Est. in 1921

UNION CHRISTIAN COLLEGE (AUTONOMOUS) ALUVA

Affiliated to Mahatma Gandhi University, Kottayam, India
NAAC Accredited with A++ Grade in Vth cycle
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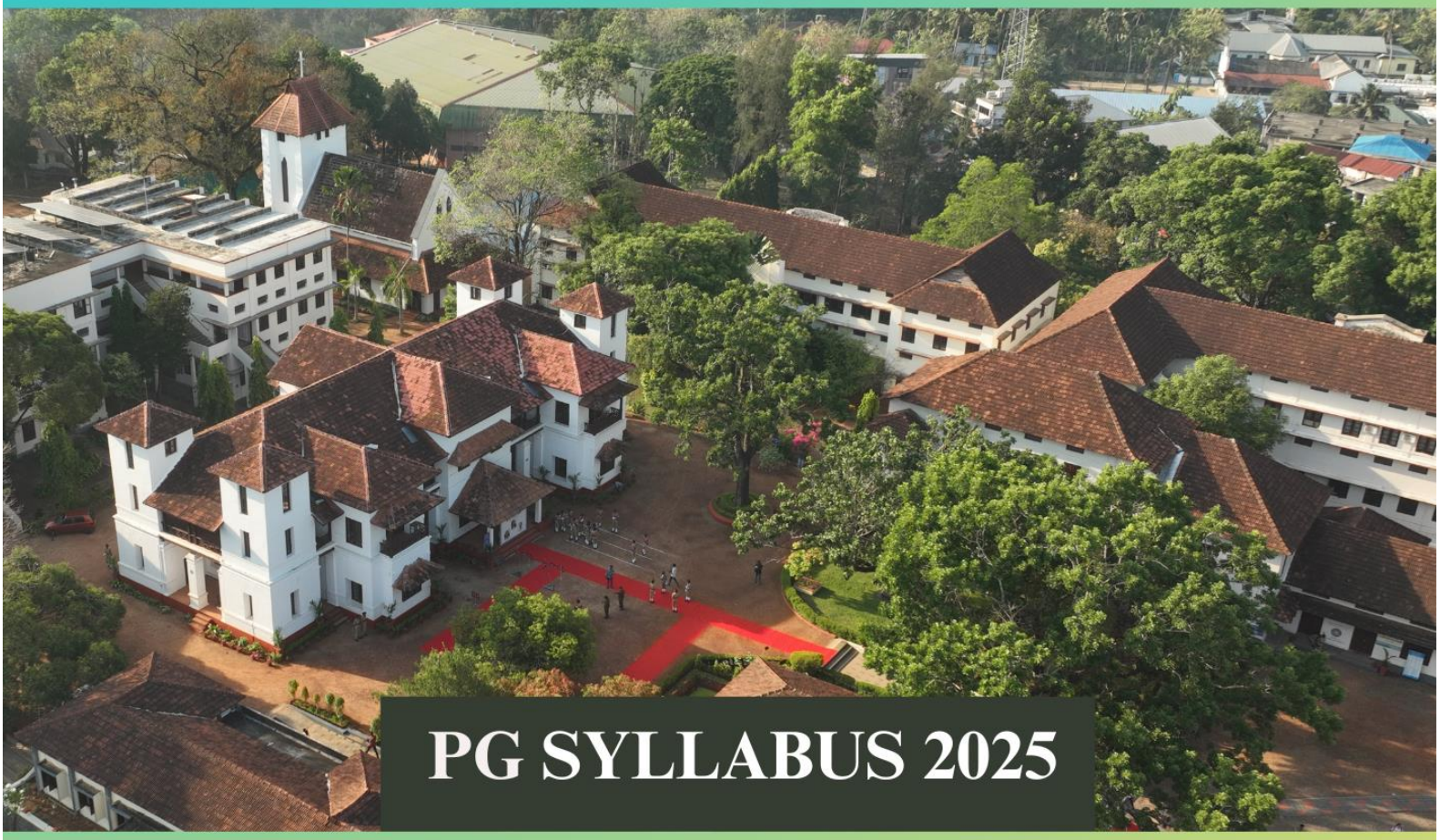
DEPARTMENT OF ZOOLOGY

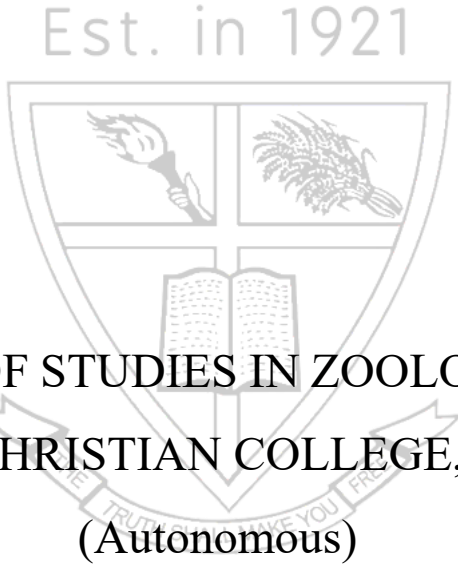


PG SYLLABUS 2025

POSTGRADUATE PROGRAMME {UCC PGP}
IN ZOOLOGY

Master of Science in Zoology

PROGRAMME STRUCTURE AND SYLLABUS
2025-26 ADMISSIONS ONWARDS



BOARD OF STUDIES IN ZOOLOGY (PG)

UNION CHRISTIAN COLLEGE, ALUVA

(Autonomous)

2025

Board of Studies in Zoology

Sl.No	Name & Designation	Position
01	**Dr. Elizabeth V Mathew,** Assistant Professor, Department of Zoology, Union Christian College, Aluva.	Chairperson
02	**Ms. Rima Joseph**, Assistant Professor, Department of Zoology, Union Christian College, Aluva.	Member
03	**Dr. Revathy V S**, Assistant Professor, Department of Zoology, Union Christian College, Aluva.	Member
04	**Dr. Niladevi K N**, Assistant Professor, Department of Zoology, Union Christian College, Aluva.	Member
05	**Dr. Dhanush B Danes**, Assistant Professor, Department of Zoology, Union Christian College, Aluva.	Member
06	**Dr. Ann Mary Jacob**, Assistant Professor, Department of Zoology, Union Christian College, Aluva.	Member
07	**Dr. Femi Anna Thomas**, Assistant Professor, Department of Zoology, Union Christian College, Aluva.	Member
08	**Dr. Abhilash R**, Associate Professor and Research Guide, P.G. Department of Zoology, Christian College, Chengannur.	Subject Expert
09	**Dr. Zeena K V,** Associate Professor, PG & Research Department of Zoology, Sree Neelakanta Govt Sanskrit College, Cherpulassery Road, MelePattambi.	Subject Expert
10	**Ms. K Leena Joseph,** Assistant Professor & Head, Department of Zoology, Morning Star Home Science College, Angamaly.	Subject Expert
11	**Mr. Santhosh Baby**, Director, Aqualine Exports, Door No:582 C, Green Pastures Road, Ashtamichira.	Representative from Industry
12	**Dr. Sudhikumar A V** Associate Professor, Department of Zoology, Christ College, Irinjalakuda.	Member of the College Alumni

Preface

It gives me immense pleasure to present the syllabus for the Master of Science (MSc) programme in Zoology of Union Christian College, Aluva. This curriculum has been thoughtfully designed and carefully structured by the Board of Studies in Zoology to reflect the latest advancements in the field, address contemporary challenges, and align with global academic standards.

Zoology, as a discipline, continues to evolve rapidly, incorporating new methodologies and interdisciplinary approaches that enhance our understanding of Systematics, Evolution, Biostatistics, Biodiversity, Ecology, Physiology, Molecular Biology, and Environmental Science. This syllabus aims to provide students with a comprehensive foundation in core Zoological concepts while also encouraging critical thinking, scientific inquiry, and hands-on experience through practicals, research projects, and fieldwork.

In preparing this syllabus, inputs were drawn from experienced academicians, researchers, and industry experts to ensure that the curriculum is academically rigorous, research-oriented, and career-relevant. I would like to extend my sincere gratitude to all members of the Board of Studies, including subject experts, industry expert and alumni representative for their valuable contributions and tireless efforts. I am confident that this syllabus will equip students to pursue excellence in Zoology and contribute meaningfully to scientific research, environmental conservation, and sustainable development.

We welcome feedback from students, faculty, and stakeholders for future improvements. Let this syllabus be a stepping stone for aspiring zoologists to explore, discover, and innovate.

Dr Elizabeth V. Mathew
Chairperson
Board of Studies in Zoology

Table of Contents

M.Sc. Zoology Degree Program

(Adopted from Mahatma Gandhi University Regulations PGCSS2019 from 2019-20 Academic Year)

1. Aim of the Program:
    i. **To provide quality education in Zoology with different specializations and motivate the students for self-employment in applied branches of Zoology.**
    ii. **To inculcate the spirit of natural resource conservation and conduct filed studies and different projects of interests in Zoology.**

2. Eligibility for Admissions: **B Sc Zoology with 50% marks**

3. Medium of Instruction and Assessment: **English**

4. Faculty under which the Degree is Awarded: **Science**

5. Specializations offered, if any: **Environmental Sciences**

6. Note on compliance with the UGC Minimum Standards for the conduct and award of Post Graduate Degrees**: Two years having four semesters**

PROGRAM STRUCTURE

Course Code	Title of the Course	Type of the Course	Hours/ week	Credits
FIRST SEMESTER				
UCZL010101	Animal Diversity: Phylogenetic and Taxonomic Approaches	Theory	4	4
UCZL010102	Evolutionary Biology and Ethology	Theory	4	4
UCZL010103	Biochemistry	Theory	4	4
UCZL010104	Biostatistics and Research Methodology	Theory	3	3
UCZL010105	Practical 1: Animal Diversity: Evolutionary, Ethological and Biochemical methods &Approaches	Practical	10	4
SECOND SEMESTER				
UCZL010201	Field Ecology	Theory	4	4
UCZL010202	Developmental Biology	Theory	4	4
UCZL010203	Genetics and Bioinformatics	Theory	4	4
UCZL010204	Microbiology and Biotechnology	Theory	3	3
UCZL010205	Practical 2: Diversity of Life: Ecological, Embryological, Hereditary and Microbial Methods and Approaches	Practical	10	4
THIRD SEMESTER				
UCZL010301	Animal Physiology	Theory	4	4
UCZL010302	Cell and Molecular Biology	Theory	4	4
UCZL010303	Biophysics, Instrumentation and Biological Techniques	Theory	4	4
UCZL010304	Immunology	Theory	3	3
UCZL010305	Practical 3: Molecular, Physiological and Immunological Methods and Approaches in Biosciences	Practical	10	4
FOURTH SEMESTER				
UCZL010401	Environmental Science: Concepts and Approaches	Theory	5	4
UCZL010402	Environmental Pollution and Toxicology	Theory	5	4
UCZL010403	Environmental Management and Development	Theory	5	4
UCZL010404	Practical 4: Environmental Science	Practical	10	4
UCZL010405	Project			5
UCZL010406	Viva			2

FIRST SEMESTER COURSES

UCZL010101	Animal Diversity: Phylogenetic and Taxonomic Approaches
UCZL010102	Evolutionary Biology and Ethology
UCZL010103	Biochemistry
UCZL010104	Biostatistics and Research Methodology
UCZL010105	Practical 1: Animal Diversity: Evolutionary, Ethological and Biochemical methods & Approaches

UCZL010101: ANIMAL DIVERSITY: PHYLOGENETIC AND TAXONOMIC APPROACHES

72 Hours (45+27) 4 hrs/week **Credit – 4**

Objectives:

- To understand the phylogenetic relationships among the different groups of animals
- To provide the latest trend in animal taxonomy and phylogenetic systematics

PHYLOGENETIC APPROACHES **45 hrs**

Module 1 **(20hrs)**

Origin of Animals **(5hrs)**

LUCA, Progenote, Prokaryotes and Eukaryotes. Extant and ancient stromatolites. Unicellularity to metazoans – consequences and complexity.

Multicellular organisms – Ediacaran fauna, Burgess Shale Fauna. Cambrian explosion, Cropping and Red Queen Principle. Different hypothesis of metazoan origin – Gastraea hypothesis, Planula hypothesis.

Invertebrate Phylogeny **(15hrs)**

Phylogenetic relationships among Porifera, Placozoa, Mesozoans; Cnidaria and Ctenophora; Platyhelminthes and other acoelomates. Role of HOX genes and epigenetics.

Phylogenetic relationships among the protostome lineage – Mollusca, Annelida and Arthropoda. Evolutionary advantages of Symmetry, Metamerism and Coelom. Reasons for the success of Arthropod.

Adaptive radiation in Mollusca, Annelida, Arthropod and Echinoderms. Position and phylogeny of Hemichordates.

Module II

Vertebrate Phylogeny **(10hrs)**

Affinity with invertebrates and protochordata. Paedomorphosis in vertebrate phylogeny. Jawless vertebrates – Ostracoderms and Cyclostomes. Properties and advantages of bone in vertebrate evolution. Evolution of jawed vertebrates – Acanthodian, Placoderm, Chondricthyes, Osteichthyes. Actinoptegygians and Sarcopterygians.

Module III **(15hrs)**

Phylogeny of Herpetofauna **(8 hrs)**

Amphibian phylogeny–. Lissamphibians – Evolution of lissamphibians with special reference to climate and genomics, distribution, diversity, status and threats.

Reptilian phylogeny –Adaptive radiation in reptiles. Importance of skull in reptilian classification. Endothermy in Dinosaurs. Causes of extinction.

Phylogeny of Birds and Mammals (7 hrs)

Evidences for the origin of birds from reptiles. Role of fossils and genomic evidence. Adaptive radiation and phylogeny in mammals.

Prerequisite: Classification of mammals

TAXONOMIC APPROACHES 27hrs

Module IV (16hrs)

Biological Classification (9 hrs)

Taxonomy-Significance of Taxonomy and biosystematics.

Hierarchy of categories and higher taxa. Taxonomic Procedures- methods of collection, preservation, curation, Cataloguing collections and Identification. Taxonomic characters of different kinds. Concept of species.

Zoological type, Different kinds of type. International code of Zoological Nomenclature – features, principles and rules. Phylocode. Zoobank.

New trends in Taxonomy (7 hrs)

Modern methods – Morphological, embryological, ecological, behavioural, cytological, biochemical, numerical, molecular.

Bar coding of life – basics of barcoding, application of barcode. Molecular operational taxonomic units (MOTU), Integrated operational taxonomic unit (IOTU). Global taxonomic initiative (GTI). Constraints of DNA taxonomy. Integrative taxonomy.

Microtaxonomy and macrotaxonomy. Cybertaxonomy.

Module V (11 hrs)

Taxonomic Keys and Publications (4 hrs)

Different types of keys – single access keys, diagnostic and synoptic keys, dichotomous and polytomous keys. Computer aided keys. Merits and demerits of keys.

Types of taxonomic publications – – Research papers, Revisions, monographs, atlas, Checklist, Synopsis and reviews, Handbooks and manuals

Zoological records. Ethics in taxonomy. Preparation of a research paper.

Molecular Phylogeny and Systematics (7 hrs)

Use of protein and nucleotide sequence in molecular phylogeny. Importance of molecular phylogeny.

Cladistic analysis – Apomorphy, Plesiomorphy, Symplesiomorphy and Synapomorphy. Characteristic features of cladistics. Methodology of cladistics analysis – construction of cladogram. Significance of

phylogenetic systematics. Phylogenetic trees. Different kinds – cladogram, phenogram, phylogram, dendrogram, curvogram, eurogram, swoopogram, chronogram.

Recommended Text Books/Reference Books

1. Anderson,T.A.2001. Invertebrate Zoology (2nd edn). Oxford University Press, New Delhi. Ashok Verma 2017. Principles of Animal Taxonomy. NarosaPublicing home pvt. Ltd.
2. Barnes, R. D.1987. Invertebrate Zoology. Saunders College Publishing/Harcourt Brace; 5th Revised edition
3. Barrington, E. J. W. 2012. Invertebrate Structure and Functions. Affiliated east-west press Pvt. Ltd. New Delhi, 2nd edition.
4. David, M. H, Craig Moritz and K.M. Barbara.1996. Molecular Systematics. Sinauer Associates, Inc.
5. Hickman Jr., Cleveland, Larry Roberts, Susan Keen, Allan Larson, and David Eisenhour.2011.
6. Animal Diversity. McGraw-Hill Companies, Inc. NY
7. Kapoor, V.C. 2017. Theory and Practice of Animal Taxonomy. 8th edition, Oxford and IBH Publishing Co., Pvt. Ltd. New Delhi.
8. Margulis,Lynn and M.J.Chapman 2001. Kingdoms and Domains: An Illustrated Guide to the Phyla of Life on Earth(4th edn.). W.H.Freeman&Company,USA
9. Mayer, E.2014. Principles of Systematic Zoology. 2nd edition, McGraw Hill Book Company, Inc., NY.
10. Narendran, T.C. 2008. An introduction to Taxonomy. Zoological survey of India. Strickberger, M.W. 2013. Evolution. Jones and Bartett Publishers, London.
11. Simson G. G. 2012. Principles of animal taxonomy. Scientific publishers, India.
12. Winston, J.E.2000. Describing species: Practical Taxonomic Procedures for Biologists. Columbia University Press,Columbia, USA.

UCZL010102: EVOLUTIONARY BIOLOGY AND ETHOLOGY

72 Hours (44+28) (4hrs/week) **Credit- 4**

Objectives:

- To describe the concept of relatedness and its connection to biological evolution
- To apply knowledge to new information and data, as well as the capacity to effectively communicate the principles of evolution and its application to human biology.
- To expose students to the basics and advances in ethology, and generate an interest in the subject in order to understand the complexities of studying animal behavior on every level of the biological hierarchy

EVOLUTIONARY BIOLOGY **44 hrs**

Module I **(22hrs)**

Concepts in Evolution **(6 hrs)**

Concepts of variation, adaptation, struggle, fitness and natural selection- Mechanism of Natural selection: directional, disruptive and stabilizing selection. Contributions of Margulis (Endosymbiotic theory), Eldredge and Gould (Punctuated equilibrium), Rose Mary and Peter Grant (Molecuar evolution in Darwinian finches).

Origin and Evolution of Life **(5 hrs)**

The RNA world, The First Cell. Evolution of Prokaryotes- origin of eukaryotic cells- evolution of unicellular eukaryotes. Anaerobic metabolism - origin of photosynthesis and aerobic metabolism.

Molecular Evolution **(11 hrs)**

Neutral theory of molecular evolution; molecular divergence; molecular drive. Molecular clocks- genetic equidistance. Phylogenetic relationships- Homology; Homologous sequences of proteins and DNA - orthologous and paralogous; parsimony analysis; nucleotide and protein sequence analysis.

Module II **(13hrs)**

Population Genetics **(6 hrs)**

Gene pool, gene frequency, Hardy-Weinberg Law. Rate of change in gene frequency through natural selection, migration and random genetic drift, Founder effect and Bottle check phenomenon, Isolation and speciation, Co-evolution

Developmental and Evolutionary Genetics **(7 hrs)**

The idea of Evo-Devo, Heterochrony, Heterotopy, Heterometry and Heterotypy. Developmental genes and gene co-option. Evolution of plasticity and complexity.

Module III

Primate Evolution and Human Origins **(9 hrs)**

Geological time scale, Mass extinction and its consequences, Stages in Primate evolution- Prosimii, Anthropoidea and Hominids. Factors in human origin – morphological, anatomical, hominid fossils. Cytogenetic and molecular basis of origin of man - Hypotheses of human origin, African origin of modern man - Mitochondrial Eve, Y chromosomal Adam.

ETHOLOGY **28 hrs**

Module III **(13hrs)**

Introduction **(3 hrs)**

Definition, historical out line,

Terminologies : Sign stimuli, key stimuli, social releasers, displacement activities, ritualization, Ethograms, super normal stimuli, stimulus filtering, open and closed IRM, mimetic releaser, code breakers. JP Scotts categories of behaviour.

Neurophysiological Aspects of Behaviour **(4 hrs)**

Reflex action, Sherrington‟s neuro-physiological concepts in behavior – Latency, summation, fatigue. Fixed action patterns.Goal oriented drive, Psycho-hydrologic model of motivation. Studies of motivation in guppies.

Learning and Genetics **(3 hrs)**

Short and long term memory, Habituation, Sensitization. Conditioning, Reasoning, imprinting. Genetic basis of behaviour.

Communication **(3 hrs)**

Evolution of communication, Sensory mechanisms: Electrical, Chemical, Olfactory, Auditory and Visual. Dance language of honey bees, Pheromonal communication (Ants and mammals).

Module IV **(15hrs)**

Reproduction and Behaviour **(3 hrs)**

Reproductive strategies, Mating systems, Courtship, Sexual selection- intrasexual and intersexual, good gene hypothesis, parental care and investment – significance of prolactin

Complex behavior/Biological rhythm **(4 hrs)**

Orientation, Navigation, Migration, Navigation cues. Biological rhythms – Circadian, Circannual, Lunar periodicity, Tidal rhythms. Genetics of biological rhythms.

Social Behaviour **(4 hrs)**

Sociobiology (Brief account only), Aggregations – schooling in fishes, herding in mammals, Group selection, Kin selection, altruism, reciprocal altruism, inclusive fitness, Hamilton‟s rule, co-operation, alarm call, social organization in insects and primates.

Foraging behavior: Habitat selection and optimality in foraging; social foraging, territoriality.

Stress and Behaviour **(4 hrs)**

Adaptations to stress- basic concept of environmental stress, acclimation, acclimatization, avoidance and tolerance. Adolescent behavior- emotions aggression. Hormones and behavior.

Recommended Text Books/Reference Books

Evolutionary Biology

1. Arthur,W. (2011). *Evolution – A Developmental Approach.* Wiley-Blackwell, Oxford,UK Barton, N. H., Briggs, D. E. G., Eisen, J. A., Goldstein, D. B. and Patel, N. H. (2007).
2. Evolution.Cold Spring, Harbour Laboratory Press.

3. Camilo J.Cela - Conde and Francisco J. Ayala. (2007). *Human Evolution-Trails from the Past*. Oxford University Press.Oxford ,UK
4. Campbell.B.G. (2009). *Human Evolution*. Transaction Publishers, NJ, USA
5. Chattopadhyay Sajib. (2002). Life, Origin, Evolution and Adaptation.Books and Allied (P) Ltd. Kolkata, India.
6. Dan, G. and Li,W.H. (2000). *Fundamentals of Molecualr Evolution*. (2nd edn.). Sinauer Associates Inc. MA, USA
7. Gould, S,J. (2002). *The Structure of Evolutionary Theory*. Harvard University Press, MA, USA. Hall, B. K. and Hallgrimsson, B. (2008), Evolution. 4th Edition; Jones and Bartlett Publishers Hall, B.K and Hallgrimsson, B. (2008). *Strickberger's Evolution* (4th edn). Jones and Bartlett Pub.London,UK
8. Hall, B.K. and Olsen, W. M., (Ed). (2007). Keywords and Concepts in Evolutionary Developmental Biology. Discovery Publishing House, New Delhi,
9. Jha A.P (2000) Genes and Evolution - Macmillan Publishers India
10. Kimura,M. (1983). *The neutral theory of molecular evolution*.Cambridge University Press Lindell Bromham (2016) An Introduction to Molecular Evolution and Phylogenetics, 3rd edition, Oxford press
11. Ridley, M. (2004), Evolution 3rd Edition. Blackwell Publishing
12. Roderick Page, D.M. and Edward Holmes, C.(2009). Molecular Evolution: A phylogenetic approach, Willey Blackwell publisher.
13. Strickberger, M.W. (2000) Evolution. Jones and Bartlett, Boston.

Web Resources

http://www.talkorigins.org http://www.ucmp.berkely.edu http://www.academicearth.org

Ethology

1. Alcock John (2009). *Animal Behaviour : An Evolutionary Approach* (8th edn). Sinauer Associates Inc. Sunderland, Massachusetts.
2. Aubrey Manning and Mariam Stamp Dawkins (2000). *An Introduction to Animal Behaviour* (5th Edn). Cambridge University Press, U.K.
3. Dawkins, M.S. (1995).Unravelling Animal Behaviour. Harlow: Longman.
4. Fatik Baran Mandal (2009). *A Textbook of Animal Behaviour*. PHI Learning Private Limited, New Delhi.
5. Gundevia J.S. and Singh H.G. (1996), A Text Book of Animal Behaviour. S. Chand and Company Pvt. Ltd., New Delhi.
6. Hauser, M.(1998). *The Evolution of Communication*. MIT Press, Cambridge, Mass. USA.
7. Judith Goodenough, Betty McGuire .2010. *Perspectives of Animal Behaviour*. John Wiley & Sons Inc. USA
8. Lee Alan Dugatkin (2009). *Principles of Animal behaviour* (2nd edn). W.W. Norton and Company.
9. Macfarland, D (1998). *Animal Behaviour – Psychobiology, Ethology and Evolution*. Pitman publication Ltd. London.
10. Michael D. Breed and Janice Moore (2015) Animal Behaviour, Academic press, USA.
11. Scott Graham (2005). *Essential animal behavior*. Blackwell Publications Company, Oxford ,UK Wilson, E.O. (2000). *Sociobiology: The new synthesis.* Harvard Univ. Press, Cambridge, Mass. USA.

Web Resources: www.animalbehavioronline.com/modestable.html

UCZL010103: BIOCHEMISTRY

72Hours (4hrs/week) **Credit- 4**

Objectives:

- To understand the chemical nature of life and life process
- To provide an idea on structure and functioning of biologically important molecules
- To generate an interest in the subject and help students explore the new developments in
- Biochemistry.
- To understand the importance of metabolism of bio macromolecules in normal physiology of a man
- To understand the abnormal metabolism of biomolecules and the resultant diseases.

Module I **18hrs**

Carbohydrates **(6hrs)**

Classification, Structure, nomenclature and biological functions of carbohydrates. Glycoproteins and Mucoproteins. Isomerism – structural isomerism and stereoisomerism, optical isomerism, epimerism and anomerism. Mutarotation and inversion of sugars. Glycosidic bond.

Carbohydrate Metabolism **(9hrs)**

Major metabolic pathways- Glycolysis, Citric acid cycle and its significance. Oxidative and substrate level phosphorylation. Gluconeogenesis, Cori cycle. Glycogen metabolism- Glycogenesis, Glycogenolysis, Regulation of carbohydrate metabolism, Role of insulin and glucagon. Adenylate cascade system, Ca+2 Calmodulin-sensitive phosphorylase kinase. Regulation of glycogen synthesis. Minor metabolic pathways of carbohydrates: Pentose Phosphate pathway, Glucuronic acid metabolism, Galactose metabolism.

Disorders of Carbohydrate Metabolism **(3hrs)**

Regulation and Assessment of Blood Glucose and Sugar Tolerance in Health and Disease, Inborn errors associated with carbohydrate metabolism. Glycogen storage diseases, Lactose intolerance, Galactosuria, pentosuria, galactosemia.

Module II **18hrs**

Proteins **(9hrs)**

Structure, classification and properties of amino acids; Amphoteric properties of amino acids, pK value and iso-electric point of amino acids; Primary structure of protein (e.g. insulin); Secondary structure- Alpha helix, Collagen helix, Beta pleated sheet; Tertiary structure- e.g. Myoglobin; Quaternary structure - e.g. Haemoglobin; Fibrous proteins- Keratin; Globular proteins; Chaperons; Ramachandran plot.

Metabolism of Proteins **(7hrs)**

Amino acid metabolism-Deamination, Transamination, Trans deamination, Decarboxylation; Formation of Ammonia; Urea synthesis; Creatine synthesis.

Inborn Errors of Metabolism (2 hrs)

Phenylketonuria, alkaptonuria, albinism, tyrosinosis, maple syrup urine disease, Lesch-Nyhan syndrome, sickle cell anemia, Histidinemia.

Module III **18hrs**

Lipids **(9 hrs)**

Classification and biological importance of lipids; Fatty acids: Classification and nomenclature; Triglycerides - Structure and properties, Rancidity, Trans fatty acids; Structural lipids in membranes: Glycerophospholipids: Phosphatic acid, Phosphatidylserine, Phosphatidylethanolamine, Phosphatidylglycerol, Phosphatidylcholine, Phosphatidylinositol, Cardiolipin; Sphingolipids: Phosphosphingolipids-Sphingomyelin; Glycosphingolipids Cerebrosides, Globosides and Gangliosides; Saponification and Saponification number, Acid number, Iodine number, Polenske number and Reichert-Meissl number; Cholesterol; VLDL, LDL, and HDL; Prostaglandins.

Metabolism of Lipids **(7hrs)**

Oxidation: Beta oxidation, Alpha oxidation, Omega oxidation; Fatty acid biosynthesis and modifications; Metabolism of Cholesterol, synthesis and its regulation; Metabolism of triglycerides; Metabolism of ketone bodies.

Disorders of Lipid metabolism **(2hrs)**

Plasma lipoproteins, cholesterol and its clinical significance, triglycerides & phospholipids in health and disease, hyperlipidemia, hyperlipoproteinemia, Gauche's disease, Tay-Sach's and Niemann-Pick disease, ketone bodies, Abetalipoproteinemia.

Module IV **8 hrs**

Nucleic Acids **(6hrs)**

Structure of nucleic acids and nucleotides; Structural organization of DNA – Watson and Crick model, Triple helix model; Forms of DNA – A, B and Z; Factors that stabilize DNA; DNA supercoiling and Topoisomerases; Types of RNA; Structural organization of tRNA.

Nucleic Acid and Mineral Metabolism **(2hrs)**

Catabolism of purines and pyrimidines.

Module V **10hrs**

Enzymes: Classification- (I.U.B. system), co-enzymes, ribozyme. Enzyme specificity. Mode of enzyme action: Concept of Active site, Formation of enzyme substrate complex, Lowering of activation energy. Lock and key theory, induced fit theory, transition state and strain theory. Enzyme kinetics: Michaelis-Menten equation. Km value and its significance. Enzyme velocity and factors influencing enzyme velocity. Kinetics of enzyme inhibition, suicide inhibition, feedback inhibition- sequential, concerted and cumulative feedback control. Iso-enzymes and clinical significance.

Recommended Text Books/Reference Books

1. Creighton, T.E. Protein Structure and Molecular Properties. 1993. W.H. Freeman & Co, NY. Deb, A.C.2004. Fundamentals of Biochemistry. New Central Book Agency (P) Ltd. New Delhi. Elliott, W.H and C. Elliott, 2003. Biochemistry and Molecular Biology. Oxford University Press, Oxford,UK.
2. Eric E. Conn, Paul K. Stumpf, George Bruening, Roy H. Doi, 2007. Outlines of Biochemistry. (5th edn). John Wiley &Sons Inc., NY.
3. Garret, R.H. and C.M. Grisham. 1995. Biochemistry. Saunders College Publishers,USA. Lenhninger, A.L. 2008. Principles of Biochemistry. (5th edn). CBS Publishers and Distributors, New Delhi. Hanes, B. D. and N.M. Hoopar. 1998. Instant notes: Biochemistry. University of Leeds, Leeds, UK.
4. Horton, H.R., Morsan, L.A., Scrimgeour,K.G.,Perry, M.D and J.D.Rawn. 2006. Principles of Biochemistry. Pearson Education International, New Delhi.
5. Keith Wilson and John Walker. 2008. Principles and Techniques of Biochemistry and Molecular biology(6th edn). Cambridge University Press, UK.
6. Murray, K., Granner, D.K., Maynes, P.A and V.W.Rodwell, 2006. Harper‟s Biochemistry (25th edn). McGraw Hill, New York, USA.
7. Oser, B.L.1965. Hawk‟s Physiological Biochemistry. McGraw Hill Book Co. New Delhi. Palmer Trevor. 2001. Enzymes: Biochemistry,Biotechnology & Clinical chemistry. Horwood Publ.Com., England.
8. Rama Rao, A.V.S.S. 1986. Text Book of Biochemistry. L.K. & S Publishers, New Delhi. Stayer, L. 2011. Biochemistry. (7th edn). W.H. Freeman & Co. NY.
9. Vasudevan, D.M. and S.Sreekumari. 2000. Text of Biochemistry for Medical Students. Jaypee Brothers, Medical Publishers (P) Ltd. New Delhi
10. Voet, D and J.G Voet, 2004. Biochemistry. John Wiley & Sons.,NY. Zubay, G, 1989. Biochemistry. McMillan Publishing Co., New York.

UCZL010104: BIOSTATISTICS AND RESEARCH METHODOLOGY

54 hrs (30+24) 3 hrs/week **Credit – 3**

Objectives:

- To impart concepts of statistics and research methodology, and create awareness about the gadgets, tools and accessories of biological research
- To help students improve analytical and critical thinking skills through problem solving
- To enable learners to effectively apply suitable statistical tests in research
- To sensitize students about the ethics involved in research and enable them to come up with innovative research designs
- To equip learners to prepare research papers and project proposals

BIOSTATISTICS **30 hrs**

Module 1 **(9hrs)**

Basics of Biostatistics **(3 hrs)**

Scope and Significance of Biostatistics. Steps in Statistical Investigation, Data and Variable (Collection, Types, Sources).

Statistical Analysis Tools - Parametric and Non-Parametric; Bivariate and Multivariate Analysis. Interpretation and Forecasting.

Measures of Central Tendency – mean, median and mode.

Measures of Dispersion **(6 hrs)**

Introduction, Characteristics. Quartiles and Percentiles. Merits and Demerits of Range, Quartile Deviation, Mean Deviation and Standard Deviation. Relative Measures of Dispersion.

Calculations/Problems for frequency table. Standard error. Skewness and Kurtosis (Brief account only).

Module II **(11hrs)**

Correlation Analysis **(3 hrs)**

Correlation - types and methods of correlation analysis, Problems for Karl Pearson's correlation coefficient and Spearman's rank correlation.

Regression Analysis **(4 hrs)**

Regression and Line of Best Fit, Types and methods of regression analysis.

Graphic Methods (Scatter method, Curve fitting). Algebraic method (Fitting of straight line through regression equation). Comparing correlation and regression.

Probit Analysis (Brief account only).

Theory of Probability **(4 hrs)**

Measures of Probability and Theorems in Probability. Probability distributions – Binomial, Poisson and Normal (Brief Account only).

Module III **(10hrs)**

Testing of Hypothesis **(7 hrs)**

Hypothesis and types, Confidence Interval, Sampling, Methods and Errors.

Tests of significance (For large and small samples – Critical Ratio and p value).

Z Test (Problem for small samples), Chi- Square Test – test of independence and goodness of fit (Problem for 2×2 table only).

Student's t' test (Problem for small samples comparing mean of two variable).

F-test, Analysis of Variance (ANOVA - One way), Kruskal Wallis test (Brief account only).

Mc Nemar and Mann Whitney U test (Brief account only).

Mathematical modeling in Biology **(3hrs)**

Introduction to mathematical modeling. Applications: Medicine - models to predict spread of infectious diseases, drug discovery, Systems Biology – Blue Brain project, Ecology – Lotka Volterra model. Length - Weight Relationship. Von- Bertalanffy's Growth (VBG) Model.

Statistical Software: MS Excel, SPSS; Introduction to R (Basics only).

RESEARCH METHODOLOGY **24 hrs**

Module IV **(12hrs)**

Concepts of Research **(4 hrs)**

Scientific temper, Empiricism and Rationalism. Knowledge, Information and Data. Science and Pseudoscience. Basic concepts of research -Meaning, Objectives, Motivation and Approaches.

Types of Research - Descriptive/Analytical, Applied/ Fundamental, Quantitative/Qualitative, Conceptual/Empirical. Research methods versus Methodology, Research Process.

Research Formulation **(4 hrs)**

Research formulation -Observation and Facts, Prediction and explanation, Induction, Deduction. Defining and formulating the research problem, Selecting the problem and necessity of defining the problem. Literature review - Importance of literature review in defining a problem, Critical literature review. Theory, Principle, Law and Canon.

Research Designs **(4 hrs)**

Research Design -Basic principles, Meaning, Need and features of good design. Types of research designs.

Development of a research plan - Exploration, Description, Diagnosis, Experimentation, determining experimental and sample designs. Case-control studies and cohort studies.

Module V **(12 hrs)**

Scientific Documentation and Communication **(6 hrs)**

Structure and components of Scientific Reports – types of Report – Technical Reports and Thesis/dissertations.

Preparing Research papers for journals, Seminars and Conference; Impact factor, Citation Index, h-index. DOI. ISBN & ISSN.

Conventions and strategies of authentication – citation styles, bibliography, referencing and footnotes. Software for managing bibliographies - EndNote, Mendeley.

Presentation techniques - Assignment, Seminar, Debate, Workshop, Colloquium, Conference, Oral presentation, Poster Presentation.

Preparation of Project Proposal. Project funding agencies – UGC, DST, BDT, MoEF. Women Scientists schemes.
Global Information System – BIOSIS, Medline and Medlars, AGRIS, Pubmed, Google Scholar.
Research Database - SCOPUS, Web of Science.

Information Science, Extension and Ethics (6 hrs)

Sources of Information - Primary and secondary sources.

Library - books, journals, periodicals, reference sources, abstracting and indexing sources, Reviews, Treatise, Monographs.

Online resources – INFLIBNET, e-libraries, e-Books, e-Encyclopedia, e-Journals, e-Thesis, Shodhganga, PG-Pathshala, TED Talk, Institutional Websites. MOOC - SWAYAM, NPTEL. Networking platforms for researchers - Academia, ResearchGate, Linkedln, Orcid, Twitter.
Ethics in research - Plagiarism, Plagiarism checking softwares - Turnitin, Viper, Urkund; Citation and Acknowledgement. Artificial Intelligence in research.

Ethics in research - Bioethics: Laws in India, Working with man and animals - Consent, Ethical Committees and Constitution.

Extension: Lab to Field, Extension communication, Extension tools.

Recommended Text Books/Reference Books

1. Chap T. Le.2003.*Introductory Biostatistics*. John Wiley &Sons, NJ, USA.
2. Daniel W.W. 2006. *Biostatistics: A Foundation for Analysis in the Health Sciences* (7th edn). John Wiley & Sons, New York.
3. Freedman D. F., Pisani R. and Purves R. 2011. Statistics. Viva Books, New Delhi.
4. Dharmapalan Biju. 2012. *Scientific Research Methodology*. Narosa Publishing House, New Delhi.
5. Gupta S. P. 2014. Statistical methods for CA foundation course. Sultan Chand & Sons, New Delhi.
6. Kothari C. R. 2009. *Research Methodology: Methods and Techniques* (2ndedn.). NewAge International Publishers, New Delhi.
7. Paul Oliver. 2005. *Writing Your Thesis*. Vistaar Publications.New Delhi.
8. Samuels M. L., Witmer J. A. and Schaffner A. 2016. Statistics for Life Sciences (5^{th} edn). Pearson Education Inc., New delhi.
9. Sundar Rao P.S.S. and Richard J. 2006. .*Introduction to Biostatistics and Research Methods* (4th edn). Prentice Hall, New Delhi.
10. Zar J. H. 2008. *Biostatistical Analysis* (3^{rd} edn.). Pearson Education Inc., New Delhi

UCZL010105: Practical 1

ANIMAL DIVERSITY: EVOLUTIONARY, ETHOLOGICAL AND BIOCHEMICAL METHODS & APPROACHES

180 Hours (10hrs/week) **Credit-4**

Biosystematics, Evolutionary Biology and Ethology **60 hrs**

- Study of museum specimens - 50 invertebrates and 20 vertebrates (List the studied items with brief descriptions enlisting at least five taxa or taxonomic rank (Diagrams not necessary)
- Larval forms - any 10 larvae from different taxa (emphasizing phylogenetic, morphological, ecological and pathological significance)
- Mounting and Submission of any three larval forms
  (Diversity should be maintained depending on the number of students and one specimen each should be submitted for the practical examination, Repetition should be avoided for examination)
- Preparation of dichotomous key up to the family of four specimens each from any of the three, from the following five groups (ie., from insects, spiders, fishes, amphibians and snakes) with necessary diagrams.
- Dichotomous key using appropriate software or online tools (students should be familiarized with the computer aided keys)
- Hardy Weinberg Law for calculation of gene frequency
- Preparation of Cladogram based on the specimens provided (at least five museum specimen) (OR software programmes can be used for construction with more number of specimens).
- Study on the skull pattern of reptiles/mammals.
- Behavioural study or activity pattern of any two organism (insects, fish, reptile, birds, mammals) based on field observation with respect to diurnal and seasonal. Viva based on behavioral observation reported. (Repetition of reports, organism and observations should be avoided on records)

Biochemistry **80hrs**

- Study of structure of biomolecules (carbohydrates, aminoacids, cholesterol) using ball and stick models and Protein and Nucleic acid using software tools
- Preparation of Buffers of specific pH using pH meter
- Calculation of Molality, Normality, percentage W/V, serial dilution and preparation of standard solutions
- Preparation of standard curve for protein (by Lowry or Biuret methods), glucose, cholesterol and/or creatinine and estimation of unknown concentration.
- Estimation of Enzyme activity from fresh tissue (alkaline phosphatase or acid phosphatase)

Biostatistics **40hrs**

- Calculation of corrected mean, and standard deviation (Problems can be solved using scientific calculator).
- Derive regression equation for protein, cholesterol and creatine using Optical density and Concentration
- Drawing best line of fit for protein, cholesterol and creatine (Problems can be solved using scientific calculator).
- Calculation of Pearson correlation coefficient.
- Calculation of regression coefficient and regression equation (x on y only)
- Calculation of Chi -square value (2x2 table only)
- Calculation of t value (for small sample comparing two samples)
- MS Excel: Preparation of graphs (bar, histogram, frequency polygon, frequency curve, pie diagram and ogives)
- MS Excel/PH Stat/SPSS: Basic statistics (mean, median, mode, standard deviation), Correlation Analysis, Regression analysis , Test of significance (T test between two sample or sample and population), Chi-square test, Problems using one way ANOVA

SECOND SEMESTER COURSES

UCZL010201	Field Ecology
UCZL010202	Developmental Biology
UCZL010203	Genetics and Bioinformatics
UCZL010204	Microbiology and Biotechnology
UCZL010205	Practical 2: Diversity of Life: Ecological, Embryological, Hereditary and Microbial Methods and Approaches

UCZL010201: FIELD ECOLOGY

72 Hours (4 hrs./Week) **Credit – 4**

Objectives:

- To provide the knowledge of animal adaptations to a variety of environment
- To learn the different aspects of population and its interactions
- To understand the natural resources and manmade issues on environment and its management

Module I

Animal and Physical Environment **(18 hrs)**

Temperature- Effect of cold and hot temperature on organisms. Global warming and change of species phenologies.

Nutrients- Herbivory, carnivory, omnivory, detritus feeding. Effect of soil development on nutrient level. Herbivore population and plant nutrient level. Availability of O_2 and Co_2 on growth and distribution of organisms.

Water- Water availability and abundance of organism. Significance of salt concentration in soil and water. Effect of soil and water pH on distribution of organisms.
Cybernetic nature of ecosystem, homeostasis and feedback systems.
Animal adaptations to drought and flood,poikilotherms, homeotherms, heterotherms. Animal adaptations to moisture environment – maintenance to water balance, response to drought and flooding. Animal adaptations to light environment.

Module II

Population Ecology **(15 hrs)**

Properties – patterns of dispersion, dispersal movements, age structure, sex ratio, life table, survivorship curve, density, population growth-exponential and logistic growth, time lags, carrying capacity. Population growth and global warming.
Density dependent and density independent influences. Population fluctuations and cycle. Extinction – deterministic extinction and stochastic extinction.
Life history strategies – Reproductive strategies, *r* and *k* selection.
Human population growth. Concept of ecological foot print.
Population regulation – dispersal, social dominance, territoriality: types of territory, territorial defence, floaters, home range.
Aggregation, Allee‟s principle, Isolation Metapopulation – Concept, structure

Module III **(17 hrs)**

Population Interactions: Competition and Predation **(10 hr)**

Different types of competition. Lotka –Volterra competition model,– Competitive Exclusion Principle, Resource partitioning and utilization. Niche, Niche overlap, Niche width, niche shift. Character replacement. Ecological and evolutionary effects of competition.

Predation –

Foraging theory – optimal diet, foraging efficiency.

Animal prey defence – chemical defence, warning coloration and mimicry, cryptic colouration, armor and defence, behavioural defence, predatory sanitation.

Predator offence – hunting tactics, cryptic coloration and mimicry in predators, adaptations of hunting. Cannibalism, Intraguild predation (IGP).

Predator –prey relationship and climate change.

Population Interactions: Parasitism and mutualism **(7 hrs)**

Parasitism- Characteristics and life-cycle of parasite, Social parasitism – Brood parasitism and kleptoparasitism.

Types of defence against parasites by host. Invasive parasite. Parasitism and climate change.

Non-native parasite and biological control.

Mutualism – Origin and types. Dispersive mutualism, defensive mutualism, resource based mutualism. Mutualistic relationship of human with crops.

Module IV

Applied Ecology **(10 hrs)**

Air, water, soil and radioactive pollution – Sources, causes and consequences. Disposal of radioactive waste. Ecological indicators.

Concept of waste – types and sources of solid waste. Health and environmental implications. E-waste-types and management aspect. and solid waste management – aerobic and anaerobic systems. Concept of bioreactors in waste management. Liquid wastes and Sewages.

Scope of bioremediation. Phytoremediation, bio-augmentation, biofilms, bio filters, bio scrubbers and trickling filters.

Module V

Resource Ecology **(12 hrs)**

Currents status of forest resources and deforestation in India. Fresh water sources, water scarcity and water conservation measures. Wet lands, its importance, reclamation and conservation measures. Sand mining and its impacts - case studies from Kerala

Energy resources – solar, fossil fuels, hydro, tidal, wind, geothermal and nuclear. Recent issues in energy production and utilization. Green technology and sustainable development. Depletion of natural resources and its impacts on life.

Ecosystem monitoring – GIS and its application, Role of remote sensing in ecology. Environmental Impact Assessment (EIA)-Tools and technique. Ecosystem modelling (Brief account only).

Recommended Text Books/Reference Books

1. Abbasi, S.A. and Ramasami, E.V 1998. Biotechnological Methods of Pollution Control. Oxford University Press, Hyderabad
2. Benton, A.H. and Werner, W.E 1976. Field Biology and Ecology. Tata McGraw Hill, New Delhi. Boitani, L and T.K.Fuller2000.Research Techniques in Animal Ecology. Columbia University Press, USA
3. Daniel, C.D 2010.Environmental Science.(8thedn.).Jones and Bartlett Publishers. Misra, S P and Pandey S. N.2009. Essential Environmental Studies. AneBooksPvt. Ltd. Odum, E P. 2017.Fundamentals of Ecology, India edition.
4. Peter Stilling, 2012. Ecology: Global Insights and Investigations. The McGraw-Hill companies, New york
5. Peter, H.R., Berg, L.R., and Hassenzahl, D.M. 2008. Environment. (5thedn.).John Wiley Publishers. Pianka, E. R. 1981. Competition and Niche Theory in "Theoretical Ecology". (2ndedn.).In: May, R.M. (Ed.). Blackwell, London.
6. Rana,S.V.S. 2009.Essentials of Ecology and Environmental Science.(4thedn.). PHI learning Pvt. Ltd., New Delhi
7. Simons, I.G. 1981. Ecology of Natural Resources. Edwin-Arnold Ltd., London.
8. Robert Leo Smith and Thomas M Smith 2001. Ecology and Field biology (6th Edition), New York

UCZL010202: DEVELOPMENTAL BIOLOGY

72 Hours (4hrs/week) **Credit – 4**

Objectives:

- To introduce the concepts and process in developmental biology
- To help students understand and appreciate the genetic mechanisms and the unfolding of the same during development
- To expose the learner to the new developments in embryology and its relevance to Man

Module I **(24hrs)**

Introduction: Basic Concepts of Development **(14 hrs)**

Potency of embryonic cells, Commitment, Specification (Autonomous and Conditional), Induction, eye lens induction, Regional specificity of induction, Genetic specificity of induction, Competence, Determination and Differentiation, Morphogenetic gradients and movements, Cell fate and cell lineages.

Fertilization and Early development **(10 hrs)**

Fertilization- (biochemical and molecular aspects, cell surface molecules in sperm-egg recognition), Polyspermy. Early development and axis specification in *Caenorhabditis elegans*, Vulval induction in *C.elegans*

Module II

Development of Model organisms—Drosophila **(14 hrs)**

Early development and axis specification in Drosophila: Fertilization, Cleavage and Mid blastula transition; Anterior-posterior polarity, Dorsal-ventral polarity, effect of dorsal protein gradient; Role of Maternal effect genes- bicoid, nanos, hunchback, caudal; Body segmentation in Drosophila embryo: role of segmentation genes: Gap genes, Pair rule genes, Segment polarity genes, Homeotic selector genes, Realisator genes

Module III

Axis and Pattern Formation in Amphibians **(16 hrs)**

Axis formation in amphibia- Anterior-posterior patterning in Amphibia. Hox code hypothesis. Nieuwkoop centre and mesodermal polarity. Molecular basis of mesoderm induction. Transcription factors induced in the organizer. Neural induction.Vertebrate limb development.

Module IV **(6 hrs)**

Cellular Interactions in Development **(6 hrs)**

Paracrine factors - Hedgehog family, Wnt family, TGF, BMP. Surface receptors and signal transduction pathway - RTK pathway, Smad pathway, Wnt pathway, Hedgehog pathway and Cell death pathway.

Metamorphosis and Regeneration **(8 hrs)**

Metamorphosis of Amphibians and Insects; Hormonal control of metamorphosis.Heterochrony-neoteny, progenesis (Brief accounts); regeneration - different types of regeneration; Histological processes during regeneration; Polarity and Metaplasia in regeneration; Lens regeneration in amphibia.

Module V

Human Welfare and Developmental Biology **(4 hrs)**

In vitro fertilization and other assisted reproductive technologies (ART). Cloning experiments - (Amphibians, Mammals and Human), ethical issues. Malformations and disruptions,Malformations and disruptions,Gene – phene relationship, Autophene, Allophene and Pleiotrophy; Environmental oestrogens.Teratogenic agents – alcohol, retinoic acid, drugs and chemicals, heavy metals, pathogens.

Recommended Text Books/Reference Books

1. Balinsky, B.I.2004. An Introduction to Embryology.W.B.SaundersCo.,Philadelphia.
   Berril, N.J. 1979. Developmental Biology.Tata McGraw-Hill Pub.Co.Ltd.,New Delhi.
2. Gilbert, S.F. 2016. Developmental Biology (11thedn).Sinauer Associates Inc., Publishers, Masachusettes, USA
3. Hopper, A.F. and Hart ,N.H.1985. Foundations of Animal Development.Oxford University Press, Oxford.
4. Lewis Wolpert. 2007. Principles of Development. Oxford University Press.Oxford Saunders,
5. J.W.1982. Developmental Biology-Patterns,Principles and Problems. Macmillan Publishing Co.,New York.
6. Subramanian, T. 2002. Developmental Biology.Alpha Science International Ltd.,New Delhi
7. Sunstard,D.P., Simmons, M. J. and J.B Jenkins.1997. Principles of Genetics.John Wiley and sons, New York.
8. Wolpert L. and C. Tickle. 2011. Principles of Development.(4thedn). Oxford University Press, Oxford.

UCZL010203: GENETICS AND BIOINFORMATICS

72 Hours (54+18) (4 hrs/week) **Credit -4**

Objectives:

- To learn and understand the principles and mechanism of inheritance
- To study the fine structure of genetic material and molecular basis of hereditary transmission
- To understand the significance of Genetics in Principle in heritance of traits in Man
- To understand the role of genetics in evolution
- To explore the emerging field of bioinformatics and to equip the students to takeup bioinformatics studies

GENETICS **54 Hours**

Module 1 **(14hrs)**

Principles of Genetic Transmission **(4hrs)**

(Prerequisites: The basic principles of inheritance: Alleles, Pseudo alleles, Dominance, Segregation, Independent assortment, Test cross and ratios)

Extensions of Mendelian Principles: Codominance, Incomplete Dominance, Gene interactions with Epistasis,Pleiotropy, Penetrance and Expressivity, Phenocopy.

Linkage,Recombination and Crossing over,Cytogenetic Mapping **(10hrs)**

Linkage, Recombination, Crossing over as the physical basis of recombination,Molecular mechanism of crossing over and recombination, Holliday Model, Evolutionary significance of recombination.

Recombination mapping with a three point test cross in Drosophila, Interference and the Coefficient of Coincidence. Stern's experiment. Mitotic recombination.

Gene Mapping - Conjugation mapping, Complementation Mapping, Deletion Mapping.

Organization and mapping of mitochondrial genome.

(Prerequisites:Mechanisms of genetic exchange in Bacteria)

Module II **16hrs**

Molecular Organization of Chromosomes **(6hrs)**

Genome size and C – value paradox, Chromatin Structure and levels of DNA packaging in Prokaryotic and Eukaryotic chromosomes,Molecular structure of Centromere and Telomere, Telomere shortening and Aging (Werner's syndrome), Repeated DNA sequences in Eukaryotic Genome:Highly repetitive,Moderately repetitive,Single copy,Kinetics of renaturation,Cot Curve.

(Prerequisites: DNA, Histone, Chromatin, Euchromatin and heterochromatin)

Gene Fine Structure **(10hrs)**

Classical versus Molecular concept of the gene, Cis-Trans test for functional allelism, Fine structure of the phage T4 rll locus, Modern findings on the nature of gene: Interrupted genes in eukaryotes, Exons and introns, Genes with in genes in phage φx174, Gene synthesis : in vitro synthesis - Works of Watson and Crick, Khorana, Kornberg and Nirenberg.

Transposable genetic elements

Transposable elements in Bacteria, Cut and Paste transposons in Eukaryotes, Retrotransposons Transposable elements in Humans. Genetic and evolutionary significance of transposable elements.

Module III

Replication and Mutation **(10 hrs)**

Unidirectional replication, Bidirectional replication, Theta replication, Rolling circle replication, Replication Machineries – prokaryotes and eukaryotes.

Mutagenesis and Molecular Mechanism of Mutation,Tautomeric shift. DNA Repair Mechanisms. Inherited Human Diseases with defects in DNA repair. Gene conversion. Ames test.

(Prerequisites:Messelson and Stahl Experiment, Semiconservative replication, Somatic or germinal mutation,Spontaneous or induced Mutation,Conditional lethal mutation, *Variation in chromosome Number and Structure: Aneuploidy, Deletions and Duplications, Inversions, Translocations*)

Module IV **14hrs**

Human Genetics, Quantitative Genetics and Population Genetics **(11hrs)**

Karyotype,Chromosome banding techniques, Pedigree analysis, anticipation,Lod Score,Complex traits, Quantitative traits,Threshold traits.Analysis of quantitative traits:The MultipleFactor Hypothesis, Broad sense heritability, Narrow sense heritability. Artificial selection, Correlation between Relatives. The theory of allele frequencies and allelic natural selection.

Applications of Molecular Genetics

Identification of human genes and diagnosis of human diseases.Uni parental Disomy, Huntington's disease, Fragile X syndrome, Cystic fibrosis. Gene therapy-SCID-Autosomal disease of immune system, DNA profiling, Micro RNA, Si RNA and their control in Genetic disorders. Mitochondrial gene in Aging and Human Disease.

(Prerequisite: Sex chromosome and sex determination, Sex-linked genes in humans, Dosage compensation of X-linked genes, Sex limited and sex influenced characters in man.)

Epigenetics **(4 hrs)**

Epigenetics, Histone code hypothesis. Chromatin modifications and their mechanisms of action: Modification of histone proteins - Acetylation, phosphorylation, methylation, ubiquitylation, sumoylation. Chromatin remodeling, Genomic imprinting, X chromosome inactivation, Gene Silencing.

BIOINFORMATICS **18hrs**

Module V
Biological Databases **(6 hrs)**

Primary databases - Nucleotide sequence databases: GenBank, EMBL, DDBJ; Protein sequence databases: SWISSPROT, PIR; steps involved in use and interpretation of results

Structure databases: PDB, NDB; Secondary databases: PROSITE, Pfam, CATH; Composite databases: OWL; Literature database: PubMed; Database searching – Entrez; Database sequence submission – BankIt.

Sequence Analysis **(6hrs)**

Types of sequence alignment, methods of sequence alignment, scoring schemes, gaps and gap penalties, Phylogenetic trees – CLUSTAL W and CLUSTAL ω, PHYLIP

Genomics and Proteomics and Systems Biology **(6hrs)**

Structural genomics, functional genomics, comparative genomics, data mining, proteomics – Microarrays.Protein modeling and drug designing.

System Biology - metabolomics, gene network, synthetic biology.

Recommended Text Books/Reference Books

1. *Concepts of Genetics*, Pearson (Global Edition), 11 edition , William S Kug, Micheal R Cummings, Charlotte A Spenser, Machael A Palladino
2. Principles of Genetics, Wiley, 8th Edition, Eldon JohnGardner, Michael J Simmons, D Peter Snustard
3. Genetics: Principles and Analysis, DanielHartel and Elizabeth W Jones
4. Lewin‟s Genes X , Jones and Bartlett, 10 Edition Jocelyn E Kreb, Elliott S Goldstein Stepen T Kilpatrik
5. Epigenetics CSH Press, Second Edition, C David Allis, Marie-Laure Capparros, Thomas Jenuwein, Danny Reinberg (E
6. Main references:*Principles of Genetics*, Gardner,Simmons,Snustad.
7. *Principles of Genetics,*Snustad,Simmons. *Genetics,A Conceptual Approach,*Benjamin A. Pierce

Bioinformatics

1. Alberghina,L and H.V. Westerhoff (Eds).2008. *Systems Biology-Definitions & Perspectives*. Springer-Verlag, Berlin.
2. Attwood T.K. and Parry Smith, D. 2006. *Introduction to Bioinformatics*. Pearson Education. Bourne P. E and Weissig H, 2003. *Structural Bioinformatics*.Wiley -Liss. USA
3. David W. M. 2004. *Bioinformatics, Sequence and Genome Analysis* (2ndedn). CSHP, New York Krane, D. E and M.L. Raymer. 2006.*Fundamental concepts of Bioinformatics*. Pearson Education,New Delhi
4. Lesk A. M, 2005. *Introduction to Bioinformatics*. Oxford Press, New Delhi
5. Pengcheng Fu and Sven Panke, (Eds.) 2009. *Systems Biology and Synthetic Biology*. John Wiley & Sons, Inc. NJ,USA
6. Tisdall J. D, 2001. *Beginning Perl for Bioinformatics*.O‟Reilly Media Inc.CA,USA
7. Masaru Tomita and TakaaiNishioka, 2005. *Metabolomics*.*The Frontier of Systems Biology*. Springer Japan

UCZL010204: MICROBIOLOGY AND BIOTECHNOLOGY

54 Hours (18+27) (3hrs/week) **Credit- 3**

Objectives:

- To provide an over view of the microbial world, its structure and function
- To understand the fundamental aspects of the basic biology of bacteria and viruses
- To give students an intensive and in-depth learning in the field of biotechnology
- To familiarize the student with emerging field of biotechnology
- To understand the modern biotechnology practices and approaches with an emphasis in technology application, medical, industrial, environmental and agricultural areas and nanomedicine
- To familiarize the students with public policy, biosafety, and intellectual property rights issues related to biotechnology

MICROBIOLOGY **18hrs**

Module I **(10hrs)**

General Characters and Classification of microbes **(4 hrs)**

General characters of microorganisms- bacteria, virus, fungi, Outline classification of microrganisms

Functional Anatomy of Prokaryotic Cells - Cell structure, plasma membrane, cytoskeleton, cytoplasm, nucleoid, cytoplasmic inclusions. The prokaryotic cell envelope, peptidoglycan structure, gram positive and negative cell walls.Components outside the cell wall: capsules, slime layers, pili and fimbriae, flagella and motility.

Methods in Microbiology **(6 hrs)**

Culture medium, methods of isolation, pure culture techniques, microbial strain identification – cultural and biochemical, Control of microorganism- physical, chemical and antimicrobial agents.

Module II

Microbial Growth and Interactions **(8 hrs)**

Nutrient requirements, growth factors, uptake of nutrients by the cell. Growth curve. Physical requirements for bacterial growth and influence of environmental factors on growth. Microbes in nutrient cycling.

Symbiosis, commensalism. Mutualism between microbes, microbes and plants, microbes and animals. Cooperation, competition, predation, antagonism. Parasitism, plant parasites, animal parasites. Microbial communication system- Quorum sensing, Biofilms.

BIOTECHNOLOGY **36 hrs.**

Module III

Recombinant DNA Technology - Tools and Techniques **(12 hrs)**

Introduction – rDNA and cloning, Restriction enzymes and DNA modifying enzymes.

Vectors: cloning and expression vectors - Plasmids, Ti and Ri plasmids, cosmids, phagemids, bacteriophage, SV40, vectors with combination features; PUC19 and Bluescript vectors, shuttle vectors, viral vectors, BAC and YAC vectors. Adaptors, Linkers.

Methods of gene transfer: chemical transfection methods: calcium chloride, PEG, polyplex, DEAE dextran. Physical methods: electroporation, microinjection, particle bombardment, ultrasonication, liposome mediated transfer. Biological methods: use of vectors, Selection and screening of recombinants, insertional inactivation- blue white screening, Generation of cDNA and genomic library.

Basic techniques in Biotechnology

Polymerase chain Reaction- different types and applications, Gene cloning, Chromosome walking, chromosome jumping, DNA foot printing.

DNA sequencing methods- Maxam and Gilberts chemical degradation method, Sanger and Coulson method, Automated DNA sequencers.

Protein sequencing methods

Module IV

Animal Biotechnology and health care (12 hrs)

Cell and Tissue culture: Basic techniques of mammalian cell culture Growth media- types, biology and characterization of cultured cells.Measurement of viability and cytotoxicity, organ culture.

Cryopreservation and maintenance of cell line

Transgenic animals – production and its applications. Gene knockout and gene knock, Site directed mutagenesis, molecular chimeras

Gene therapy:Exvivo, Invivo, Insitu- Cell and tissue engineering, Gene products in medicine – Humulin, Erythropoietin, Growth Hormone/Somatostatin, tPA, Interferon. DNA vaccine Biosensors and Biochip.

Module V. Biotechnology in Industry, Agriculture and Environment (5 hrs)

Fermentation technology – Stages of fermentation - Fermentation products (antibiotics, alcohol, amino acids, organic acids, vinegar, vitamins, and fuels). Enzyme engineering and applications. Transgenic plants, Biological nitrogen fixation; Nif genes, Nitrogen fixers – Bio fertilizers (Rhizobium, Azotobacter, Azospirillum, VAM) - Bio pesticides (Bacterial, Fungal, Viral). Terminator gene technology

Module VI

Nanobiotechnology (3 hrs)

Introduction, Nanobiotechnological devices, Types and applications of Nanobiosensors, Drug delivery technologies, personalized nanomedicine.

Intellectual Property Rights, Biosafety and Bioethics (4 hrs)

Introduction to Intellectual PropertyRights, Types of IP: Patents, Trademarks, Copyrights.

Basics of Patents Types of patents; Indian Patent Act 1970; Recent Amendments, Protection of New GMOs. IPs of relevance to Biotechnology and few Case Studies (Rice, Neem, Curcumin).

Introduction to History of GATT, WTO, WIPO and TRIPS.

Biosafety concepts and issues. Biosafety protocol 2000.

Bioethics: Principles of bioethics: autonomy, human rights, beneficence, privacy, justice, equity

Recommended Text Books/Reference Books

Microbiology

1. Ananthanarayanan, R. and Jayaram Panikar, C.K. (2013). Text Book of Microbiology. University Press, Hyderabad.
2. Arora,D.R. and Arora,B. (2008). *Text Book of Microbiology*. CBS Publishers and Distributers, New Delhi
3. Atlas RM. (2005). *Principles of Microbiology*. 4th edition. WMT.Brown Publishers. Chakraborty, P. A. (2009). *Text Book of Microbiology*. New Central Book Agency.New Delhi Harma and Kanika (2009). *Manual of Microbiology Tools and Techniques*. Ane Books Pvt. Ltd. New Delhi
4. Ingraham, J. L. and Ingraham, C. A. (2000). *Microbiology* (2ndedn). Brooks/Cole-Thomson Learning,MA,USA
5. Pelczar MJ, Chan ECS and Krieg NR. (2010). *Microbiology*. 8th edition. McGraw Hill Book Company.
6. Talaro, Park.,Kathelee, N and Talaro,Arthur. (2002). *Foundations of Microbiology*.McGraw Hill Higher Education,NY
7. Wheelis Mark (2010). *Principles of Modern Microbiology*. Jones and Bartlett Publishers,NY,USA.
8. Willey JM, Sherwood LM, and Woolverton CJ. (2008). *Prescott, Harley and Klein's Microbiology*. 8th edition. McGraw Hill Higher Education.

Biotechnology

1. Sathyanarayana, U. (2009), Biotechnology, Books and allied (p) Ltd
   Singh, B.D. (2009). Biotechnology, Kalyani publishers.
2. Click, B. R. and Pasternak (2002). Molecular Biotechnology: Principle and applications of recombinant DNA. ASM Press.
3. Dale, Jeremy W and Schantz, Malcom V. (2002). *From Gene to Genomes*. John Wiley and SonsLtd,NY,USA
4. Das, H.K. (2007). *Text book of Biotechnology*.Wiley India Pvt. Ltd. New Delhi
5. Doyle, Alan and Griffith Bryan J. (1999). *Cell and Tissue Culture- Laboratory Procedures in Biotechnology*.WileyInternational,NY.
6. Freshney, Ian, R. (2006). *Culture of Animal Cell* (5th edn).Wiley- Liss publications.
7. Jenkins, N (Ed) (1999). Animal cell biotechnology: Methods and Protocols. Humana press, New Jersey.
8. Pandian, T.T. and Kandavel, D. (2008). *Text Book of Biotechnology*. I.K International Publishing House, New Delhi.

UCZL010205: Practical 2

DIVERSITY OF LIFE: ECOLOGICAL, EMBRYOLOGICAL, HEREDITARY AND MICROBIAL METHODS & APPROACHES

180 Hours (10hrs./week) **Credit-4**

Ecology **70 Hrs**

- Study of Pond/ Wetland/ River ecosystem (any one) – Separate work book should be maintained by each student specifying objectives and methods adopted based on field study.
- Ecological analysis - Estimation of following parameters
  Water:- Salinity, Phosphates, Nitrate, pH & Conductivity
  Soil:- Organic carbon and Chlorides.
- Separation and identification of soil arthropods using Berlese funnel
  (A minimum of five specimens should be reported with the comments in practical record)
- Qualitative and Quantitative study of marine/freshwater planktons.
- Collection and temporary mounting of minimum 3 fresh water planktons (Group/Generic level identification is necessary) .
- Viva based on field study

Genetics **20 Hrs**

- Culture, sexing and etherization of *Drosophila*.
- Study of Mutants in *Drosophila*.
- Genetics problems (Di hybrid cross, test cross and sex linked inheritance)
- Gene order mapping in three point cross (Data to be provided)

Bioinformatics **30 Hrs**

- Data base search and data retrieval-using NCBI, SWISS-PROT, PDB, Expasy.
- Methods of sequence alignment-BLAST and ClustalW.
- Phylogenetic tree using MESQUITE/MEGA/ PHYLIP.
- Gene Prediction using GENSCAN/GRAI.
- Protein structure visualization using RASMOL.

Developmental Biology **30 Hr**

- Study of the developmental stages of Drosophila
- Study of the developmental stages of frog (egg, blastula, gastrula, neurula, tadpole, with external gill and internal gill) using permanent slides/Diagrams.
- Study of serial sections of embryo (tadpole/chick).
- Vital staining of early gastrula of chick - Window method.
- Blastoderm mounting and age determination of chick embryo using vital stains.
- Morphological and histological details of different types of mammalian placenta.

Microbiology **36 Hrs**

- Culturing of microorganism –
  broth culture
  pure culture techniques- streak plate, pour plate culture, lawn culture, stab culture
- Serial dilution and standard plate count, calculation of Cfu/ml in water samples.
- Identification of microorganisms-
  Staining techniques- gram staining of mixed cultures, negative staining and spore staining, oxidase test, catalase test, TSI, IMViC test
- Oxidation/fermentation (O/F) test
- Antibiotic sensitivity (different natural fluids)
- Staining and enumeration of microorganisms using haemocytometer
- Environmental sample analysis.
  - Coliform count in water
  - MPN method
  - Identification of symbiotic bacterioids from root nodules of leguminous plants, Bacteriological analysis of milk- methylene blue reductase test

THIRD SEMESTER COURSES

UCZL010301	Animal Physiology
UCZL010302	Cell and Molecular Biology
UCZL010303	Biophysics, Instrumentation and Biological Techniques
UCZL010304	Immunology
UCZL010305	Practical 3: Molecular, Physiological and Immunological Methods and Approaches in Biosciences

UCZL010301: ANIMAL PHYSIOLOGY

72 Hours. (4hrs/week) **Credit-4**

Objectives:

- To study and compare the functioning of organ systems across the animal world
- To give an overview of the comparative functioning of different systems in animals
- To learn more about human physiology

Module I

Digestion and Absorption **(8 hrs)**

Types of nutrition, functional anatomy of stomach and intestine. Physiology of starvation and obesity, Leptin: synthesis, secretion and its role in adipogenesis

Module II **(16hrs)**

Circulation **(8hrs)**

Circulatory mechanisms in different animal groups , Haemodynamics, Blood volume and its regulation, Comparative anatomy of heart structure in different animals, Myogenic heart-Conducting system, Cardiac cycle, Cardiac output, stroke volume, Neural and chemical regulation of cardiac activity ECG - its principle and significance.

Respiration **(8 hrs)**

Anatomy of respiratory organs and mechanism of respiration in invertebrates and vertebrates, Pulmonary ventilation, Neural and Chemical Regulation of respiration. Respiration in unusual environment– foetal and neonatal respiration, high altitude, diving.

Module III **(22 hrs)**

Nerve Physiology **(6hrs)**

Neuroanatomy of the central and peripheral nervous system, Modifications of synaptic transmission, Mechanism of excitatory and inhibitory pathway. Neuromuscular Junction-organization and properties,neuromodulators. Neural control of muscle on concentration, Role of kidney in maintaining homeostasis. Micturition, Dialysis, kidney transplantation.

Sensory and Effector Physiology **(10 hrs)**

Classification of somatic senses and somatic receptors, modality of sensation, exteroceptors, interoceptors, Chemo receptors: Mechanism of reception.

Mechanoreceptors: Mechanism of hearing and Equilibrium. Photo receptors: Structure of invertebrate and vertebrate eye. Physiology of vision. Pain receptors: Headache, pain suppression (analgesia). Tactile receptors: Mechanism of transmission of signals.

Muscle Physiology **(6 hrs)**

Skeletal muscle- ultra structure and molecular organization. Red and white muscles. Mechanism of muscle contraction and relaxation. Energetics of muscle contraction. Catch muscle and fibrillar muscle.

Module IV **(10 hrs)**

Osmoregulation and Excretion **(6 hrs)**

Osmoregulation in fresh water, marine and terrestrial animals.
Comparative physiology of excretion in different animals, Hormonal regulation of urine. Role of kidney in maintaining homeostasis. Micturition, Dialysis, kidney transplantation.

Thermoregulation **(4 hrs)**

Temperature compensation and temperature regulation in poikilotherms and homeotherms, Comfort zone, body temperature – physical, chemical, neural regulation. Adaptations for extreme environments, aestivation and hibernation.

Module V **(16 hrs)**

Endocrinology **(10 hrs)**

Invertebrate and vertebrate endocrine glands, Classification of hormones and mechanisms of hormonal action. Endocrine glands- Hormones and functions - Pituitary, Thyroid, Adrenal, Pineal and Pancreas. Diseases/disorders of hormonal hypo and hyper secretion. Stress and Stress adaptation, acclimation and acclimatization, physiological role and mechanism of hormone action. Bioamines, Eicosanoids, Chalones, Lumones.

Reproductive physiology **(6hrs)**

Anatomy and histology of Testis and Ovary, Hormonal regulation of gametogenesis, Physiology of implantation, pregnancy, parturition and lactation.

Recommended Text Books/Reference Books

1. Bentley,P.J. 1998. *Comparative Vertebrate Endocrinology* (3rd edn). Cambridge University Press Bray, J.J., Cragg, P. A, Macknight, A.D, Mills, R.S and Taylor, D.W 1986. *Lecture Notes on human Physiology*. ELBS, New Delhi.
2. William. S.Hoar, General and comparative physiology
3. C.L. Prosser, Comparative animal Physiology
4. Kenneth .S. Saladin 2011, Anatomy and Physiology Sixth edition
5. Brijlal Gupta and J.A. Ramsay, 1977. *Transport of Ions and Waterin Animals*. Academic Press, New York.
6. Chatterjee, C.C. 1997. *Human Physiology.* Medical allied agency, Calcutta.
   Ganong, W.F1987. *Reviewof Medical physiology*. Appleton and lang, Norwalk.
7. Guyton, A.C. 1996. *Text Book of Medical physiology*. Prism Books Pvt. Ltd. Bangalore.
8. Bray, J.J., Cragg, P. A, Macknight, A.D, Mills, R.S and Taylor, D.W. 1986. Lecture Notes on human Physiology. ELBS, New Delhi.
9. Brijlal Gupta and J.A.1977. Transport of Ions and Water in Animals. Ramsay Academic Press, New York
10. Chatterjee, C.C. 2022. Human Physiology. Medical allied agency, Calcutta.
11. Ganong, W.F. Appleton and lang, Norwalk.1 987.Review of Medical physiology.
12. Hill, W.R., Wyse, G.A and Anderson, M. 2007. Animal Physiology (2nd Edn). Sinauer Associates Inc. Publishers, MA, USA.

13. Hoar, W.S. 1983.General and Comparative Physiology. Prentice Hall of India, New Delhi.
14. Hochachka, P.W. and Somero, G.N. 2014.Biochemical Adaptation. Princeton University Press, New Jersey. 8. Knut Schmidt-Neilsen. 1997.Animal physiology: Adaptations and Environment. Cambridge University Press
15. Larsson, P.R. 2002.William's Text Book of Endocrinology (10th edn). W.B. Saunders, Philadelphia

UCZL010302: CELL AND MOLECULAR BIOLOGY

72 Hours (4 hrs/week) **Credit- 4**

Objectives:

• To help study the structural and functional details of the basic unit of life at the molecular level

• To motivate the learner to refresh and delve into the basics of cell biology

• To introduce the new developments in molecular biology and its implications in human welfare

Module I **(24hrs)**

Cell Membrane& Cell Interactions **(8 hrs)**

Membrane structure,chemistry and functions, dynamic nature of the plasma membrane, membranepotentials, ion channels.

Extracellular matrix: Basement membrane, Collagen, Proteoglycans, Fibronectin and laminin. Interaction ofcells with extracellular matrix: Integrins. Focal adhesion and hemidesmosomes. Interaction of cells with other cells: Selectins, Immunoglobulins, Cadherins, Adherens.

Cell Junctions:Tight junctions,Gap junctions, Desmosomes

Prerequisite: *membrane models**,** membrane transport: Simple diffusion, Facilitated,Active&Bulk transport*

Cell Organelles **(8 hrs)**

Endoplasmic reticulum – protein insertion, protein folding, signal sequences and signal hypothesis, Golgi complex-protein glycosylation and protein sorting , mechanism of vesicular transport, Lysosomes.

Prerequisite**:** *Mitochondria, Peroxisomes, Glyoxysomes, Nucleus and Nuclear membrane.*

Cell organization and Cell movement **(8hrs)**

Structure and organization of Microtubules, Intermediate filaments & Microfilaments, Molecular motors, Non muscle motility and musclecontractility.

Module II

Cell Signaling **(12 hrs)**

Extracellular messengers (signaling molecules), role of Calcium and Nitric oxide (NO) as intracellular and intercellular messengers.

Receptors: G- Protein coupled receptors, Receptor tyrosine kinases (RTK), Ion channel receptors, Cytokinereceptors (Tyrosine kinase linked receptors).

Second messengers: Cyclic-AMP, Cyclic-GMP, Inositol1,4,5-trisphosphate (IP3), Di-acyl glycerol (DAG). Signaling pathways: G-protein coupled receptor (GPCR) and cyclic AMP pathway – role of proteinkinase A (PKA), GPCR pathway in rod cells, Receptor protein tyrosine kinase and Ras-MAP kinasepathway, JAK-STAT pathway, Calcium phosphatidyl- inositol pathway, PhosphoInositide 3-kinase (PI-3 kinase), Transforming growth factor (TGF) signaling pathway. Regulation of signaling pathways. Convergence, divergence and crosstalk among pathways different pathways.

Prerequisite: *Basic principles of cell communication*

Module III

Gene Expression (12 hrs)

Transcription in prokaryotes and eukaryotes, Promoter, enhancer and silencer RNA processing in prokaryotes and eukaryotes, post transcriptional modifications,Translation in prokaryotes and eukaryotes,

Pre- requisite: *Gene and Genetic code*

Module IV

Gene Regulation (12 hrs)

Regulation of gene expression in *E. coli* :Catabolite repression, *Trp* operon in *E.coli*-repression and attenuation, *Ara* operon in *E.coli*-positive and negative controls. Riboswitches.

General introduction to gene regulation in eukaryotes at the level of chromatin structure, transcriptional - Transcription activators, coactivaors and repressors, Activation and repression of transcription, post transcriptional, translational and post translational levels, methods to identify post translational modification: RNA editing, RNA interference (RNAi).

Pre-requisite: *Fundamentals of gene regulation, Lac operon, Monocistronic and Polycistronic mRNA*

Module V (12hrs)

Cell Growth (5 hrs)

Cell cycle: Stages in cell cycle, Control of cell cycle, Checkpoints in cell cycle. Control of cell division and cell growth.Apoptosis- extrinsic and intrinsic pathways, significance.

Prerequisite: *Mitosis, meiosis*

Cancer (7 hrs)

Basic properties of a cancer cell: Metastasis, interaction of cancer cells with normal cells, Types of cancer, Causes of cancer, Genetics of cancer, Tumor suppressor gene, Oncogene.

New strategies for combating cancer: Immunotherapy, Gene therapy, inhibiting cancer promoting proteins,inhibiting formation of new blood vessels.

Pre- requisite: *benign and malignant tumour*

Recommended Text Books/Reference Books

1. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K. And Walter, P. 2017. *Molecular Biology of the Cell*. (6thedn). Garland Science.- Taylor and Francis group, USA.
2. Clark, D.P. 2010. *Molecular Biology*. Elsevier Publishers, London.
3. Cooper, G.M. and Hausman, R.E. 2018. *The cell: A Molecular Approach* (8thedn). Sinauer Associates,Inc, ASM Press, Washington DC.
4. Griffiths, A.J.F., Wesler, S.R., Carroll, S.B. and Doebley, J. 2008. *Introduction to Genetic Analysis.* W H Freeman and Company,USA
5. Hardin, J., Bertoni, G. 2018. *Becker's World of the Cell*. (9thedn). Pearson, England.
6. Hyde, D.R. 2010.*Genetics and Molecular Biology*. Tata McGraw Hill Education Private Ltd., NewDelhi.

7. Karp, G. 2013. C*ell and Molecular Biology* (7thedn). John Wiley and Sons, Inc.NJ, USA.
8. Klug, W.S. and Cummings, M.R. 2004. *Concepts of Genetics*. Pearson International, New Delhi. Krebs, J.E., Goldstein, E.S. and Kilpatrick, S.T. 2017. *Lewin's Genes XII*. Jones and Bartlett publishers,NY.
9. Lodish, H., Berk, A., Kaiser, C.A., Krieger, M., Bretscher, A., Ploegh, H.,Amon, A.and Martin,K.C. 2016. *Molecular Cell Biology* (8th edn). W H Freeman & Company, U.S.A. Pierce, B.A. 2008. *Genetics: A conceptual approach*. W H Freeman and Company.
10. Pollard, T.D. and Earnshaw, W.C. 2008. *Cell Biology*. Saunders Elsevier.
11. Snustad, D.P. and Simmons, M.J. 2010. *Principles of Genetics*. John Wiley and Sons. Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R. 2013. *Molecular Biology of the Gene*(7th edn). Pearson.

UCZL010303: BIOPHYSICS, INSTRUMENTATION AND BIOLOGICAL TECHNIQUES

72Hours (18 + 54)4hrs/week **Credit – 4**

Objectives:

- To understand the biological system and processes based on physical principles
- To provide and insight on the tools and techniques of various instruments available for biochemical and biophysical studies
- To train the learner the operational skills of different instruments required in Zoology

BIOPHYSICS 18hrs

Module 1

Diffusion and Osmosis (6hrs)

Diffusion – Kinetics of diffusion. Fick‟s law and diffusion coefficient.Gibb‟s Donnan equilibrium. Application of diffusion processes in biology: haemolysis. Vant Hoff‟s laws. Osmotic concentration, Osmotic pressure and osmotic gradient.
Biological significance of osmosis in animals and plants.

Bioenergetics (6hrs)

Reversible thermodynamics and irreversible thermodynamics; Systems – open, closed and isolated. Photo bioenergetics. Photosynthesis – light and dark reactions, Redox couple and redox potential. Chemo-bioenergetics: electron transport and oxidative phosphorylation, Chemiosmotic theory and binding change mechanism of ATP synthesis.

Radiation Biophysics (6hrs)

Interaction of radiation with matter – Photoelectric effect, ion pair production, absorption and scattering of electrons. Biological effects of radiation: effect on nucleic acids, proteins, enzymes and carbohydrates. Cellular effects of radiation: somatic and genetic. Nuclear medicine: Internally administered radioisotopes. Radioiodine in thyroid function analysis.

INSTRUMENTATION & BIOLOGICAL TECHNIQUES 54hrs

Module II

Microscopy and Histological Techniques (18hrs)

Microscopy (10hrs)

Differential Interference contrast (Nomarsky) microscopy, Fluorescence microscopy, Confocal microscope, Scanning Tunnelling, Electron microscope - TEM, SEM,Specimen preparation-Shadow casting, Freeze fracturing, Freeze etching,Negative staining. Atomic force microscope

Histological Techniques (8hrs)

Types of microtomes and microtomy. Fixation, preparation of temporary and permanent slides, whole mounts, smears, squashes and sections. Cytochemical and histological method. Histochemistry of nucleic acids, detection of carbohydrates, proteins and lipids.

Module III

Separation Techniques **(20hrs)**

Centrifugation **(2hrs)**

Basic principle and application. Differential, density and ultracentrifugation.

Chromatography **(10 hrs)**

Basic principles, working and applications of Thin-layer chromatography, Ion – exchange and Affinity chromatography; High performance liquid chromatography (HPLC), Fast protein liquid chromatography (FPLC), Gel permeation chromatography.

Electrophoresis **(8 hrs)**

Gel electrophoresis– PAGE, SDS and non SDS, 2D Gel electrophoresis, Isoelectric focusing, Density gradient gel electrophoresis, , Electrophoretic mobility shift assay (EMSA).

Module IV

Advanced Techniques and Applications **(12hrs)**

Colorimetry **(2 hrs)**

Principle and applications of colorimetry and spectrophotometry- Beer Lambert law

Spectroscopy **(10hrs)**

Fourier-Transform infrared spectroscopy (FTIR), Raman spectroscopy, Flame emission spectroscopy, Nuclear Magnetic- resonance spectroscopy (NMR), Mass spectroscopy- Different types and applications: MALDI-TOF, LCMS, Tandem Mass Spectrometry.

Module V **(4hrs)**

Radioisotope Detection and Measurement **(2hrs)**

Dosimetry: Ionization chamber, GM counter, Solid and liquid scintillation counters, Autoradiography.

Biomimetics technology **(2 hrs)**

Principles and applications-Bio-Nanorobotics, Artificial muscles using Electroactive polymers, Multifunctional materials

Recommended Text Books/Reference Books

1. Alonso, A., and Arrondo, J.L.R.2006. *Advanced Techniques in Biophysics*.Springer,UK
   Arora, M. P. 2007. *Biophysics*. Himalaya Publishing House, New Delhi
2. Bar-Cohen, Yoseph. *Biomimetics: Biologically-Inspired Technologies*. 2006. CRC Press.
   Das, D. 1991. *Biophysics and Biophysical Chemistry*. Academic Publishers, Calcutta
   Edward, A.L. 1997. *Radiation Biophysics*. Academic Press,NewYork,USA
3. Ernster, L. (Ed.). 1985. *Bioenergetics*. Elsevier, NewYork,USA

4. Ghatak K.L. 2011.*Techniques and Methods in Biology*. PHI Learning Pvt. Ltd. New Delhi Gupta A. 2009. *Instrumentation and Bio-Analytical Techniques*.PragatiPrakashan, Meerut Hoope, W. et.al. 1983. *Biophysics*. Springer Verlag, Berlin
5. Keith Wilson and John Walker. 2010. *Principles and techniques of Biochemistry and Molecular Biology*.7th Edition.
6. Lehninger, A.L.1971. *Bioenergetics*. W.A. Benjamin, London,UK
7. Narayanan, P. 2000. *Essentials of Biophysics*.New Age International (P) Ltd. Publishers, New Delhi
8. Nelson D.L. & Cox, M.M., 2006. *Lehninger's Biochemistry*, W.H. Freeman and company, USA Pradeep T. 2007. *NANO: The Essentials. Understanding Nanoscience and Nanotechnology*.Tata McGraw Hill Education Pvt. Ltd., New Delhi
9. Roy, R.N. 1996. *A Textbook of Biophysics*. New Central Book Agency (P) Ltd. Calcutta
10. Sandhu, G.S. 1990. *Research Techniques in Biological Sciences*. Anmol Publications, New Delhi
11. Srivastava,P.K. 2006. *Elementary Biophysics.AnIntroduction*.Narosa Publishing House, New Delhi
12. Trunk Dung Ngo. 2015. *Biomimetic Technologies: Principles and Applications.*Woodhead Publishing
13. Varghese, T. and Balakrishna, K.M.2012. *Nanotechnology-An Introduction to Synthesis, Properties and Applications of Nanomaterials*. Atlantic Publishers and Distributors. (P) Ltd. New Delhi

UCZL010304: IMMUNOLOGY

Total: 54 Hours. (3hrs. /week). **Credit- 3**

Objectives:

- To provide an intensive and in-depth knowledge to the students in immunology
- To help the learner to understand the role of immunology in human health and well-being
- To familiarize the students the new developments in immunology

Module I **(12hrs)**

Overview of the Immune System **(4 hrs)**

- Cells, tissues and organs involved in immune system.
- Haematopoiesis, Haematopoietic growth factors.
- B-cell and T-cell maturation and differentiation.
- B-Cell and T-Cell receptors
- Pattern Recognition Receptors, Toll-like receptors

Immunogenicity and Antigenicity **(8 hrs).**

- Immunogenicity Vs Antigenicity. Factors that influence immunogenicity
- Haptens, Adjuvants, Epitopes.
- Properties of B-cell and T-cell epitopes
- SuperAntigens and Toxic Shock Syndrome.
- Immunoglobulins-structure, classes and functions.
- Antigenic determinants of immunoglobulin - (a) Isotype (b) Allotype (c) Idiotype.
- Immunoglobulin genes- Multigene organization.
- Generation of antibody diversity.
- Monoclonal antibodies and clinical uses.
- Antibody engineering.

Module II **(10 hrs)**

Antigen –Antibody Interactions **(6 hrs)**

- Strength of antigen-antibody interaction- antibody affinity and avidity.
- Types of antigen-antibody reactions - Cross-reaction, Precipitation, Agglutination.
- **Immunological Techniques** - Immunoprecipitation. Immunofluorescence. Flow cytometry and fluorescence. Immunoelectron microscopy. Radio-allergosorbent Test (RAST). ELISA and RIA .

The Complement System **(4 hrs)**

- Complement activation-Classical, Alternate and Lectin Pathways
- Terminal sequence of complement activation (MAC)
- Regulation of complement system.
- Biological consequences of complement activation.
- Complement deficiencies .

Module III **(9hrs)**

(5 hrs)

Immune Effector Mechanisms

- Types of Inflammation- acute and chronic.
- Chemokines.
- Role of cytokines in the immune system.
- Properties and functions of Cytokines.
- Cytokine antagonists.

Hypersensitivity **(4 hrs)**

- Types of Hypersensitivity- IgE- mediated (type- I) hypersensitivity. Antibody- mediated cytotoxic (type- II) hypersensitivity. Immune complex- mediated (type- III) hypersensitivity.
  Delayed type (type- IV) hypersensitivity.
  Stimulatory (type V) hypersensitivity

Module IV

Major Histocompatibility Complex **(18hrs)**

(8 hrs)

- General organization and inheritance of MHC.
- MHC genes. Genomic map of H-2 Complex in the mouse.
- HLA Complex in humans. MHC-peptide interaction.
- Expression of MHC molecules on different cell types.
- Biological significance of MHC. HLA typing
- Antigen processing and presentation

Immunity in Health and Disease **(10 hrs)**

- Congenital immunodeficiency diseases (SCID, WAS, CVI, Ataxia, CGD, LAD). Acquired Immunodeficiency Disease (AIDS).
- Autoimmunity. Organ- specific autoimmune diseases. Systemic auto-immune diseases.
- Immune response during bacterial (Tuberculosis), parasitic (Malaria) and viral (HIV) infections (include).
- Vaccines –Whole organism vaccines, Purified macromolecules as Vaccines, Recombinant vector vaccines, DNA vaccines. Synthetic peptide vaccines, Multivalent subunit vaccines.

Module V

Transplantation immunology **(5 hrs)**

- Immunologic basis of graft rejection.
- Clinical manifestation of graft rejection.
- General and specific immunosuppressive therapy.
- Clinical transplantation.

Recommended Text Books/Reference Books

1. Abbas, A.K., Lichtman,A.K and Pober , J.S. 1997. *Cellular and Molecular Immunology.* W.B. Saunders Co. New York
2. Darla,J, Wise &Gordeon,R.Carter. 2004. *Immunology- A Comprehensive Review*. Iowa State University Press. A Blackwell Science Co,USA
3. David Male,JonathanBrostoff, David Roth and Ivan Roitt. 2006. *Immunology*. Mosby, Edinburgh,UK
4. Ivan M. Roitt, 2002. *Essential of Immunology*. ELBS, New Delhi.
5. Khan.F.H. 2009.*The Elements of Immunolgy*.Pearson Education.New Delhi.
6. Kuby J, 2000. *Immunology* (7thedn.). WH Freeman & Co. New York.
7. Richard Coico and Geoffrey Sunshine. 2009. *Immunology: A short course*. Wiley-Blackwell,CA,USA
8. Thomas J. Kindt, Richard A. Goldsby and Barbara A. Osborne. 2013. Kuby Immunology. WH Freeman and Company, New York

UCZL010305: Practical 3

MOLECULAR, PHYSIOLOGICAL AND IMMUNOLOGICAL METHODS & APPROACHES IN BIOSCIENCES

180 Hours (10hrs./week) **Credit-4**

Cell & Molecular biology and Biotechnology 72hrs

- Squash preparation of grasshopper testis to study meiotic stages.
- Squash preparation and identification of salivary gland chromosomes in *Drosophila* / *Chironomus* larva.
- Determination of mitotic index in the squash preparation of onion root tip.
- Effect of drugs on cell division (Colchicine or any other inhibitor)
- Cell fractionation and Differential Centrifugation to isolate mitochondria and nuclei
- Preparation of Microtome section & spreading
- Histochemical staining of carbohydrates (PAS), Protein (Bromophenol blue), lipids (Sudan Black), DNA (Fuelgen stain
- Gel electrophoresis of protein and nucleic acid (Demonstration)
- Isolation of genomic and Plasmid DNA.

Biophysics/Instrumentation/Biological Techniques 36 hrs

- Micrometry- principle and measurement of microscopic objects: Low power and high power
- Camera Lucida – Diagrammatic representation of specimen using camera lucida
- Principle and working of phase contrast microscope, Micro-photographic equipment,
- Identification of absorption maxima of the given sample by colorimetry
- TLC using amino acids from purified samples and calculation of RF values
- Analysis of biological materials (Arthropodan perilymph) using TLC

Animal Physiology 72 hrs

- Rate of salivary amylase activity on starch (colorimetry)
- Effect of different pH on salivary amylase activity (colorimetry)
- Influence of temperature on salivary amylase activity – Calculation of Q10
- Effect of drugs on the heartbeat of cockroach (Result with graphical representation corresponding to different concentration and time intervals expected)
- Oxygen consumption in fish (normal and stressed).
- Kymograph: working principle and applications.
- Virtual Practicals in Physiology
  (Use of PhysioEX 9.0 : *Laboratory Simulations in Physiology* by P.Zao.,T.Stabler., L.A.Smith and E .Griff. 2011.is suggested) for muscle and nerve physiology practical for class room training and for practical examination in order to replace Frog as per UGC guidelines). Any four of the following:
  Muscle Twitch and the Latent Period, The effect of stimulus Voltage on Skeletal Muscle Contraction, Tetanus, Fatigue, Receptor Potential, The Action Potential Threshold, Importance of Voltage –Gated Na+ Channels

- Differential count of Human WBC
- Haematocrit and ESR of Human blood
- Feeding activity of paramecium
- Effect of different concentration of NaCl solution (0.1%-2%) on the diameter of RBCs (preferably human) and determination of the concentration , which is isotonic to the blood from a plot of diameter of RBC against concentration of NaCl

Immunology

- Separation of lymphocytes from whole blood.
- Separation of T and B lymphocytes
- Blood Typing in Man.
- WIDAL Test and Western Blotting –Demonstration
- ELISA -Demonstration
- Rocket Immuno electrophoresis- Demonstration

Note:

Good laboratory practices and green protocol should be practiced in the lab. Virtual Practical developed by the Ministry of Human Resources, Govt. of India and available in the web site:**www.vlab.ac.in** can be availed for demonstration.

FOURTH SEMESTER COURSES

ELECTIVE B: ENVIRONMENTAL SCIENCE

UCZL010401	Environmental Science: Concepts and Approaches
UCZL010402	Environmental Pollution and Toxicology
UCZL010403	Environmental Management and Development
UCZL010404	Practical 4: Environmental Science

Objectives:

- To provide a broad and deep understanding on environment and influence of man on environment
- To equip the students to use various tools and techniques for the study of environment
- To enable the learner to understand, think and evolve strategies for management and conservation of environment for sustaining life on earth
- To take up further studies and research in the field

UCZL010401: ENVIRONMENTAL SCIENCE: CONCEPTS AND APPROACHES

90 Hrs. (5hrs./week) **Credit- 4**

Module I **(26hrs)**

Structure of Earth **(4 hrs)**

The origin and structure of earth, primary differentiation and formation of core, mantle, crust, atmosphere and hydrosphere.

The Physical Environment **(22 hrs)**

Lithosphere - Weathering and soil formation, - soilcolloids, adsorption and exchange of anions andcations, role of microbes in soil, types of soil, soil profile, classification of rocks, folds, faultsanddykes and other geological formations and their environmental significance. Geomorphologicalprocesses-plate tectonics, sea floor spreading, mountain building, evolution of continents and structural deformation.

Atmosphere -Physico-chemical characteristics, divisions, composition and significance of atmospheric components.

Hydrosphere -Visible and invisible hydrosphere, Range of aquatic habitats, water cycles betweenearth and the atmosphere, Global water balance, ice sheets, origin and composition of sea water, sealevel changes, River basins and watershed. Physico-chemical characteristics of water- diffusion ofoxygen from the atmosphere to surface waters. Influence of pH, turbidity and light on aquatic life.

Module II **(18hrs)**

Weather, Climate and Microclimate **(12 hrs)**

Definitions and scope of climatology, weather, climate and microclimate, components of climate system, earth's thermal environment, earth intercepts solar radiation, seasonal variation in intercepted solar radiation, air temperature in relation to altitude, global circulation of air masses, wind and earth's rotation on ocean currents, influence of temperature on moisture content of air. Global pattern of precipitation,influence of topography on regional pattern of precipitation. Classification of climate-Koeppen's classification and Thornthwaite's scheme.Climatic types and zones.

Climate Change **(3hrs)**

Global climatic phenomena-El Nino and La Nina. Causes and factors of climate change. Effect of Climate change on ecosystems and human welfare. Global climate models.

Climate of India **(3 hrs)**

Climatic regions of India, tropical monsoon climate-onset, rain bearing systems, break in the monsoon, retreat of monsoon. Monsoon in Kerala : Western Ghats, oceanic and continental influence.

Module III

Landscape Ecology **(10 hrs)**

Land Use in agro-ecosystems, urban ecosystems, rangelands, riparian and wetland systems, coastal and estuarine systems.

Concept of ecological land degradation, desertification, water logging, salinisation and soil erosion.

Integrated analytical techniques- land suitability analysis and carrying capacity studies; Use of soil survey, aerial photos, topographic maps and other resource data in landscape management; corridor selection problems.

Module IV

Biodiversity and Conservation **(20 hrs)**

Biodiversity-concepts and patterns. Types of biodiversity-wild biodiversity, agro-biodiversity, domesticated biodiversity. Values of biodiversity, ecosystem functions and biodiversity, mobile links and valuating ecosystem services. Drivers of biodiversity loss.

Tools and techniques for biodiversity estimation- biodiversity indices.

Strategies for biodiversity conservation- In-situ conservation: sanctuaries, biospheres reserves, national parks, nature reserves, preservation plots.

Ex-situ conservation: botanical gardens, zoos, aquaria, homestead garden; herbarium; In-vitro Conservation: germplasm and gene bank; tissue culture: pollen and spore bank, DNA bank. GEF-World Bank initiatives. Biodiversity hotspots and their characteristics, global distribution. CBD, National and international programmes for biodiversity conservation. CITES and TRAFFIC.

Indian Biodiversity Act 2002 and laws, National Board of Biodiversity, State Board of Biodiversity. Ecosystem people and traditional conservation strategies; People‟s participation in conservation-PFM, community reserve and People's Biodiversity Register (PBR). Biodiversity Management Committee (BMC). Wildlife values and eco-tourism, wildlife distribution in India, problems in wildlife protection-Policies and programmes. Threatened animals of India, Project Tiger

Module V **(16hrs)**

Biological Invasions **(12 hrs)**

Introduction Elton's hypothesis – Invasion patterns and process biological attributes for invasion: Reproductive potential, Allelopathy, Phenotypic plasticity, fitness to the new environment. Hypotheses for invasion success: Natural enemy hypothesis, evolution of invasiveness hypothesis, empty niche hypothesis, novel weapon hypothesis, disturbance hypothesis and Propagule pressure hypothesis. Invasive alien species of India (plants and animals). Databases of biological invasions. Impacts and management of invasions:

impacts of exotics on biodiversity, productivity, nutrient cycling.Management: Bio-control programmes, mechanical and chemical control. Positive utilization. Quarantine and EIA of biological invasion.

Environmental Economics **(4 hrs)**

Origin and scope of environmental economics, Green Economy: sustainable utilisation of natural resources.

UCZL010402: ENVIRONMENTAL POLLUTION AND TOXICOLOGY

90 Hrs (5hrs/week) **Credit – 4**

Module I **(15hrs)**

Introduction **(3 hrs)**

Definition of pollution, Different types of pollution- Air, Water and soil and their local, regional and global aspects.

Air Pollution **(12 hrs)**

Sources and classification of air pollution; particulates and gaseous pollutants in the atmosphere(GHG). Primary and secondary pollutants. Effects of air pollutants on human health, animals, vegetation, materials and structures. Air pollution monitoring - methods, air quality standards; ISI, EPA.Sampling and measurement of particulate matters (SPM) - gaseous pollutants, C02, CO, NOx, S02, H2S, oxidants, ozone and hydrogen fluoride.Control of gaseous emission: adsorption by liquids,adsorption by solids, combustion and condensation.
Control of S02, NOx, CO, CO2and hydrocarbons. Carbon sequestration,Carbon Credit,Carbon foot print and carbon trade,Case study:Air pollution in Delhi.

Module II

Water Pollution **(15 hrs)**

Sources of water Pollution-Domestic (municipal sewage), industrial and agricultural. Ground water pollution. Water quality standards for potability:BIS,WHO,Pollution parameters:BOD, COD, Coliform bacteria. Effects of water pollution on human health and aquatic systems. Traditional water purification techniques. Treatment of water for potable purpose (mixing, sedimentation, coagulation, filtration and disinfection).
Waste water treatment: Primary and Secondary treatment, Biological treatment: Kinetics of Biological growth - activated sludge treatment - trickling filters - anaerobic digestion, combined aerobic and anaerobic treatment process, aerobic process.Sludge disposal
Advanced waste water treatment - removal of dissolved organics and inorganic - precipitation, iron exchange, reverse osmosis, electro dialysis, adsorption and oxidation. Removal of nutrients. Removal of heavy metals. overall waste water treatment for sewage water. Sewage treatment and Sewage treatment plants. Water pollution treatment using constructed wetlands. Ganga action plan.

Soil Pollution **(10 hrs)**

Sources of soil pollution; - agricultural, industrial and domestic. Hazardous waste compounds, formulations and classes of substances, chemical classification of hazardous waste. Soil factors affected by pollution – physico-chemical and biological impacts. Case study on soil pollution in wetland and Highland soils in Kerala. Control of soil pollution. Soil quality parameters.

Module III
Solid Waste Management **(15 hrs)**

Municipal solid wastes (MSW) - quantities and characteristics, waste collection and transport, waste processing and resources recovery and recycling. Aerobic and anaerobic systems-composting, vermicomposting; Bio digesters (Biogas plants); incineration, pyrolysis, plasma pyrolysis; sanitary landfills and open dumping yards. Management of plastic and e-waste.Treatment process for unsegregated waste, fixation of hazardous solid waste prior to

disposal, hazardous waste in land fill. Hazardous waste (Management and Handling) Rules 1989 - the Manufacture Storage and Import ofHazardous Chemicals Rules 1989 - Biomedical Waste (Management and Handling) Rules 1998 -Plastic Act 1999.

Module IV **(15hrs)**

Noise, Thermal and Oil Pollution **(7 hrs)**

Definition: sound and noise. Assessment and measurement of sound, National and International Standards, Effects of noise on People and ecosystem. Basic principles of noise control.
Thermal Pollution-causes and consequences.
Oil pollution – causes and consequences (any two case studies).

Radiation Pollution **(8 hrs)**

Radiation pollution- Definition, Sources and effects
Radioactive pollution: Radioactivity, Radioactive decay and build up, Radionuclide, Radiation emissions, safety standards. Radioactive waste management. Nuclear reactor disasters (Any one case studies), Impacts radiation pollution on ecosystem.

Module V

Toxicology **(20 hrs)**

Selective toxicity, dose, synergism and antagonism.
Dose – Response relationships – Graded response, quantal response, Time action curves, Threshold Limit value (TLV); LC50; Margin of safety; Toxicity curves; Cumulative toxicity and LD50.
Toxic chemicals in the Environment – Biochemical aspects of As, Cd, Pb, Hg, Cu, O3, PAN, pesticides, MIC and other carcinogens.
Bio accumulation and bio magnification.
Occupational toxicology- hazardous chemicals, disorders from chemical exposure at work.

Toxicity testing and Bioassay – Definition, purpose, criteria for selection of test organism, methodology, estimation of LC50, acute toxicity (single); sub-acute toxicity; chronic toxicity; teratogenicity, carcinogenicity and mutagenicity.Limitation and importance of bioassay.

Bio-monitoring of toxic chemicals, concepts of bio indicators. Bio-transformation of Xenobiotics, Bioremediation

UCZL010403: ENVIRONMENTAL MANAGEMENT AND DEVELOPMENT

90Hrs (5hrs/week) **Credit - 4**

Module I

Environmental Management **(20 hrs)**

Basic principles, Concepts and scope of environmental planning, regional planning and management. Cost-benefit analysis and Resource economics. Environmental modelling-simulation modelling, input-output modelling, Linear programming SEA, Ecological Economics, Eco funds.

Environmental auditing and standards, Eco labelling and certification, accreditation – need, objectives and benefits; Corporate social responsibility and Corporate environmental responsibility, ISO standards for environmental management systems (EMS) ISO 14000, 14001 and 26001; OHSAS 18001.

Module II

Ecosystem Management **(20 hrs)**

Population, Resources and ecosystem management Exponential growth in human numbers and the implications. The five basic laws of Ecology and their relevance for ecosystems management. Management practices for various ecosystems: grasslands, forests, mountains, wetlands and coastal areas. Environmental planning and management of – waste lands, industrial lands and agricultural lands.

Eco restoration/remediation; the common property resources and their management; local knowledge and management systems; environment management through Biotechnology; Green revolution-environmental impacts

Module III

Environmental Impact Assessment (EIA) **(20 hrs)**

Introduction- Definition, history, Aim, principles, concept and scope. Baseline data collection, Methods and steps - Adhoc method, checklist method, matrices, Map overlays method, network method, index method.

Impact assessment and impact evaluation-EIA Process, Environmental Impact Statement (EIS), Public Participation in EIA, Environment management plan- Risk assessment. National Policy on EIA and Regulatory Framework: Environmental Impact Assessment Notification 2006 and Coastal Zone Notification 1991; and its amendments. Environmental Clearance Process in India; Central and state pollution control boards for environmental protection. EIA case studies. Life Cycle Assessment (LCA) and its significance.

Module IV **(22hrs)**

Remote Sensing and GIS* **(17 hrs)**

Principles and concepts of Remote Sensing, spectral characteristics of surface features (rocks, soils, vegetation, water). Space Imaging Landsat, SPOT, IRS, NOAA, Seasat, ERS, RADARSAT, INSAT. Digital Image Processing: Image Rectification and restoration, Image enhancement and Mosaicing. Image classification: Supervised, Unsupervised.

Geographical Information System (GIS): Basic principles, Raster and vector data, Map projection, Topology creation, overlay analysis, Data structure and Digital cartography; Software used in GIS, Geodetic survey.

Global Positioning System (GPS) Basic principles, Applications to environmental studies.

Module V

Disaster management **(5hrs)**

Disaster management- floods, droughts, earthquakes; tsunami, cyclones and landslides; Nuclear hazards. Causes and Mitigation Measures.

Module VI

Sustainable Development **(8 hrs)**

Idea of Sustainable Development. Johannesberg Conference 2002; Millennium Development Goals and Strategies (MDG & S); Earth charter; Participatory & community based environmental management strategies. Ecological Footprint analysis and its significance. Environmental concerns in traditional societies, Gandhian environmentalism.

**** Note:***

Students and faculty can avail of the facility RS & GIS Division of School of Environmental Sciences of the MG University for technical support and guidance for Module IV.

Recommended Text Books/Reference Books

1. Agarwal, N.K. 2004. *Essentials of GPS*. Spatial Networks Pvt. Ltd., Hyderabad.
   Agarwal, S.K. 2002. *Eco informatics*. APH Publishing Corporation, Hyderabad.
2. Asit K. Biswas *et.al.*, 1987. *EIA for Developing Countries*. United Nations University, Tokyo. Carter,L.1996. Environmental Impact Assessment. McGraw Hill,New Delhi
3. Coronel, C., Morris, S. and Rob, P. 2009. Database Systems: Design, Implementation and Management.9th edn., Course Technology.
4. Eagles, P.F.J.1987. *The planning and Management of Environmentally Sensitive areas*. Longman Group Ltd., USA.
5. Elachi, C. 1978. *Introduction to Physics and Techniques of Remote sensing.* John Wiley Pub., N.Y.
6. Ewing B., D. Moore, S. Goldfnger, A. Oursler, A. Reed, and M. Wackernagel. 2010.
7. Floyd F., and SabinsJr.,W.H. 1987.*Remote Sensing, Principles and Interpretation*. Freeman & Company, New York, 2nd Ed., 1987.
8. Gadgil, M. and Guha, R. 1995. *Ecology and Equity- The Use and Abuse of Nature in ContemporaryIndia,*.Penguin India.
9. Gadgil, M. and Guha, R.1998. *The Fissured Land; An Ecological History of India*; Oxford University Press, New Delhi.
10. Goldsmith, B. 1992. (Ed.) *Monitoring for Conservation and Ecology.* Chapman and Hall, London.
11. Jorgensen, S.E. 1996. *Applications of ecological modeling in environmental management.*
12. Elsevier Sci. Co., London.
13. Jorgensen, S. E., Chon, T S. and Recknage, F. A., 2009. *Handbook of Ecological Model inand Informatics.* WIT Press
14. Kang-tsung, C. 2000. *Introduction to GIS*. Tata Mc Graw Hill, New Delhi.
15. Knight, R L and White, L. 2009. *Conservation for a New Generation Redefinig Natural ResourcesManagement*. Island Press, USA
16. Kurian Joseph and Nagenddran, R. 2004. *Essentials of Environmental Studies*. Pearson Education (Singapore) Pvt.Ltd. New Delhi.
17. Lawrence, D.P. 2003. *Environmental Impact Assessment: Practical Solutions to Recurrent Problems.*John Wiley and Sons, New Delhi.
18. Lillesand, T.M.and Kiefer, R.F. 1994. *Remote Sensing and Image interpretation*. John Wiley & Sons, New York.
19. Maguire, D., Batty, M., Goodchild, M., (Eds.) 2005. *GIS, Spatial Analysis,and Modeling,* Esri Press, USA
20. Meadows, D., Randers, J. and Meadows, D. 2004.*Limits to Growth: The 30 Year Update*
21. London, Earthscan.
22. Meffe, G. K., L. ,Nielsen, R. ,KnightandSchenborn. 2002. *Ecosystem Management: Adaptive, CommunityBased Conservation*.Plenum Press.
23. Miller. G.T., Jr. 2004. *Environmental Science*. Thomson, California.
24. Milner Gulland,E.J. and J Marcus Rowcliffe, 2007. *Conservation and Sustainable Usea handbook of Techniques.* Oxford University Press
25. Muralikrishna, I.V. 2001. *Spatial Information Technology- RS and GIS*. Vol.I and II BS
26. Peter Calow. 1998. (Ed.) *Handbook of Environmental Impact Assessment*. Mc Graw Hills Inc., New Delhi
27. Pullin, A.S. 2002. *Conservation Biology*. Cambridge University Press, UK.

28. Rao,D.P (Ed).1998. *Remote Sensing for Earth Resources*. Association of Exploration Geophysicist,Hyderabad
29. Simon Dresner 2008. The Principles of Sustainability Solutions. Earthscan paperbacks, *The Ecological Footprint Atlas 2010*. Oakland: Global Footprint Network.
30. Tyler Miller, G Jr, 2005. *Advantage Series: Sustaining the EarthAn Integrated Approach* (with CD ROM and Info Trac). 7th Edition., Thomson/Brooks Cole, USA
31. UN General Assembly.2010. *Keeping the promise: a forward-looking review to promote an agreedaction agenda to achieve the Millennium Development Goals by 2015.* Report of the SecretaryGeneral.
32. Westman W.E 1995. *Ecology, Impact Assessment and Environmental Planning*. John Wiley and sons.NY,USA.
33. World Commission on Environment and Development.1987. „*Our Common Future'*, New York: Oxford University Press

Web Resources

1. www,moef.gov.in (of Ministry of Environment and Forests, Govt. of India) www.millenniumassesment.org. (for Millennium Ecosystem Assessment Synthesis Reports) www.unep.org

UCZL010404: Practical 4
ENVIRONMENTAL SCIENCE

180 Hours (10hrs/week) **Credit - 4**

Soil texture using micrometry from two different sites.

Determination of moisture content.

Determination of soil pH from at least three different locations and correlate it with the soil type.

Determination of Chloride, Calcium, Magnesium, Potassium and Phosphorous in soil.

Determination of Calcium Carbonate in Egg shell- (Three different types of egg)

Identification of trophic levels from gut analysis (Fish or insect)

Air Quality Analysis:

Air samplers - Simple, Handy and High volume air samplers.

Water Quality Analysis:

a. Determination of pH, Electrical conductivity, Alkalinity, Hardness, Phosphate and silica
b. Determination of total dissolved salts (TDS)

Toxicity Analysis of Water: For Chlorine, Ammonia, Copper and chromium and COD of polluted water

Toxicity analysis by using Probit method

Study of histo-pathological changes in any two of the tissues (Liver/Kidney/ Gonad) using CCl_4 or NH_3 (five stained permanent slides [normal and affected] to be submitted for the examination).

Field Study Report:

An internship/training/field study of not less than 10 days related to environment/ environmental pollution/environmental management. Submit a detailed report with a minimum of 10 pages giving the dates, day wise itinerary, methodology, results/activity and references. Include photographs of the activity. Group and individual assignments shall be preferred.

MODEL QUESTION PAPERS

M Sc.Zoology Degree (C.S.S) Examination

First Semester

Faculty of Sciences

UCZL010101ANIMAL DIVERSITY: PHYLOGENETIC AND TAXONOMIC APPROACHES

(2019 admissions onwards)

Time: Three hours Max. Weight: 30

Section- A

(Answer any **eight**questions. Each question carries a weight of 1)

1. Stromatolites
2. Cambrian explosion
3. Advantages of bone in vertebrate phylogeny
4. Significance of paedomorphosis in chordate phylogeny
5. Endothermy in dinosaurs
6. Evolutionary significance of Sarcopterygians.
7. What are the threats to the modern amphibian?
8. List out the endangered mammals of India 9.Phylocode
10. E-taxonomy

(8 x 1 = 8)

Section B

(Answer any **six** questions. Each question carries a weight of 2)

11. Comment on the different hypothesis of metazoan origin
12. What are the evolutionary advantages of symmetry and metamerism?
13. Comment on adaptive radiation in annelids
14. Discuss the affinity of invertebrates and protochordate in vertebrate evolution
15. Explain the importance of skull in reptilian classification
16. Comment on the significance of jaws and hearing in mammalian phylogeny
17. Briefly explain the taxonomic procedure
18. Give an account on the cladistics analysis in systematics

(6 x 2 = 12)

Section C

(Answer any **two** questions. Each question carries a weight of 5.)

19. Comment on the phylogenic relationship amongmollusca, annelida and arthropoda
20. Write an essay on reptilian phylogeny and adaptive radiation
21. Explain about the different types of taxonomic publications
22. Write an essay on the use of biomolecules in molecular phylogeny

(2 x 5 =10)

M Sc Zoology Degree (C.S.S) Examination

I Semester

Faculty of Science

UCZL010102 EVOLUTIONARY BIOLOGY AND ETHOLOGY

(2019 admissions onwards)

Time: Three hours Max. Weight: 30

Section- A

(Answer any **eight** questions. Each question carries a weight of 1)

1. What is meant by punctuated equilibrium?
2. Comment on RNA World.
3. Define heterochrony.
4. What is co-evolution?
5. Define key stimuli.
6. What is goal oriented drive?
7. Explain lunar periodicity.
8. Comment on pheromones.
9. Define sociobiology.
10. Differentiate avoidance from tolerance behaviour

(8 x 1 = 8)

Section B

(Answer any **six** questions. Each question carries a weight of 2)

11. Write down the contributions of Margulis.
12. Explain evolution of prokaryotes
13. Comment on gene pool, gene frequency and Hardy Weinberg law.
14. Give an account on molecular evolution
15. Describe Lorenz‟s Psycho-hydraulic model of motivation
16. Explain conditioning with example
17. Give an account of navigation cues employed by animals during migration.
18. Discuss about hormones and behaviour.

(6 x 2 = 12)

Section C

(Answer any **two** questions. Each question carries a weight of 5.)

19. Write an essay on isolating mechanisms and speciation.
20. Give an account on various stages in primate evolution.
21. Explain the social organisation in primates.
22. Explain different modes of communication in ants and mammals.

(2 x 5 = 10)

M Sc. Zoology Degree (C.S.S) Examination

Second Semester Faculty of Sciences

UCZL010201 FIELD ECOLOGY

(2019 admissions onwards)

Time: Three hours Max. Weight: 30

Section- A

(Answer any **eight** questions. Each question carries a weight of 1)

1. Effect of global warming in species phenologies
2. Circadian rhythm and biological clock
3. Comment on mutualistic relationship of human with crops
4. Distinguish between deterministic extinction and stochastic extinction
5. Territoriality
6. Competitive exclusion principle
7. Different types of niches
8. Intraguild predation
9. Risk-sensitive foraging
10. Green technology

(8 x 1 = 8)

Section B

(Answer any **six** questions. Each question carries a weight of 2)

11. What are the effect of cold and hot temperature on organisms?
12. Comment on the response of animals to drought and flood
13. Comment on social parasitism
14. Discuss about the hunting tactics and adaptations
15. Write an account on different types of mutualism
16. Explain about antipredator adaptations
17. Comment on water scarcity and water conservation measures
18. What are the sources and effect of soil pollution?

(6 x 2 = 12)

Section C

(Answer any **two** questions. Each question carries a weight of 5.)

19. Discuss the characteristic properties of population
20. Write an essay on animal prey defense in natural ecosystem
21. Give an account on the responses of host to parasitism
22. Explain the biotechnological approaches to waste management

(2 x 5 =10)

M Sc Zoology Degree (C.S.S) Examination

III Semester

Faculty of Science

UCZL010204 MICROBIOLOGY AND BIOTECHNOLOGY

(2019 admissions onwards)

Time: Three hoursMax. Weight: 30

Section- A

(Answer any **eight** questions. Each question carries a weight of 1)

1. What is Slime layer?
2. Comment on culture medium.
3. Define quorum sensing.
4. What is YAC?
5. Define microinjection.
6. What is chromosome walking?
7. Explain cell culture.
8. Comment on Nif genes
9. Define nanobiosensors.
10. What is TRIPS.

(8 x 1 = 8)

Section B

(Answer any six questions. Each question carries a weight of 2)

11. Give the general characters and outline classification of bacteria.
12. Describe the bacterial cell wall.
13. Give an account on pure culture techniques.
14. Explain the role of microbes in nutrient cycling.
15. Describe the different methods of gene transfer.
16. Explain the types of PCR. Add a note on its applications.
17. Give a brief account on gene therapy.
18. Discuss about terminator gene technology.

(6 x 2 = 12)

Section C

(Answer any **two** questions. Each question carries a weight of 5.)

19. Write an essay on the various methods of sterilization.
20. Give an account on microbial interactions.
21. Explain the various sequencing methods.
22. Describe any four fermentation products.

(2 x 5 = 10)