Meta transcriptomic Sequencing, Identification and Characterization of Specific Bacteria from a Microbiome, Environment Surveillance, Monitoring

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Microbiomes Associated with Food Storage Conditions, Monitoring Environmental Antimicrobial Resistance Genes. **5 classes**

Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes:	POs Addressed	PSOs Addressed	Cognitive Level
CO 1:	Demonstrate and analyse various cellular metabolic disorders	PO 1	PSO 1	U, An
CO 2:	Demonstrate and evaluate the mendelian principles related to gene interactions and construct pedigree	PO 1, 2	PSO 4	U, E, C
CO 3:	Define, demonstrate and discuss the gene transfer and gene manipulation methodologies in biotechnology	PO 1, 3	PSO 4, 5	R, U, C
CO 4:	Demonstrate, design and apply the tools and techniques in molecular biology viz. PCR, Cloning,	PO 1, 2, 3	PSO 4, 5	U, C, Ap
CO 5:	Demonstrate, evaluate and apply various nucleotide sequencing techniques	PO 1, 2, 3	PSO 4, 5	U, E, Ap

R= remembering, U = understanding, Ap = applying, An = analysing, E = evaluating, and C = creating

Books for Reference:

- Alberts, B., Johnson, A., Lewis, J., Morgan, D., Raff, M., Roberts, K. and Walter, P. (2015). Molecular Biology of the Cell. 6th edition, Garland Science, New York and London.
- Ananthanarayanan, R. and Jeyaram Paniker, C. K. (2010). Textbook of Microbiology. Orient Longman limited, Madras.
- Atlas, M., Ronald. (2013). Principles of Microbiology. II Ed. WCB McGraw Hill, Boston.
- Black, G., Jacquelyn (1996). Microbiology – Principles and Applications III. Ed. Prentice Hall, Upper Saddle River,
- Brooker, R.J. (2012). Genetics: Analysis and Principles. 4th edition. McGraw Hill Education.
- Brown, T. (2012). Introduction to Genetics : A molecular Approach. Garland Science.
- Cassimeris, L., Lingappa, V.R. and Plopper, G., editors (2011). Lewin's Cells. 2nd edition, Jones and Bartlett Publishers, Massachusetts.
- Cooper, G.M. and Hausman, R.E. (2009). The Cell: A Molecular Approach. 5th edition, ASM Press, Washington D.C. and Sinauer Associates, INC. Sunderland, Massachusetts.
- Cox, M.M., Doudna, J.A and O'Donnell, M. (2012). Molecular Biology : Principles and Practice. 1st edition, Macmillan Higher Education, W.H. Freeman and Company, New York.

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- Creager, J. C., Black J.D., Davison V. E. (1990). Microbiology – Principles and Applications . Prentice Hall, Englewood Cliffs, New Jersey.
- De Robertis, E.D.P. and De Robertis, E.M.F., Jr. (2001). Cell and Molecular Biology. 8th edition, WoltersKluwer/Lippincott Williams and Wilkins.
- Dubey, R. C. and Maheshwari, D.K.(2014). A Text book of Microbiology. S. Chand and Company Ltd.
- Godbey, W.T. (2014). An Introduction to Biotechnology :TheScience, TechnologyandMedicalApplication. Elsevier.
- Joanne, M., Linda,W., Sherwood,M. and Christopher, J. W.(2014). Prescott's Microbiology, VIII Ed. McGrawHill International, Boston.
- Karp, G. (2010). Cell Biology. 6th edition, International Student Version, John Wiley and Sons, INC.
- Krebs, J.E., Goldstein, E.S. and Kilpatrick, S.T. (2014). Lewin's Genes XI. Jones and Bartlett Learning.
- Lodish, H., Berk, A., Kaiser, C.A., Krieger, M., Bretscher, A., Ploegh, H., Amon, A. and Scott, M.P. (2013). Molecular Cell Biology. 7th edition, W.H. Freeman and Company, New York.
- McNeil and Harvey, L. M. (1990). Fermentation. Blackwell Scientific Publication. Lansing.M.Prescott (2002) ,Microbiology,VEd.Mcgraw Hill Science.
- Nelson, D.L. and Cox, M.M. (2013). Lehninger Principles of Biochemistry. 6th edition, International edition, Macmillan Higher Education, W.H. Freeman and Company, New York.
- NewJercy. Casida, L. E. (1999). Industrial Microbiology. New Age International Publishers, New Delhi.
- Pelczer, M. J. and Reid, R. D. (1990). Microbiology.McGraw Hill Book Company, New York
- Russell, P.J. (2010). iGenetics : A Molecular Approach. 3rd edition, Pearson International Edition, Pearson Benjamin Cummings.
- Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. 5th edition, International Student Version, John Wiley and Sons, Inc.
- Stainer, R .Y., Ingraham, J. L., Wheelis, M. L. and Painter, P.R. (2008) General Microbiology, Macmillan, London.
- Talaro, P. K. and Talaro, A. (2009).] Foundations in Microbiology III Ed. WCB McGraw Hill, Boston.
- Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R. (2008). Molecular Biology of the Gene. 6th edition, Pearson International Edition, Pearson Benjamin Cummings.

SEMESTER – IV	
Course name	Phylogenetics, Biostatistics and Bioinformatics
Course code	PGZOOCC 4.4
Course type	Practical
Number of lectures	90
Credits	4
Marks	50

Course Objectives:

After completion of this course the student will be able to

Sl. No.	Course Objectives:
1:	Apply MEGA software to draw Phylogenetic tree
2:	Demonstrate the molecular taxonomy and bar coding
3:	Demonstrate and apply the Basics and operations of R, Data Visualization with R
4:	Perform various data analysis tools and techniques
5:	Apply the concept of facilitating the access from various Bioinformatics databases
6:	Perform various in silico Experiments
7:	Apply the python for bioinformatic analysis

PGZOOCC 4.4: Practical course Phylogenetics, Biostatistics and Bioinformatics **Class: 90 hrs**

1.1. Phylogenetic tree drawing by using MEGA software

1.2. Demonstration of molecular taxonomy and bar coding

2.1. Introduction to R Basics and operations

- Introduction to R Matrices
- Introduction to R Data Frames
- Data Input and Output with R
- Programming Basics
- Data manipulation

2.2. Data Visualization in R

- Basic data visualization and plotting
- Spatial data visualization and operation in R and ArcGIS

2.3. Data analytics

- Linear models
- K Nearest Neighbors

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- Decision Trees and Random Forests
- Natural Language Processing

2.4. Evaluation:

- Data visualization project for evaluation
- Regression project for evaluation

3.1. Facilitating access from various Bioinformatics databases:

NCBI, PDB, SWISS PROT, Pfam etc., and pairwise sequence alignment using BLAST.

3.2. Insilico Experiments:

Genomics- orf finder, Gene finder, Sequence alignment- pairwise –Blast, Dot plot analysis, multiple sequence alignment using MEGA software.

3.3. Application of python in bioinformatics:

Computing the nucleotide composition of a given DNA sequence. Computing the amino acid composition of a given protein sequence. Finding the AT and GC Composition of a given DNA sequence, Finding the ORFs in a given DNA sequence, Sequence alignment (BLAST), Transcribe a DNA sequence into RNA, Translate the given DNA sequence into corresponding amino acid sequence, Mapping amino acid sequence with different physiochemical features like hydrophobicity, finding n-mer frequencies in DNA and amino acid sequences.

Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes:	POs Addressed	PSOs Addressed	Cognitive Level
CO 1:	Demonstrate and apply MEGA software to draw Phylogenetic tree	PO 1, 2	PSO 3	U, Ap
CO 2:	Demonstrate, analyse and evaluate the molecular taxonomy and bar coding	PO 1, 2	PSO 3, 4	U, An, E
CO 3:	Demonstrate and apply the Basics operations in R, data Visualization with R and construct graph	PO 1, 2	PSO 3, 4	U, Ap, C
CO 4:	Demonstrate and apply various data analysis tools and techniques	PO 1, 3	PSO 3, 4, 5	U, Ap
CO 5:	Demonstrate, evaluate and apply the concept of facilitating the access from various Bioinformatics databases	PO 1, 4	PSO 3, 4, 5	U, E, Ap
CO 6:	Examine various in silico Experiments	PO 1, 4	PSO 4	An
CO 7:	Demonstrate and apply the python for bioinformatic analysis	PO 1, 2	PSO 3, 5	U, Ap

R= remembering, U = understanding, Ap = applying, An = analysing, E = evaluating, and C = creating

SEMESTER – IV	
Course name	Submission of final dissertation and practical of elective paper - Entomology
Course code	PGZOOEC 4.2A
Course type	Dissertation Project and Practical (Elective)
Number of lectures	90
Credits	4
Marks	50

Course Objectives:

After completion of this course the student will be able to

Sl. No.	Course Objectives:
1:	Apply the knowledge of morphology of typical insects under different orders
2:	Demonstrate the wing venations of insects under order Diptera, Coleoptera & Lepidoptera
3:	Prepare a report on Apiary / Sericulture institute visit
4:	Design and perform original research work in Entomology

PGZOOEC 4.2A: Elective Course 4.6 1B: Practical for Entomology

Class: 90 hrs

- Study of morphology of typical insects under different orders
- Mouth parts dissection of insects under order Diptera, Coleoptera & Lepidoptera
- Study of wing venations of insects under order Diptera, Coleoptera & Lepidoptera
- Visit to an Apiary / Sericulture institute
- Dissertation works and preparation of final report

Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes:	POs Addressed	PSOs Addressed	Cognitive Level
CO 1:	Demonstrate and evaluate the knowledge of morphology of typical insects under different orders	PO 1	PSO 3	U, E
CO 2:	Demonstrate, analyse and evaluate the wing venations of insects under order Diptera, Coleoptera & Lepidoptera	PO 1, 4	PSO 2, 3	U, Ap, E
CO 3:	Prepare a report on Apiary / Sericulture institute visit	PO 1, 3	PSO 3, 5	C
CO 4:	Design, examine and interpret original research work in Entomology	PO 1, 4	PSO 3, 5	C,

R= remembering, U = understanding, Ap = applying, An = analysing, E = evaluating, and C = creating

SEMESTER – IV	
Course name	Dissertation (Submission of final dissertation) and practical of elective paper - Cellular and Molecular Biology
Course code	PGZOOEC 4.2B
Course type	Dissertation Project and Practical (Elective)
Number of lectures	90
Credits	4
Marks	50

Course Objectives:

After completion of this course the student will be able to

Sl. No.	Course Objectives:
1:	Apply the knowledge of PCR
2:	Apply the knowledge of cloning and sequencing
3:	Apply the knowledge of mitochondrial DNA barcoding
4:	Design, examine and interpret original research work using molecular biology techniques

PGZOOEC 4.2B: Practical of Cellular and Molecular Biology

Class: 90 hrs

- PCR
- Cloning, Sequencing
- Mitochondrial DNA barcoding study
- Dissertation works and preparation of final report

Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes:	POs Addressed	PSOs Addressed	Cognitive Level
CO 1:	Demonstrate, explain and apply the knowledge of PCR	PO 1, 2	PSO 3, 4	U, E, Ap
CO 2:	Demonstrate, perform and discuss cloning and sequencing	PO 1, 2, 3	PSO 3, 4	U, Ap, C
CO 3:	Demonstrate and apply the knowledge of DNA barcoding	PO 1, 2, 3	PSO 3, 4	U, Ap
CO 4:	Design, examine and interpret original research work using molecular biology techniques	PO 2, 4	PSO 3, 5	C, Ap, E

R= remembering, U = understanding, Ap = applying, An = analysing, E = evaluating, and C = creating

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SEMESTER – IV	
Course name	Fundamentals of remote sensing and GIS
Course code	PGZOOSOC-4
Course type	Theory
Number of lectures	15
Credits	1
Marks	25

Course Objectives:

After completion of this course the student will be able to

Sl. No.	Course Objectives:
1:	Learn the basics of GIS and remote sensing and its application
2:	Demonstration and learn the basic Map preparation in ArcGIS
3:	Learn how the handling satellite data download and visualization

PGZOOSOC-4: Fundamentals of remote sensing and GIS”

Class: 15 hrs

1. Section-I: basic of maps
 - a. Introduction about GIS and remote sensing
 - b. Fundamentals of Maps and Cartography
 - c. Map projections and Datum
2. Section -II: basics of GIS and its application
 - a. Fundamentals of GIS and Remote Sensing, familiarization with the ArcGIS interface. b. Platforms for data spatial data download (live demonstration). c. Application of GIS in various sectors (with examples). d. GIS and its use in faunal resource conservation.
3. Section -III: Practical demonstration and learning by doing (Basic Map preparation in ArcGIS)
4. Section -IV: global datasets, GBIF, access to data and analysis
 - a. Global datasets. b. GBIF (Global Biodiversity Information Facility) and others. c. Access to data and primary evaluation.
5. Practical demonstration of raster and vector data download and visualization in spatial platform e.g., ArcGIS.
6. Practical demonstration of satellite data download and visualization in ArcGIS platform.

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Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes:	POs Addressed	PSOs Addressed	Cognitive Level
CO 1:	Define, Demonstrate and evaluate the basics of GIS and remote sensing and its application	PO 1, 3	PSO 3, 5	R, U, E
CO 2:	Demonstrate and apply the basic Map preparation in ArcGIS	PO 1, 2	PSO 3, 5	U, Ap, C
CO 3:	Illustrate and analyses the handling of satellite data and visualization	PO 1, 2, 3	PSO 3, 4	U, An

R= remembering, U = understanding, Ap = applying, An = analysing, E = evaluating, and C = creating

Books for Reference:

- John A. Richards (2005) Remote Sensing Digital Image Analysis: An Introduction (Hardcover), Springer.
- Steven M. de Jong (2004) Remote Sensing Image Analysis: Including the Spatial Domain, Springer.
- Martin Wegmann, Benjamin Leutner (Editor), Stefan Dech (Editor) (2016) Remote Sensing and GIS for Ecologists: Using Open-Source Software, Pelagic Publishing.
- Basudeb Bhatta (2008) Remote Sensing and GIS, Oxford University Press, USA

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