MAHATMA GANDHI UNIVERSITY

PRIYADARSHINI HILLS
KOTTAYAM-686 560

RESTRUCTURED CURRICULUM FOR POSTGRADUATE PROGRAMME UNDER CREDIT SEMESTER SYSTEM (CSS) IN ZOOLOGY

(w.e.f. 2012 admission)

Abstract of the CSS Programme of Zoology

	Code	Course	Hours/ Week	Total Hours	Credit
Semester 1	ZY1CT01	Biosystematics and Animal Diversity	5	90	4
	ZY1CT02	Evolutionary Biology and Ethology	5	90	4
	ZY1CT03	Biochemistry	5	90	4
	ZY1CT04	Biostatistics, Computer Application and Research Methodology	5	90	4
	ZY1CP05	**Practical 1**-Biosystematics and Animal Diversity, Evolutionary Biology and Ethology, Biochemistry , Biostatistics, Computer Application and Research Methodology	5	90	3
		Total	**25**	**450**	**19**
Semester 2	ZY2CT06	Ecology- Principles and Practices	5	90	4
	ZY2CT07	Genetics and Bio-informatics	5	90	4
	ZY2CT08	Developmental Biology	5	90	4
	ZY2CT09	Biophysics, Instrumentation and Biological Techniques	5	90	4
	ZY2CP10	**Practical 2**- Ecology, Genetics and Bioinformatics, Developmental Biology, Biophysics and Instrumentation	5	90	3
		Total	**25**	**450**	**19**
Semester 3	ZY3CT11	Animal Physiology	5	90	4
	ZY3CT12	Cell and Molecular Biology	5	90	4
	ZY3CT13	Microbiology and Biotechnology	4	72	4
	ZY3CT14	Immunology	3	54	3
	ZY3CP15	**Practical 3** - Cell and Molecular Biology, Microbiology and Biotechnology	4	72	2
	ZY3CP16	**Practical 4** -Animal Physiology, Immunology	4	72	2
		Total	**25**	**450**	**19**
Semester 4	ZY4ET01	Elective - 1	5	90	4
	ZY4ET02	Elective - 2	5	90	4
	ZY4ET03	Elective - 3	5	90	4
	ZY4EP 04	Practical -I	5	90	2
	ZY4EP 05	Practical- II	5	90	2
	ZY4 Pt.22	Project	-	-	4
	ZY4Vv. 23	Viva voce	-	-	3
		Total	**25**	**450**	**23**
		Grand Total			**80**

OPTIONAL PROGRAMMES (ELECTIVES)

ELECTIVES	COURSES		
	COURSE CODE	COURSE TITLES	Theory/ Practical
A ENTOMOLOGY	ZY 4A ET01	Morphology and Taxonomy	Theory
	ZY 4A ET02	Anatomy and Physiology	
	ZY 4A ET03	Applied Entomology	
	ZY 4A EP04	Morphology, Anatomy and Taxonomy	Practical-I
	ZY 4A EP05	Insect Physiology and Applied Entomology	Practical-II
B FISHERY SCIENCE	ZY 4B ET01	Ichthyology	Theory
	ZY 4B ET02	Fishery Resources and Management	
	ZY 4B ET03	Fishery Technology	
	ZY 4B EP04	Taxonomy, Anatomy, Physiology and Pathology	Practical-I
	ZY 4B EP05	Fishery Biology and Technology	Practical-II
C ENVIRONMENTAL SCIENCE	ZY 4C ET01	Environmental Science-Concepts and Approaches	Theory
	ZY 4C ET02	Environmental Pollution and Toxicology	
	ZY 4C ET03	Environmental Management and Development	
	ZY 4C EP04	Environmental Science –I	Practical-I
	ZY 4C EP05	Environmental Science-II	Practical-II
D MEDICAL MICROBIOLOGY	ZY 4D ET01	General Microbiology and Parasitology	Theory
	ZY 4D ET02	Bacteriology, Virology and Mycology	
	ZY 4D ET03	Clinical Microbiology	
	ZY 4D EP04	General Microbiology, Parasitology and Mycology	Practical-I
	ZY 4D EP05	Bacteriology, Virology and Clinical Microbiology	Practical-II

Mahatma Gandhi University

PG Prgoramme for Credit Semester System 2011

(MGU-CSS-PG)

*Scope, Definitions, Programme Structure, Registration, Admission, Admission Requirements, Examination, Direct Grading System, Grade Card, Award of Degree etc., are given in the PG Programme Regulations for Credit Semester System 2011 as per U.O.No.5386/L/Acad/ PGCSS(R)2011/. Dated 30th September and U.O.No.6581/Ac. A-IX/2011P.G. Dated 7th December 2011.***Available at – www.mgu.ac.in**

Evaluation and Grading in Zoology

1. Evaluation

The evaluation scheme for each course shall contain two parts; (a) internal evaluation and (b) external evaluation. 25% weight shall be given to internal evaluation and the remaining 75% to external evaluation and the ratio and weights between internal and external is 1:3. Both internal and external evaluation shall be carried out using direct grading system.

(a). Internal evaluation

The internal evaluation shall be based on predetermined transparent system involving periodic written tests, assignments, seminars and attendance in respect of theory courses and based on written tests, lab skill/records/viva and attendance in respect of practical courses. The weights assigned to various components for internal evaluation are as follows.

Theory Internal Evaluation- Total weight: 10

Components	Weight
Attendance	1
*Two test paper	2+2
**Assignment	3
*** Seminar	2

Attendance

% of attendance	Grade
> or 90%	A
Between 85and 90	B
Between 80 and 85	C
Between 75 and 80	D
< 75	E

* The test paper must be a minimum of two hour duration.

** **Assignment**- One assignment for each course #. The assignment must be a written or typed 4-6 page document with proper introduction pertaining to the topic, a thoroughly referred subject matter, conclusion and all cited references in the bibliography. While assigning grade take into account the six point's *viz*., punctuality, introduction, content, conclusion, language and references **(0.5 weight for each point).**

 # During the first semester, for course 2 (ZY1CT02) instead of the course content based assignment students may submit a review of any popular book in biology as an assignment. The format and grading will be the same as given above.

*** **Seminar** – The grading of seminar shall be based on punctuality, content, style of presentation and response to questions **(0.5 weight for each component).**

Practical Internal Evaluation- Total weight: 5

Components	Weight
Attendance	1
Punctuality and Lab performance	1
Test	2
Record	1

Best of two tests/ one model per semester

Project Internal Evaluation - Total weight: 5

Suggested schedule for project work

Sl.No.	Assigned work	Time
1	Topic selection & review of literature	2nd semester
2	Introduction and methodology presentation and evaluation	3rd semester first month
3	Lab and field experiments (project work)	3rd sem. 1st month to 4th sem. 2nd month
4	Results presentation; report writing	4th sem. 3rd month
5	Final project presentation with power point	4th sem. 4th month

Components	Weight
Punctuality	1
Introduction and Methodology	1
Report and Presentation	2
Viva	1

Theory External Evaluation - Total weight: 30

Theory examination conducted at the end of every semester will be of Three hours duration
Pattern of question papers

Section	Type	No. to be Answered	Weight	Total weight=30
A	Short answer	10 out of 12	1	10
B	Short essay	5 out of 8	2	10
C	Essay	2 out of 3	5	10

Directions for question setting

While preparing the question papers for each course, make sure that the questions proportionately cover all units. Earmark 10% of the questions from the ***prerequisite*** topics suggested in each course.
Section A - question should be answered in 5 minutes duration.
Section B - question to be answered in 10 minutes duration
Section C - question to be answered in 30 minutes duration.

Practical External Evaluation - Total weight: 15. Duration 4 Hours

External Practical examination shall be conducted at the end of each semester. There will be one external examiner and one internal examiner for the conduct of the examination. Records will also be evaluated by the examiners for which the assigned weight is 1 (one). The division of the remaining 14 weights (15-1=14) will be decided by the Chairman of the Board of Examination in consultation with the Chairman of Board of Studies.

Project Evaluation and Viva voce - shall be conducted by a Board of three examiners at the end of the fourth semester, after the conduct of the practical examination. The Project-Viva Board shall have two external examiners and one internal examiner (the HoD or nominee). It can be done on the same day as per the schedule prepared by the Chairman of the Board of Examiners.

Project External Evaluation - Total weight: 15

Components	Weight
Area / Topic Selected	1
Introduction / Review	2
Objectives	1
Materials and Methods	2
Results and Discussion	3
Conclusion	1
Bibliography	1
Presentation and Viva	3+1

Comprehensive Viva voce - Total Weight: 10

The Viva board is expected to be unbiased and very fair. The questions should be subject specific and curriculum oriented. A minimum of 20-30 minutes should be allowed for each student.

Components	Weight
Questions from subject of special interest	2
Fundamentals of Biology	2
Topics covering all semesters	4
Awareness of current and advanced topics	2

SEMESTER I

ZY1CT01 BIOSYSTEMATICS AND ANIMAL DIVERSITY

ZY1CT02 EVOLUTIONARY BIOLOGY AND ETHOLOGY

ZY1CT03 BIOCHEMISTRY

ZY1CT04 BIOSTATISTICS, COMPUTER APPLICATION AND RESEARCH METHODOLOGY

ZY1CP05 PRACTICAL - 1: BIOSYSTEMATICS AND ANIMAL DIVERSITY, EVOLUTIONARY BIOLOGY AND ETHOLOGY, BIOCHEMISTRY, BIOSTATISTICS, COMPUTER APPLICATION AND RESEARCH METHODOLOGY

ZY1CT01 BIOSYSTEMATICS AND ANIMAL DIVERSITY

90 Hours (25+65) 5 hrs/week **Credit – 4**

Objectives:

- To give a thorough understanding in the principles and practice of systematics
- To help students acquire an in-depth knowledge on the diversity and relationships in animal world
- To develop an holistic appreciation on the phylogeny and adaptations in animals

BIOSYSTEMATICS 25 hrs

Module I. Biological Classification 5 hrs.

Hierarchy of categories and higher taxa. Taxonomic Procedures-collection, preservation, curetting and process of identification. Taxonomic characters of different kinds- quantitative and qualitative analysis of variation, Process of typification, different zoological types and their significance.

Prerequisite: *Fundamentals of Systematics*

Module II. Methods of Biosystematics 5 hrs.

Classical and modern methods-Typological, Phenetics, Evolutionary, Phylogenetic, Cladistics and Molecular Taxonomy.Phylocode, Tree of Life and Bar-coding of Life.

Module III. Taxonomic Publications 5 hrs.

Keys, types, use of keys, merits and demerits. International Code of Zoological Nomenclature(ICZN), Rules and formation of Scientific names of different taxa. Homonymy and Synonymy.

Ethics in taxonomy- authorship, suppression of data, undesirable practices in taxonomy.

Module IV. Concepts and Techniques in Systematics 10 hrs.

Three Domain Concept in Systematics, two, five and six kingdom classification.Concept of species-taxonomic diversity within species.

Molecular Phylogeny-use of Proteins, DNA and RNA. Phylogenetic trees.

ANIMAL DIVERSITY 65 hrs.

Module I. Introduction 3 hrs.

Origin of Protists. Prokaryotes and Eukaryotes. Levels of organization in animal kingdom.

Module II. Multi-cellularity 8 hrs.

Edicaran and Burgess Shale fauna. Cambrain explosion- causes and consequences. Cropping and Red Queen principle. Possible theories of metazoan origin.

Symmetry, Coelom and Metamerism-evolutionary advantages.

Module III. Lower Metazoans 6 hrs.

Porifera, Cnidaria-Polymorphism, Ctenophora, Acoelomata, Placozoa, Mesozoa and Pseudocoelomata-evolutionary relationships and adaptive modifications only.

Module IV. Protostomes and Deuterostomes 10 hrs.

Phylogenetic position of Molluscs, Adaptive Radiation in Molluscs and Annelids.

Phylogeny of Arthropod-Monophyly and Polyphyly, Reasons for the success of Arthropods.

Major classes under Arthropoda and adaptive radiation.

Module V. Lesser Protostomes **4 hrs.**

Sipuncula, Echiura, Phoronida, Brachipoda, Onychophora and Chaetognatha- Phylogeny only.

Module VI. Echinoderms **3 hrs.**

Classification and adaptive radiation.

Pre-requisite:*Larval forms of Annelids, Molluscs, Arthropods and Echinoderms.*
Impact of sedentary life on the organization of invertebrates.

Module VII. Hemichordates **2 hrs.**

Position in the animal kingdom, phylogeny and evolutionary significance

Module VIII. Ancestry of Chordates **9 hrs.**

Cephalochordates and Urochordates. Vertebrate Phylogeny-Agnatha, Ostracoderms and Gnathostomes-Placoderms, Acanthodians, Chondrichthyes and Osteichthyes. Structural and Functional adaptations of fishes.

Module IX. Terrestrial Vertebrates **8 hrs.**

Tetrapod phylogeny - modern Amphibians, diversity, distribution, status and threats.
Reptiles – origin and adaptive radiation. Skull of reptiles and its importance in biosystematics. Mesozoic world of reptiles and extinction.

Module X. Birds and Mammals **12 hrs.**

Origin of birds and mammals. Structural and functional modifications for aerial life. Orders under class Aves.
Class Mammalia: Prototheria, Metatheria and Eutheria. Phylogeny of Mammalian orders. Adaptive radiation in mammals.

Prerequisite **:** *Classification and characteristics of Mammalia.*

REFERENCES

Alfred, J.R.B and Ramakrishna. 2004. *Collection, Preservation and Identification of Animals*. Zoological Survey of India Publications, Calcutta.

Anderson,T.A.2001. *Invertebrate Zoology* (2nd edn). Oxford University Press, New Delhi.

Barnes, R. D.1982. *Invertebrate Zoology* (6th edn). Toppan International Co.,NY

Barrington, E. J. W. 1969. *Invertebrate Structure and Functions*. English Language Book Society.

Benton, M.J.2005. *Vertebrate Paleontology* (3rd edn). Blackwell Publishing Com.Oxford,UK.

Campbell, N.A and J.B. Reece .2009. *Biology* (8th edn). Benjamin Cummings Publ. NY,USA

David, M. H, Craig Moritz and K.M. Barbara.1996. *Molecular Systematics*. Sinauer Associates, Inc.

Hyman, L. H. 1940 –1967. *The Invertebrates* (6 vols). McGraw-Hill Companies Inc. NY

Hickman Jr., Cleveland, Larry Roberts, Susan Keen, Allan Larson, and David Eisenhour .2011. *Animal Diversity*. McGraw-Hill Companies, Inc. NY

Kapoor, V.C. 1991.*Theory and Practice of Animal Taxonomy*. Oxford and IBH Publishing Co., Pvt. Ltd. New Delhi.

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

Mayr, E .1969. *Principles of Systematic Zoology*. McGraw Hill Book Company, Inc., NY.

Mayr, E. 1997. *This is Biology: The Science of Living world*. Universities Press Ltd.

Narendran, T.C. 2008. *An introduction to Taxonomy*. Zoological survey of India.

Niles, E. 2000.*Life on earth: an Encyclopedia of Biodiversity, Ecology and Evolution* (Vol.1&II).ABC-CLIO,Inc.CA,USA

Pat, W. 1996. *Invertebrate Relationships-Patterns in Animal Evolution*.Cambridge University Press

Pechenik, J. A. 2000. *Biology of the Invertebrates* (4th edn). McGraw-Hill Companies, Inc. NY, USA.

Pough Harvey F, Christine M .Janis and John B. Heiser .2002. *Vertebrate Life* (6th edn). Pearson Education Inc. New Delhi.

Romer, A.S. and T.S. Parsons. 1985. The Vertebrate Body. (6th edn.) Saunders, Philadelphia.

Rupert E.Edward.,R.S.Fox and R.D.Barnes.2006.*Invertebrate Zoology: A Functional Evolutionary Approach.* Thomson/Cole, Singapore

Strickberger, M.W. 2005. *Evolution*. Jones and Bartett Publishers, London.

Waterman, A.J. 1971. *Chordate Structure and Function*. Macmillan Co. London

Winston, J.E.2000. *Describing species: Practical Taxonomic Procedures for Biologists*. Columbia University Press,Columbia, USA.

Young, J.Z. 1950. *Life of Vertebrates*. Clarendon Press, Oxford, UK.

■

ZY1CT02 EVOLUTIONARY BIOLOGY AND ETHOLOGY

90 Hours (55+35) **Credit- 4**

Objectives:

- To provide an understanding on the process and theories in evolutionary biology
- To help students develop an interest in the debates and discussion taking place in the field of evolutionary biology
- To equip the learners to critically evaluate the debates and take a stand based on science and reason
- To expose students to the basics and advances in ethology, and generate an interest in the subject in order to understand the complexities of both animal and human behavior

EVOLUTIONARY BIOLOGY 55 hrs.

Module I. Concepts in Evolution **10 hrs.**

Pre-Darwanian, Lamarck, Darwin and Wallace and Post Darwanian. Concepts of variation, adaptation, struggle, fitness and natural selection-spontaneity of mutation and the evolutionary synthesis. Neutral Evolution, Molecular Evolution. Neutralist versus Selectionist. Contributions of Margulis (Endosymbiotic theory), Eldredge and Gould (Punctuated equilibrium), Rose Mary and Peter Grant (Molecuar evolution in Darwinian finches). Debates in evolutionary biology.

Prerequisite: *Biography of Lamarck, Darwin and Wallace*

Module II. Origin and Evolution of Life **13 hrs.**

Origin of basic biological molecules, abiotic synthesis of organic monomers and polymers, concept of Oparin - Haldane, Miller-Urey Experiments. The RNA world. Idea of Panspermia. The First Cell. Evolution of Prokaryotes- origin of eukaryotic cells- evolution of unicellular eukaryotes, genome evolution. Anaerobic metabolism- origin of photosynthesis and aerobic metabolism.

Module III. Geological Timescale **7 hrs.**

Major events in evolutionary timescale. Anthropocene. Tools and techniques in estimating evolutionary time scale. Mass extinction and its consequences. Fossils- fossilization and its significance.

Prerequisite*: Geological time scale - eras, periods and epochs*

Module IV. Population Genetics **10 hrs.**

Gene pool, gene frequency, Hardy-Weinberg Law. Rate of change in gene frequency through natural selection, migration and random genetic drift. Founder effect. Isolating mechanisms and speciation. Micro Macro and Mega evolution. Co-evolution.

Module V. Developmental and Evolutionary Genetics **5 hrs.**

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

Module VI. Primate Evolution and Human Origins **10 hrs.**

Stages in Primate evolution- Prosimii, Anthropoidea and Hominids. Factors in human origin, hominid fossils. Cytogenetic and molecular basis of origin of man-African origin of modern man- Mitochondrial Eve, Y chromosomal Adam,- early migration,hunter- gatherer societies. Evolution of human brain-communication, speech and language. Evolution of culture.

ETHOLOGY 35 hrs.

Module 1. Introduction 3 hrs.

Historical background, Stimulus-Response, Causal factors, Quantitative aspects – Duration, interval frequency. Behaviour bouts. Darwinian Perspective on Animal behaviour, Scope of ethology, Genetic basis of behaviour.

Module II. Neurophysiological Aspects of Behaviour 3 hrs.

Reflex action, Kinesis, Taxes, Fixed action patterns. Sherrington's neuro-physiological concepts in behaviour – Latency, summation, fatigue.

Module III. Motivation 4 hrs.

Goal oriented drive, internal causal factor, Homeostatic and Non-homeostatic drives.
Hormones and behaviour, Psycho-hydrologic model of motivation.

Module IV. Learning 4 hrs.

Short and long term memory, Habituation, Classical conditioning (Pavlov's experiments), Instrumental conditioning, Latent learning, Trial and error learning, Instinct, Imprinting.

Module V. Communication 5 hrs.

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

Module VI. Reproduction and Behaviour 4 hrs.

Reproductive strategies, Mating systems, Courtship, Sexual selection- patterns, parental care and investment.

Module VII. Complex Behaviour 5 hrs.

Orientation, Navigation, Migration (Fishes and birds), Navigation cues.
Biological rhythms – Circadian, Circannual, Lunar periodicity, Tidal rhythms.
Genetics of biological rhythms.

Module VIII. Social Behaviour 5 hrs.

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

Module IX. Stress and Behaviour 2 hrs.

Adaptations to stress- basic concept of environmental stress, acclimation, acclimatization, avoidance and tolerance.

REFERENCES

Evolutionary Biology

Arthur,W. 2011. *Evolution – A Developmental Approach.* Wiley-Blackwell, Oxford,UK

Camilo J.Cela - Conde and Francisco J. Ayala. 2007. *Human Evolution-Trails from the Past*. Oxford University Press.Oxford ,UK

Campbell.B.G.2009. *Human Evolution*. Transaction Publishers, NJ, USA

Charles W. Fox and Janson B.Wolf . 2006. *Evolutionary Genetics-Concepts and Case Studies.* Oxford University Press, NY. USA

Carroll, SB. 2005. *Endless Forms Most Beautiful: The New Science of Evo-Devo*. WW Norton, New York

Cleveland P.Hickman, Jr., Larry S. Roberts and Allan Larson. 2011. *Integrated Principles of Zoology.* (11th edn.). McGraw-Hill, NY, USA.

Darwin, C.D. 1859. *On the Origin of Species by Means of Natural Selection*. John Murray, London.

Dan, G. and Li,W.H. 2000. *Fundamentals of Molecualr Evolution*. (2nd edn.). Sinauer Associates Inc. MA, USA

Elliott,Sober.2008. *Evidences and Evolution: The Logic Behind the Science*. Cambridge University Press,UK.

Futuyma,D.J.1986. *Evolutionary Biology*.(2nd edn.). Sinauer Associates Inc. MA, USA.

Gould, S,J. 2002. *The Structure of Evolutionary Theory*. Harvard University Press, MA, USA.

Hall, B.K and Hallgrimsson, B. 2008. *Strickberger's Evolution* (4th edn). Jones and Bartlett Pub.London, UK

Hall, B.K. and Olsen, W. M., (Ed). 2007. *Keywords and Concepts in Evolutionary Developmental Biology*. Discovery Publishing House, New Delhi,

Hall, B.K., Pearson, R. and Muller, G.B. 2003. *Environment, Evolution and Development: Toward a Synthesis*. MIT Press,Cambridge MA, USA

Kimura,M. 1983. *The neutral theory of molecular evolution*.Cambridge University Press

Margulis, L and Michael J. C.1998. *Kingdoms & Domains: An Illustrated Guide to the Phyla of Life on Earth* (4th edn.).W. H. Freeman and Company,USA

Richard E. M and Levin, R B.1988. *The Evolution of Sex: An Examination of Current Ideas*. Sinauer Associates Inc. MA, USA

Stearns C.S.1987. *The Evolution of Sex and its Consequences***.** Birkhäuser, Basel, Switzerland.

West- Eberhard M.J. 2003. *Developmental Plasticity and Evolution*. Oxford University Press, Oxford, UK.

Web Resources

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

Ethology

Alcock John.2009. *Animal Behaviour : An Evolutionary Approach* (8th edn). Sinauer Associates Inc. Sunderland, Massachusetts.

Aubrey Manning and Mariam Stamp Dawkins. 2000. *An Introduction to Animal Behaviour* (5th Edn). Cambridge University Press, U.K.

Eibl – Ebesfeldt, I. Hol.1970. *Ethology : The Biology of Behaviour*. Reinhart & Winston. New York.

Fatik Baran Mandal .2009.*A Textbook of Animal Behaviour*. PHI Learning Private Limited, New Delhi.

Hauser, M.1998. *The Evolution of Communication*. MIT Press, Cambridge, Mass. USA.

Jeffrey C. Hall.2003. *Genetics and Molecular Biology of Rhythms in Drosophila and other Insects.* Elsevier Science, USA.

Judith Goodenough, Betty McGuire .2010. *Perspectives of Animal Behaviour*. John Wiley & Sons Inc. USA

Krebs, J. R. and N.B. Davis.2000. *An Introduction to Behavioral Ecology.* Blackwell Scientific Publications, Oxford.

Lee Alan Dugatkin .2009. *Principles of Animal behaviour* (2nd edn). W.W. Norton and Company.

Lee C. Drickamer, Stephen H.Vessey, Elizabeth Jakob.2002. *Animal Behaviour –Mechanisms, Ecology, Evolution* (5th edn).McGraw-Hill Publishing Company, New York

Macfarland, D1998. *Animal Behaviour – Psychobiology, Ethology and Evolution*. Pitman publication Ltd. London.

Scott,Graham.2005. *Essential animal behavior*. Blackwell Publications Company, Oxford ,UK

Thorpe, W.H.1979.*The origins and rise of Ethology.* Heinmann Educational Books, London.university press, U.K.

Wilson, E.O.2000. *Sociobiology: The new synthesis.* Harvard Univ. Press, Cambridge, Mass. USA.

Web Resources

www.animalbehavioronline.com/modestable.html

■

ZY1CT03 BIOCHEMISTRY

90 Hours (5hrs/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

Module I. Introduction **2 hrs.**

Atoms, molecules and chemical bonds. Water: biological importance, pH and acid - base balance. Buffers - biological importance.

Module II. Carbohydrates **10 hrs.**

Monosaccharides: Classification and nomenclature**,** Biological importance, Structural representations of sugars-Acetal and hemiacetal, ketal and hemiketal linkages, Glucose, fructose, galactose, mannose and ribose. Isomerism – structural isomerism and stereoisomerism, optical isomerism, epimerism and anomerism. Mutarotation and inversion of sugars.

Reactions of monosaccharides: Oxidation, reduction, ester formation, osazone formation.

Glycosidic bond.

Disaccharides: Sucrose, Lactose, Maltose, Isomaltose, Cellobiose and Trehalose.

Polysaccharides**:** Homopolysaccharides- Starch, Glycogen, Cellulose, Chitin, Dextrans, Inulin, Pectin. Heteropolysaccharides- Hyaluronic acid, Heparin, Chondroitin sulphate, Keratan sulphate, Dermatan sulphate and Agar-agar. Glycoproteins and Mucoproteins.

Module III. Proteins **10 hrs.**

Structure, classification and properties of amino acids. Amphoteric properties of amino acids, p*K* value and iso-electric point of amino acids. Peptide bond formation and peptides. Reactions (due to carboxyl group, amino group and side chains). Colour reactions of amino acids and proteins.

Primary structure of protein (*e.g.* insulin).

Classification and properties of proteins. Conformation of proteins- chemical bonds involved, Secondary structure- Alpha helix, Collagen helix, Beta pleated sheet, Ramachandran angles and Ramachandran map. Fibrous proteins- examples (Keratin, Collagen, Elastin, Resilin, Fibrous muscle proteins). Chaperons. Tertiary structure- *e.g.* Myoglobin. Quaternary structure – *e.g.* Haemoglobin.

Module IV. Lipids **10 hrs.**

Classification of lipids: simple, compound and derived lipids. Biological importance of lipids.

Fatty acids: classification, nomenclature.

Simple fats: Triacylglycerol (Triglycerides) - Physical properties. Reactions-Hydrolysis, Saponification, Rancidity. Acid number, Saponification number, Iodine number, Polenske number and Reichert-Meissl number of lipids. Waxes.

Compound lipids: Phospholipids- Lecithin, Phosphatidyl inositol, Cephalins, Plasmologens.

Glycolipids, Sphingolipids. Derived Lipids, Steroids: Biologically important steroids-cholesterol, Vitamin D, Bile acids, Ergosterol, Terpenes, Lipoproteins.

Prostaglandins- structure, types, synthesis and functions.

Module V. Nucleic Acids **10 hrs.**

Structure of nucleic acids and nucleotides: Structural organization of DNA (Watson –Crick model) Characteristic features of A, B, C and Z DNA. Structural organization of tRNA; Protein-nucleic acid

interaction. DNA regulatory proteins, folding motifs, conformation flexibilities, denaturation, renaturation, DNA polymerases, Restriction endonucleases. Biological roles of nucleotides and nucleic acids.

Module VI. Enzymes **10 hrs.**

Classification- (I.U.B.system), co-enzymes, iso-enzymes, ribozyme. Enzyme specificity. Mode of action of enzymes. Formation of enzyme substrate complex. Lowering of activation energy, Various theories, Active site.

Enzyme kinetics: Michaelis-Menten equation. Km value and its significance. Enzyme velocity and factors influencing enzyme velocity. Kinetics of enzyme inhibition, suicide inhibition and feedback inhibition.

Enzyme regulation: Allosteric regulations- Key enzymes, Covalent modification. Enzyme engineering**.**

Module VII. Carbohydrate Metabolism **12 hrs.**

Major metabolic pathways- Glycolysis – Fate of pyruvate. Citric acid cycle and its significance; Central role of citric acid cycle. Oxidative and substrate level phosphorylation. Gluconeogenesis, Cori cycle.

Glycogen metabolism**-** Glycogenesis, Glycogenolysis, 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. Inborn errors associated with carbohydrate metabolism. Glycogen storage diseases,Lactose intolerance, Galactosuria.

Module VIII. Metabolism of Proteins **10 hrs.**

Amino acid metabolism-Deamination, Transamination and Trans-deamination. Formation and disposal of ammonia. Urea cycle. Fate of carbon skeletons of aminoacids: glucogenic, ketogenic, partly glucogenic and ketogenic with examples. Synthesis of biologically significant compounds from different aminoacids with special reference to glycine, glutamic acid, phenylalanine, tyrosine and tryptophan.

Module IX. Metabolism of Lipids **8 hrs.**

Beta oxidation, alpha oxidation and omega oxidation of fatty acids. *De novo* synthesis of fatty acids. Metabolism of cholesterol, synthesis and its regulation. Biosynthesis of triglycerides. Metabolism of ketone bodies - Ketogenesis, Ketolysis, Ketosis.

Module X. Nucleic Acid and Mineral Metabolism **8hrs.**

Catabolism of purines and pyrimidines.

Major and minor nutrients.Role of Calcium, Phosphorus, Magnesium, Sodium, Potassium, Chloride, Sulphur and Iron.

Free radicals and antioxidants, Generation of free radicals. Reactive oxygen species. Free radical scavenger systems. Lipid peroxidation. Preventive antioxidants.

REFERENCES

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.

Eric E. Conn, Paul K. Stumpf, George Bruening, Roy H. Doi. 2007. *Outlines of Biochemistry*. (5th edn). John Wiley &Sons Inc., NY.

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.

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.

Keith Wilson and John Walker. 2008. *Principles and Techniques of Biochemistry and Molecular biology*(6th edn). Cambridge University Press, UK.

Murray, K., Granner, D.K., Maynes, P.A and V.W.Rodwell. 2006. *Harper's Biochemistry* (25th edn). McGraw Hill, New York, USA.

Oser, B.L.1965. *Hawk's Physiological Biochemistry*. Mc Graw Hill Book Co. New Delhi.

Palmer Trevor. 2001.*Enzymes: Biochemistry,Biotechnology & Clinical chemistry*. Horwood Publ .Com., England.

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.

Vasudevan, D.M. and S.Sreekumar. 2000. *Text of Biochemistry for Medical Students*. Jaypee Brothers, Medical Publishers (P) Ltd. New Delhi

Voet, D. and J.G. Voet.2004. *Biochemistry*. John Wiley & Sons.,NY.

Zubay, G.1989. *Biochemistry*. McMillan Publishing Co., New York.

■

ZY1CT04 BIOSTATISTICS, COMPUTER APPLICATION AND RESEARCH METHODOLOGY

90 Hours (40+30+20) **Credit-4**

Objectives:

- To impart concepts, generate enthusiasm and make awareness about the tools/gadgets and accessories of biological research
- To equip the learner to carry out original research in biology
- To help the students to improve analytical and critical thinking skills through problem solving
- To provide hands on training in the use of various tools and techniques suggested in the course

BIOSTATISTICS 40 hrs.

Module 1.Basics of Biostatistics 6 hrs.

Steps in Statistical Investigation, Data and Variable (Collection, Types, Sources).
Population, Sample, Sampling Methods (Random, Cluster, Stratified and Geographical) and Sampling Errors/Bias.
Organization of Data - Editing, Classification, Tabulation (forming a frequency distribution from raw data and types and characteristics of a Frequency table).
Presentation of Data - Types and Characteristics of Tables and Visual aids – Graphs, Charts, Diagrams, Flow charts, Cartographs.
Statistical Analysis Tools - Parametric and Non-Parametric; Bivariate and Multivariate Analysis.
Interpretation and Forecasting.
Prerequisite: *Statistics and Biostatistics – scope and significance.*

Module II. Measures of Central Tendency 4 hrs.

Introduction, Characteristics, Merits and Demerits of Mean, Median and Mode.
Calculations/Problems for different data (raw, frequency table).
Harmonic and Geometric Mean (Brief account only).

Module III. Measures of Dispersion 5 hrs.

Introduction, Characteristics, Merits and Demerits of Range, Quartile Deviation, Mean Deviation and Standard Deviation. Calculations/Problems for frequency table.
Standard Error and Relative Measures of Dispersion, Skewness and Kurtosis (Brief account only).

Module IV. Correlation Analysis 3 hrs.

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

Module V. Regression Analysis 7 hrs.

Regression and Line of Best Fit , Types and methods of regression analysis.
Graphic Methods (Scatter method, Curve fitting). Algebraic method (Fitting of strait line through regression equation).
Probit Analysis (Brief account only), Mathematical Models in Biology (Brief account only).
Length - Weight Relationship. Von- Bertalanffy's Growth (VBG) Model.

Module VI. Theory of Probability **4 hrs.**

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

ModuleVII. 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 (Problem for 2×2 table only).
Student's 't' test (Problem for small samples comparing mean of two variable).
F-test and Analysis of Variance (ANOVA - One way) (Brief account only).
Non-parametric tests: Mc Nemar and Mann Whitney U test (Brief account only).

Module VIII. Vital Statistics **4 hrs.**

Introduction, uses, records and system of classification of vital statistics.
Sample registration system, Sample design, Survey of causes of death and Age classification.
Measures of Vital Statistics and Measures of Population (Mortality rates, Fertility rates).
Life tables (Brief account only).

COMPUTER APPLICATIONS 30 hrs.

Module I. Basics of Computers **6 hrs.**

Types of Computers. Binary Number System, Digital and Analog systems.
Hardware/Software/Firmware. Basics of Computer Functioning- Booting; Formatting;
File, File Extensions; Temporary Files; Folder; GUI, Icon; Installation of Programs, Commands, Bios-setup, Date and Time, Memory Partitions, Registry, Default Operations; Defragmentation (Brief account only).
Prerequisite: *Basics of Computers (Characteristics, History and Generations, Components and Organization).*

Module II.Hardware Basics **7 hrs.**

Memory -Classification and Types of memory; memory devices; Units.
Input Devices -Types, working and functions. Output Devices –Types, working and functions.
CPU components - Processors, Mother boards, SMPS, Accessory Cards – Graphic /Sound/ Networking/ Bluetooth/Wifi (Brief account only).
New Generation Computers - Servers, Laptop; Palmtop; Cyborgs; Robotics, Zoobotics (Brief account only).

Module III. Software Basics **7 hrs.**

System Software/Operating System -System Files; Working of OS; DOS, Widows, Linux and UNIX (Brief account only).
Application Software -Programs and Packages, Calculator, MS Paint, MS Word, MS Excel, MS PowerPoint, Publisher, Acrobat Reader, E Book Reader, Explorer, Photoshop.
Virus and Antivirus (Brief account only).
Statistical Software (MS Excel, PH Stat, SPSS).
Databases -MS Access (Brief account only).

Module IV. Computer Language and Programming **5 hrs.**

Computer language -Classification and types, HTML, C and Java
Programming concepts -Algorithm, Codes (Brief account only).

Module V. Networking, Internet and Information Technology **5 hrs.**

Computer Communication -Network Topology, Media of networking, Networking Protocols, PAN, LAN, WAN, MAN, INFLIBNET, Modem and Gateway.

Internet and Internet Services -World Wide Web, Uploading, Downloading, Hosting, Portal, Search Engines, Firewall.

Global Information System -BIOSIS, Medline and Medlars, AGRIS; E Journals and E Books Publishing.

Cyber Crime and Cyber Laws (Brief account only).

RESEARCH METHODOLOGY 20 hrs.

Module I. Science and Life Sciences **2 hrs.**

Basic concepts - Knowledge, Information and Data - Science, Pseudoscience.

Life Science - Definition, Laws, Characteristics.

Scientific temper, Empiricism, Rationalism and Units of measurements.

Module II. Concepts of Research **4 hrs.**

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 and scientific method. Research Process.

Module III. 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 reviewing in defining a problem, Critical literature review, Identifying gap areas from literature review.

Hypothesis -Null and alternate hypothesis and testing of hypothesis -Theory, Principle, Law and Canon.

Module IV. Research Designs **4 hrs.**

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

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

Data collection techniques.

Module V. Scientific Documentation and Communication **3 hrs.**

Project proposal writing, Research report writing (Thesis and dissertations, Research articles, Oral communications).

Presentation techniques - Assignment, Seminar, Debate, Workshop, Colloquium, Conference.

Module VI. Information Science, Extension and Ethics **3 hrs.**

Sources of Information -Primary and secondary sources.

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

Internet -Search engines and software, Online libraries, e-Books, e-Encyclopedia, TED Talk, Institutional Websites.

Intellectual Property Rights - Copy right, Designs, Patents, Trademarks, Geographical indications.

Safety and precaution - ISO standards for safety, Lab protocols, Lab animal use, care and welfare, animal houses, radiation hazards.

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

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

REFERENCES

Ahuja,V.K. 2010. *Law of Copy Rights and Neighbouring Rights : National and International Perspectives.*.Lexis Nexis- Butterworths Wadhwa, Nagpur

Ahuja,V.K. 2007. *Law Relating to Intellectual Property Rights*. Lexis Nexis-Butterworths Wadhwa, Nagpur.

Anitha Goel.2010. *Computer Fundamentals*. Pearson Education India.

Bailey,N.T.J. 1994. *Statistical Methods in Biology* (3rdedn). Cambridge University Press.

Bright Wilson. 1990. *An Introduction to Scientific Research*. Dover Publications. NY.

Chap T.Le.2003.*Introductory Biostatistics*. John Wiley &Sons, NJ, USA.

Clough,P.and C.Nutbrown.2002. *A Student's Guide to Methodology: Justifying Enquiry*. Sage, London.

Daniel, W.W. 2006. *Biostatistics: A Foundation for Analysis in the Health Sciences* (7th edn). John Wiley & Sons, New York.

Dharmapalan, Biju. 2012. *Scientific Research Methodology*. Narosa Publishing House, New Delhi

Finney ,D.J. 1980.*Statistics for Biologists*. Chapman and Hall, London

Frank, Harry and Steven C. Althoen, 1995. *Statistics: Concepts and Applications*. Cambridge University Press

Glenn McGee.2003. *Pragmatic Bioethics*. The MIT Press, MA, USA

Jeremy R. Garret.2012. *The Ethics of Animal Research*. The MIT Press, MA. USA

Kothari C.R., 2009. *Research Methodology: Methods and Techniques* (2ndedn.). NewAge International Publishers, New Delhi.

Pagano, M and K.Gauvreau. 2000. *Principles of Biostatistics*. Brooks/Cole, CA, USA

Paul Oliver.2005. *Writing Your Thesis*. Vistaar Publications.New Delhi.

Peter Medawar.1979. *Advice to Young Scientist*. Harper and Row, London.

Phillippe Cullet.2005. *Intellectual Property Protection and Sustainable Development.* Lexis Nexis-Butterworths Wadhwa, Nagpur

Prabhakara ,G.N. 2006.*Biostatistics*.Jaypee Bro. New Delhi

Pradeep Sinha and Priti Sinha.2010.*Computer Fundamentals*. BPB Publications., New Delhi

Rajathi A. and P. Chandran, 2010. *SPSS for You*. MJP Publishers, Chennai.

Shane Torbert.2011. *Applied Computer Science*. Springer-verlag, New York.

Sudipto Das.2010. *A Complete Guide to Computer Fundamentals*. Lakshmi Publishers (P) Ltd. New Delhi

Sundar Rao,P.S.S and J.Richard.2006.*Introduction to Biostatistics and Research Methods* (4th edn). Prentice Hall, New Delhi.

WHO.2011. *Laboratory Quality Standards and Their Implementation*. WHO Regional Office. New Delhi.

Zar, Jerrold H. 2008. *Biostatistical Analysis* (3rdedn.). Pearson Education Inc., New Delhi.

■

ZY1CP05 PRACTICAL 1: BIOSYSTEMATICS AND ANIMAL DIVERSITY, EVOLUTIONARY BIOLOGY AND ETHOLOGY, BIOCHEMISTRY, BIOSTATISTICS, COMPUTER APPLICATION AND RESEARCH METHODOLOGY

90 Hours (5hrs./week) **Credit-3**

Biosystematics and Animal Diversity, Evolutionary Biology and Ethology

Study of museum specimens - 70 invertebrates and 30 vertebrates (List the studied items with brief descriptions. Diagrams not necessary).
Larval forms – any 10 larvae from different taxa
Study of the skull of vertebrates - Varanus, Crocodile, Bird, Dog, Rabbit/ Rat
Preparation of dichotomous key of 4 specimens up to family (insects/spiders/ fishes/ snakes of any three taxa).
Preparation of Cladogram based on the specimens provided (at least five museum specimen).
Calculating gene frequencies and genotype frequencies in the light of Hardy-Weinberg Law in human/ other populations.
Study of fish in response to three temperatures (Normal and + 5^0C) of water in a microenvironment and preparation of an ethogram
Study of the grooming behaviour in insects/bird

Biochemistry

Quantitative estimation of blood glucose by Folin-Wu/Anthrone /DNS/O-Toluidine/Enzymatic method
Estimation of proteins by Biuret/ Lowry *et al.* method
Quantitative estimation of blood urea/ creatine/ uric acid
Quantitative estimation of cholesterol in the blood
Estimation of alkaline and acid phosphatases

Biostatistics

(Problems can be solved using scientific calculator).
These exercises can be done as assignments of the theory sessions
Calculation of mean, median and mode from grouped data
Calculation of mean deviation and standard deviation from grouped data
Calculation of Pearson correlation coefficient.
Calculation of regression coefficient and regression equation ('x' on 'y' only)
Calculation of length-weight relationship
Calculation of 'Z' value (small sample only)
Calculation of Chi square value (2×2 table only)
Calculation of 't' value (for small sample comparing two variable)
Draw line graph, vertical bar diagram, horizontal bar diagram, histogram, frequency polygon, frequency curve, pie diagram and ogives on graph paper for simple grouped data.

Computer Applications

MS Excel: Preparation of table
MS Excel: Preparation of graphs (bar, pie and ogives)
MS Excel: Formula writing (Addition, Subtraction, Multiplication, Division, Power and Root)
MS Excel: Correlation Analysis
MS Power Point: Preparation of a presentation with minimum 5 slides based on First Semester theory topics

PH Stat: Basic statistics (mean, median, mode, standard deviation)
PH Stat: Chi square test
PH Stat: Students t test
PH Stat : Regression

■

SEMESTER II

ZY 2CT06	ECOLOGY: PRINCIPLES AND PRACTICES
ZY 2CT07	GENETICS AND BIO INFORMATICS
ZY2CT08	DEVELOPMENTAL BIOLOGY
ZY2CT09	BIOPHYSICS, INSTRUMENTATION AND BIOLOGICAL TECHNIQUES
ZY2CP10	PRACTICAL - 2: ECOLOGY,GENETICS AND BIO-INFORMATICS, DEVELOPMENTAL BIOLOGY, BIOPHYSICS, INSTRUMENTATION AND BIOLOGICAL TECHNIQUES.

ZY 2CT06 ECOLOGY: PRINCIPLES AND PRACTICES

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

Objectives:

- To provide an understanding on the basic theories and principles of ecology
- To help study various disciplines in ecology
- To learn current environmental issues based on ecological principles
- To gain critical understanding on human influence on environment

Module I. Ecology and Environment **15 hrs.**

Physical Environment- biotic and abiotic interactions. Concept of Homeostasis;Concepts of habitats-host as habitat, niche, niche width and overlap, fundamental and realized niche, resource partitioning, character displacement.

Cybernetic nature of ecosystem, stability through feedback control and through redundancy of components; resistance and resilience stability.Gaia hypothesis.

Concept of limiting factors- Liebig's law, Shelford's law.

Ecological indicators.

Prerequisite: *Definition, history and scope of ecology, sub divisions of ecology, Ecology Vs Environmental science.*

Module II. E**cosystem - Structure and Function** **15 hrs.**

Ecosystem and Landscapes, pathways in ecosystem, energy in the environment-Laws of thermodynamics, energy flow in the ecosystem. Primary productivity, Biomass and productivity measurement.Food chain, food web, trophic levels. Ecological efficiencies, Ecological pyramids,Biogeochemical cycles- patterns and types (CNP).

Tropical versus Temperate Ecology.

Module III. Population Ecology **15 hrs.**

Population group properties, density and indices of relative abundance,Concept of rate.

Natality and mortality. Population age structure, Growth forms and concept of carrying capacity.

Population fluctuations, density dependent and density independent controls.Life history strategies, *r & k* selection.

Population structure, aggregation, Allee's principle, isolation, dispersal and territoriality.

Population interactions- types, positive and negative, interspecific and intraspecific interactions.Ecological and evolutionary effects of competition.

Concept of metapopulation. Levin's model of metapopulation. Comparison of Metapopulation and Logistic population model. Metapopulation structure.

Module IV.Community Ecology **10 hrs.**

Concept of community - community structure and attributes, ecotone and edge effect.Development and evolution of the ecosystem, concept of climax.Species diversity in community and it's measurement-Alpha diversity,Simpson's diversity index, Shannon index, Fisher's alpha, rarefaction. Beta diversity-Sorensen's similarity index,Whittaker's index, Evenness, Gamma diversity, Guild and its functioning in the community.

Drivers of species diversity loss and conservation.

Prerequisite:*Community interactions*

Module V. Resource Ecology **15 hrs.**

Natural Resources: Soil-soil formation, physical and chemical properties of soil. significance of soil fertility.Mineral resources with reference to India. Impact of mining on environment; Forest resources-deforestation,forest scenario of India. Aquatic resources - Freshwater and water scarcity, water conservation measures - case studies from India; Wetlands and its importance, international initiatives for wetland conservation - Ramsar sites. Sand mining and its impacts. Wetland reclamation- causes and consequences. Depletion of resources and impacts on quality of life.

Energy Resources- solar, fossil fuels, hydro, tidal, wind, geothermal and nuclear.Energy use pattern in different parts of the world, recent issues in energy production and utilization; Energy audit, Green technology and sustainable development.

Ecosystem monitoring- GIS, Physics of remote sensing, role of remote sensing in ecology,
GPS and its application; EIA- tools and techniques, Ecosystem Modelling (Brief account only).

Module VI. Applied Ecology **10 hrs.**

Environmental Pollution-types, causes and consequences.Concept of waste, types and sources of solid wastes including e-waste; Environmental biotechnology and solid waste management- aerobic and anaerobic systems. Concept of bioreactors in waste management. Liquid wastes and sewage. Bioremediation- need and scope of bioremediation in cleaning up of environment. Phytoremediation, bio-augmentation, biofilms, biofilters, bioscrubbers and trickling filters.

Radiation Biology - natural and man-made sources of radioactive pollution; radioisotopes of ecological importance; effects of radioactive pollution; nuclear disasters (two case studies), Disposal of radioactive wastes.

Toxicology- Principles, toxicants- types, dose and effects, toxicity of heavy metals.

Module VII. Biogeography and Conservation **10 hrs.**

Major terrestrial Biomes, theory of island biogeography, bio-geographical zones of India; Western Ghats and its significance.

Principles and major approaches to conservation and environmental management.Role of UN- conventions, protocols; Climate change and the emerging discussions – mitigation and adaptation; Role of UNFCC and IPCC. Country specific laws- mention major environmental/ conservation laws and rules in India-Wildlife Protection Act 1972 amended 1991, Forest Conservation Act, 1980, Air (Prevention and Control of Pollution) Act 1981, Water (Prevention and Control of Pollution) Act 1974, amended 1988, The Environment Protection Act, 1986 and Rules, 1991. The Biological Diversity Act 2002, Rules 2004.

Restoration Ecology- need and policies, case studies and success stories - global and national;

Global environmental problems and debates - past and present; Participatory resource management, community reserves, sacred groves, biovillages.

Role of Intergovernmental and Non-governmental organizations in conservation-IUCN, WCMC,WRI,WWF, CI and Green Peace.National and Local NGOs**.**

Prerequisite: *Ecological foot print, carbon footprint, carbon credit and eco-taxes.*

REFERENCES

Abbasi, S.A. and Ramasami, E.V.1998.*Biotechnological Methods of Pollution Control*. Oxford University Press, Hyderabad.

Benton, A.H. and Werner, W.E. 1976. *Field Biology and Ecology.* Tata McGraw Hill, New Delhi.

Boitani, L and T.K.Fuller.2000.*Research Techniques in Animal Ecology*. Columbia University Press, USA

Daniel,C.D. 2010.*Environmental Science*.(8thedn).Jones and Bartlett Publishers.

Mani,M.S. *Ecology and Biogeography in india*.1974. Dr.W. Junk, The Hague.

Misra, S P and Pandey S. N.2009. *Essential Environmental Studies*. Ane BooksPvt. Ltd.

Odum, E P .1996.*Fundamentals of Ecology*. W.B Saunders College Publishing, Philadelphia.

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.

Rana,S.V.S. 2009.*Essentials of Ecology and Environmental Science*.(4thedn.). PHI learning Pvt. Ltd., New Delhi

Simons, I.G. 1981. *Ecology of Natural Resources.* Edwin-Arnold Ltd., London.

Tietenberg, T.2004.*Environmental and Natural Resource Economics*.(6thedn.). Pearson, New Delhi.

Tyler, M. G. 2007. *Living in the Environment.*(15thedn). Thomson Brooks/cole, NewYork.

■

ZY2CT07 GENETICS AND BIO INFORMATICS

90 Hours (65+ 25) **Credit: 4**

Objectives:

- To give an in-depth understanding on the principles and mechanisms of inheritance
- To help study the fine structure and molecular aspects of genetic material
- To provide an opportunity to learn the importance of inheritance in Man
- To expose the learners to the emerging field of bioinformatics and equip them to take up bioinformatics studies

GENETICS 65 hrs.

Module I.Principles of Genetic Transmission 5 hrs.

Extension of Mendel's principles: allelic variation and gene function- incomplete dominance and co-dominance.Gene action-from genotype to phenotype-penetrance and expressivity, gene interaction-epistasis, pleiotropy, genomic imprinting, phenocopy.

Prerequisite: *Mendel's works and Mendelian Principles*

Module II.Molecular Organization of Chromosomes 6 hrs.

Genome size and C-value Paradox.Structure of eukaryotic chromosome,nucleosome model. Chromosome condensation - euchromatin and heterochromatin. Repetitive nucleotide sequences in eukaryotic genomes, kinetics of renaturation: Cot and Cot curve.Unique and repetitive sequences.Mini and micro satellites.Molecular structure of centromere and telomere.Polytene chromosomes and Lampbrush chromosomes.Chromosome banding techniques.

Prerequisite**:** *Sex determination,sex linkage, sex limited and sex influenced characters in Man*

Module III. Gene Fine Structure 10 hrs.

Evolution of the concept of gene function and structure.The definition of gene. The standard genetic code, redundancy and Wobble.DNA Structure- alternate forms of the Double Helix.Gene synthesis (in vitro synthesis) – works of Khorana and Kornberg. Modern findings on the nature of gene: Interrupted genes in eukaryotes, exons and introns-R loops, significance of introns. Genes-within-genes (overlapping genes) Bacteriophage Ö X174.

Transposable elements in Bacteria –IS elements, composite transposons, Tn3 elements,medical significance.Transposable elements in Eukaryotes-P elements, Retrotransposons, significance of transposons.

Prerequisite:*Works of Watson and Crick and Experiments by B. MacClintock*

Module IV. Genetic Linkage, Recombination and Chromosome Mapping 12 hrs.

Chromosome theory of heredity, Linkage and recombination of genes in a chromosome, crossing over as the physical basis of recombination, Stern's Experiment; molecular mechanisms of recombination (Holliday model), Gene conversion, Recombination mapping with two-point and three –point test cross in *Drosophila*, Coincidence and Interference.

Genetic mapping by tetrad analysis in *Neurospora*.Mitotic recombination.

Genetic recombination in Phage, rII locus, complementation test, deletion mapping, conjugation mapping, mapping by interrupted mating, mapping with molecular markers and mapping using somatic cell.

Prerequisite:*Recombination in bacteria- transformation, transduction, conjugation and sex- duction.*

Module V. Gene Mutation **6 hrs.**

Molecular basis of gene mutation; mutant types- lethal, conditional, biochemical, loss of function, gain of function, germinal verses somatic mutants. Induced mutation, The Ames test for mutagen/carcinogen detection.

DNA damage and repair mechanisms

Prerequisite: *Chromosomal mutations – structural, numerical and genetic implications.*

Module VI. DNA Replication **9 hrs.**

The Meselson-Stahl experiment, semi conservative replication of DNA in chromosomes,Theta replication, rolling-circle replication,molecular mechanisms of eukaryotic replication.

Module VII. Human Genetics **5 hrs.**

Karyotype, pedigree analysis, Lod score for linkage testing, genetic analysis of complex traits - complex pattern of inheritance, quantitative traits, threshold traits; human genome and mapping.

Pre requisite: *Chromosome anomalies : autosomal and sex chromosomal disorders.*

Module VIII. Extra Chromosomal Inheritance **2 hrs.**

Inheritance of mitochondrial and chloroplast genes, maternal inheritance.

Module IX. Epigenetics **5 hrs.**

Epigenetics - from phenomenon to field, a brief history of epigenetics - overview and concepts; chromatin modifications and their mechanism of action, concept of 'histone-code' hypothesis, epigenetics in *saccharomyces cerevisiae,* position effect variegation, heterochromatin formation and gene silencing in *Drosophila.*

Module X. Quantitative and Population Genetics **5 hrs.**

Polygenic inheritance, analysis of quantitative traits, quantitative traits and natural selection, estimation of heritability, QTL mapping, genotype-environment interactions, molecular analysis of quantitative traits, phenotypic plasticity .

BIOINFORMATICS 25 hrs.

Module 1.Introduction to Bioinformatics **2 hrs.**

Definitions of bioinformatics, applications of bioinformatics and scope of bioinformatics.

Module II. Biological Databases **7 hrs.**

Primary databases - Nucleotide sequence databases: GenBank, EMBL, DDBJ ; Protein sequence databases: SWISSPROT, PIR; Structure databases: PDB, NDB; Secondary databases: PROSITE, Pfam, CATH; Composite databases: OWL; Literature database: PubMed; Database searching – Entrez; Database sequence submission – BankIt.

Module III.Sequence Analysis **6 hrs.**

Types of sequence alignment, methods of sequence alignment, scoring schemes, gaps and gap penalties, construction of phylogenetic trees.

Module IV.Genomics and Proteomics **7 hrs.**

Structural genomics, functional genomics, comparative genomics, data mining in proteomics – Microarrays, significance of proteomics and drug design.

Module V. Systems Biology **3 hrs.**

Introduction , metabolomics, gene network, synthetic biology.

REFERENCES

Genetics

Brooker , 1999. *Genetics: Analysis and Principles*. Addison- Wesley, NY.

David Allis and Thomas Jenuwein, 2007.*Epigenetics*.Cold Spring Harbor Laboratory Press.

Hartl, D.L. 2000.*A Primer of Population Genetics*.Suinuaer Associate, Inc, Massachusetts.

Gardner. J.E.,Simmons, J.M and D.P.Snustad.2007. *Principles of Genetics* (8thedn). John Wiley,India.

Gilbert, S.F. 2006.*Developmental Biology* (9th edn).Sinauer Associates, Inc., Publishers, Masachusettes.

Griffiths *et al.,* 2002. *Modern Genetic Analysis*.W.H. Freeman, NY, USA.

Hartl, L.D., and E.W. Jones.2009.*Genetics:Analysis of Genes and Genomes* (7thedn). Jones & Bartlett Pub.,Inc. MA,USA.

Herskowiz I.H, 1977. *Principles of Genetics* .Collier Macmillan.

Lewin B, 2008 .*Genes* (9thedn). Jones and Barlett Publishers Inc.

Klug, W.S. and Michael R. Cummings, 2009.*Concept of Genetics.*Pearson Education.Inc.

Russel,J,P., 2010. *Genetics*.Pearson International Edn.

Snustard,P and M. J. Simmons, 2010. *Principles of Genetics*. John Wiley and Sons

Strickberger, M.W.1968.*Genetics*. Macmillan Publishing Co.

Watson *et al.,* 2004. *Molecular Biology of Gene* (5thedn.). Pearson Education Inc.

Bioinformatics

Alberghina,L and H.V. Westerhoff (Eds).2008. *Systems Biology-Definitions & Perspectives*. Springer-Verlag, Berlin.

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

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

Lesk A. M, 2005. *Introduction to Bioinformatics*. Oxford Press, New Delhi

Pengcheng Fu and Sven Panke, (Eds.) 2009. *Systems Biology and Synthetic Biology*. John Wiley & Sons, Inc. NJ,USA

Tisdall J. D, 2001. *Beginning Perl for Bioinformatics*.O'Reilly Media Inc.CA,USA

Masaru Tomita and Takaai Nishioka, 2005. *Metabolomics.The Frontier of Systems Biology*. Springer Japan.

■

ZY2CT08 DEVELOPMENTAL BIOLOGY

90 Hours (5hrs/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. Introduction: Basic Concepts of Development **14 hrs.**

Potency of embryonic cells, Commitment, Specification (Autonomous and Conditional), Induction, Competence, Determination and Differentiation, Morphogenetic gradients, Cell fate and cell lineages.Genomic equivalence and Cytoplasmic determinants.

Module II. Gametogenesis,Fertilization and Early development **12 hrs.**

Spermatogenesis,Oogenesis.Fertilization-(biochemical and molecular aspects), Polyspermy. Mechanisms and significance of cleavage.Blastulation and Gastrulation, Parthenogenesis.

Module III. Early Development of Model organisms **5 hrs.**

Early development and axis specification in *Caenorhabditis elegans.* Early development and axis specification in *Drosophila* (cleavage, midblastula transition, gastrulation).

Module IV. Axis and Pattern Formation in Animals **15 hrs.**

Anterior-posterior patterning in *Drosophila*(Maternal effect genes,zygotic genes, gap genes, pair rule genes,segment polarity genes; homeotic selector genes,realisator genes),Dorsal-ventral patterning and left right patterning, Dorsal protein gradient.

Axis formation in amphibia -Anterior-posterior patterning in Amphibia.Hox code hypothesis.

Module V. Cellular Interactions in Development **14 hrs.**

Nieuwkoop centre and mesodermal polarity. Molecular basis of mesoderm induction. Transcription factors induced in the organizer. Neural induction, Regional specificity of induction, Genetic specificity of induction (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.

Module VI. Differential Gene Expression **13 hrs.**

Differential gene transcription - exons and introns, promotors, silencers, enhancers, transcription factors, DNA methylation, genomic imprinting, dosage compensation, differential RNA processing;

Control of gene expression: translational and post translational control of gene expression.

Module VII. 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; Bone and neural regeneration (Medical -Advances in regeneration).

Module VIII. Teratogenesis **4 hrs.**

Malformations and disruptions,Gene – phene relationship, Autophene, Allophene and Pleiotrophy; Teratogenic agents (Retinoic acid, pathogens, alcohol, drugs and chemicals, heavy metals); Environmental oestrogens.

Module IX. Human Welfare and Developmental Biology **5 hrs.**

Infertility-Test tube babies (*In vitro* fertilization and embryo transfer). Cloning experiments- (Amphibians, Mammals and Human). Stem cells and their applications, ethical issues.

REFERENCE

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.

Gilbert, S.F. 2006. *Developmental Biology* (9thedn).Sinauer Associates Inc., Publishers, Masachusettes, USA

Hopper, A.F. and Hart ,N.H.1985. *Foundations of Animal Development*.Oxford University Press, Oxford.

Lewis Wolpert. 2007. *Principles of Development*. Oxford University Press.Oxford

Saunders, J.W.1982. *Developmental Biology-Patterns,Principles and Problems.* Macmillan Publishing Co.,New York.

Subramanian, T. 2002. *Developmental Biology*.Alpha Science International Ltd.,New Delhi

Sunstard,D.P., Simmons, M. J. and J.B Jenkins.1997. *Principles of Genetics*. John Wiley and sons, New York.

Wolpert L. and C. Tickle. 2011. *Principles of Development*.(4thedn). Oxford University Press, Oxford, UK

■

ZY2CT09 BIOPHYSICS, INSTRUMENTATION AND BIOLOGICAL TECHNIQUES

90 Hours (42+38+10) **Credit- 4**

Objectives:

- To learn the biophysical properties and functioning of life processes
- To introduce the tools and techniques available for studying biochemical and biophysical nature of life
- To equip the learner to use the tools and techniques for project work/ research in biology

BIOPHYSICS 42 hrs.

Module I. Diffusion and Osmosis 8 hrs.

Diffusion -Kinetics of diffusion, Fick's law of diffusion and diffusion coefficient, Biological significance in animals and plants, Electrochemical gradient, Stokes-Einstein equation and Graham's law, Facilitated diffusion, Gibbs-Donnan equillibrium.

Osmosis- osmotic concentration and osmotic pressure, Van't Hoff's laws.

Biological significance of osmosis in animals and plants.

Module II. Biophysics of Cell Membrane 10 hrs.

Physico-chemical properties of cell membrane, conformational properties of cell membranes,Membrane Transport – endocytosis, exocytosis, Nutrient transport across membranes, porins facilitated diffusion, porter molecules; Facilitated transport:symport,antiport, uniport,anion porter,glucose porter; Active transport: proton pumps, Na^+ K^+ pumps and Ca^{++} pumps, ionic channels. Functions of cell membrane.Artificial membranes.

ModuleIII. Bioenergetics 14 hrs.

Thermodynamics- Laws of thermodynamics, Entropy, Enthalpy, Free energy.

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.

Module IV. Radiation Biophysics 10 hrs.

Ionizing radiation, units of radioactivity, exposure and dose.

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. Renal, liver and lung function analysis.

Application of radioactive tracers, Radiation protection and therapy.

INSTRUMENTATION & BIOLOGICAL TECHNIQUES 38hrs.

Module I. Microscopy 6 hrs.

Differential Interference contrast (Nomarsky) microscopy, Confocal microscope, Electron microscope – TEM, SEM, Scanning Tunnelling and Atomic Force Microscopes.

Prerequisite: *Light microscope and dark field microscope, Phase contrast microscope, Polarizing microscope, birefringence fluorescence microscope and camera lucida*

Module II. Chromatography **7 hrs.**

Paper chromatography,Thin layer chromatography, Ion exchange chromatography.
Gel permeation chromatography,Affinity chromatography,Gas chromatography
High pressure liquid chromatography (HPLC).

Module III. Electrophoresis **6 hrs.**

Paper electrophoresis,Gel electrophoresis, Polyacrylamide gel electrophoresis (PAGE) – SDS and non SDS , Agarose gel electrophoresis , Disc electrophoresis, High voltage electrophoresis, immuno-electrophoresis, isoelectric focusing.

Module IV. Colorimetry, Spectrophotometry and Spectroscopy **8 hrs.**

Principle and applications of colorimetry and spectrophotometry.
Spectroscopy :Flame emission spectroscopy, Atomic absorption spectroscopy, Nuclear Magnetic-resonance spectroscopy (NMR), Circular dichroism spectroscopy, ESR spectroscopy, Mass spectroscopy.

Module V. Centrifugation **3 hrs.**

Basic principles of sedimentation,Types of centrifuges, Analytical and Preparative centrifugation, Differential and density gradient centrifugation.

Module VI. Radioisotope Detection and Measurement **2 hrs.**

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

Module VII. Nanotechnology **3 hrs.**

Introduction to Nanobiology. Nanosensors and Nanomedicines.

Module VIII. Assays **2 hrs.**

Radio ImmunoAssay, Enzyme Linked Immuno Sorbant Assay (ELISA).

Module IX. pH meter **1 hr.**

Principle and working. Types of pH meters.

Module X. Biological and Histological Techniques **10 hrs.**

Fixation, preparation of temporary and permanent slides, whole mounts, smears, squashes and sections. Specimen preparation for TEM, SEM, shadow casting, freeze fracturing, freeze etching,negative staining.Microphotography.
Cytochemical and histological methods- Microtome techniques, fixation, staining.
Cytochemistry of nucleic acids, detection of carbohydrates, proteins and lipids.

REFERENCES

Ackerman, E. 1962. *Biophysical Science*. Prentice Hall Inc. NJ, USA

Alonso, A., and Arrondo, J.L.R.2006. *Advanced Techniques in Biophysics.*Springer,UK

Arora, M. P. 2007.*Biophysics*. Himalaya Publishing House, New Delhi

Baker, E.J. and Silverton R.E. 1978. *Introduction to Medical Laboratory Technology.* ELBS.London,UK

Das, D. 1991. *Biophysics and Biophysical Chemistry*. Academic Publishers, Calcutta

Edward, A.L. 1997. *Radiation Biophysics*. Academic Press,NY,USA.

Ernster, L. (Ed.). 1985. *Bioenergetics*. Elsivier, NewYork,USA.

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. e*t.al*. 1983. *Biophysics.* Springer Verlag, Berlin.

Lehninger, A.L.1971. *Bioenergetics*. W.A. Benjamin, London,UK.

Narayanan, P. 2000. *Essentials of Biophysics*.New Age International (P) Ltd. Publishers, New Delhi.

Pearse, A.G.E. 1980. *Histochemistry*. Vol.& Vol. II. Churchill Livingstone, NY, USA.

Pradeep T. 2007. *NANO: The Essentials. Understanding Nanoscience and Nanotechnology*.Tata McGraw Hill Education Pvt. Ltd., New Delhi.

Roy, R.N. 1996. *A Textbook of Biophysics*. New Central Book Agency (P) Ltd. Calcutta

Sandhu, G.S. 1990. *Research Techniques in Biological Sciences*. Anmol Publications, New Delhi

Srivastava,P.K. 2006. *Elementary Biophysics.An Introduction*.Narosa Publishing House, New Delhi.

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

Weesner, F.M. 1960. *General Zoological Microtechniques*. The Williams & Wilkins Co., Baltimore, USA

■

ZY2CP10 PRACTICAL 2: ECOLOGY,GENETICS AND BIO-INFORMATICS, DEVELOPMENTAL BIOLOGY, BIOPHYSICS, INSTRUMENTATION AND BIOLOGICAL TECHNIQUES.

90 Hours (5 hrs./week) **Credit-3**

Ecology

Study of Pond/ wetland/ River ecosystem- Food web and food chain (no museum specimen). Record the date, time, methodology, and observations in the record book.
Determination of soil organic carbon and chlorides.
Separation and identification of soil arthropods using Berlese funnel.
Qualitative and Quantitative study of marine/freshwater planktons.
Estimation of primary productivity.
Quantitative estimation of salinity, phosphates and nitrates in water samples.
Study of pH and conductivity using pH and conductivity meter (2different samples).
Principles and application of the following instruments: Rain Guage, Plankton Net, Secchi Disc, GPS.
Field Study Report: Three days field study covering River/ Wetland/ Marine and forests/ grassland. Record ecosystem components (Soil, water, flora, fauna) and interactions. Viva based on Field study.

Developmental Biology

Identification of different developmental stages of frog (egg, blastula, gastrula, neurula, tadpole, with external gill and internal gill).
Vital staining of early gastrula of chick – window method.
Blastoderm mounting of chick embryo using vital stains.
Morphological and histological studies of different types of placenta in mammals.
Study of serial sections of embryo (tadpole and chick).
Regeneration studies in fish (Zebra Fish/ Earth worm).

Genetics and Bioinformatics

Culture, sexing and etherization of *Drosophila.*
Study of Mutants in *Drosophila.*
Genetics problems (Di hybrid cross, test cross and sex linked inheritance).
Abnormal human karyotypes (any five).
Data base search and data retrieval-using NCBI, SWISS-PROT, PDB, Expasy.
Methods of sequence alignment-BLAST and ClustalW.
Phylogenetic tree using PHYLIP.
Gene Prediction using GENSCAN/GRAI.
Protein structure visualization using RASMOL.

Biophysics/Instrumentation/Biological Techniques

Micrometry- principle and measurement of microscopic objects: Low power and high power.
Camera Lucida drawing with magnification and scale.
Principle and working of phase contrast microscope, micro-photographic equipment and pHmeter.
TLC using amino acids from purified samples and biological materials.
Study of Enzyme kinetics - Salivary amylase on maltose standards- influence of temperature and Substrate concentration on enzyme activity (Lineweaver Burk Plot) on enzyme activity.

■

SEMESTER III

ZY3CT11 ANIMAL PHYSIOLOGY

ZT3CT12 CELL AND MOLECULAR BIOLOGY

ZY3CT 13 MICROBIOLOGY AND BIOTECHNOLOGY

ZY3CT14 IMMUNOLOGY

ZY3CP15 PRACTICAL - 3: CELL AND MOLECULAR BIOLOGY, MICROBIOLOGY AND BIOTECHNOLOGY

ZY3CP16 PRACTICAL - 4: ANIMAL PHYSIOLOGY AND IMMUNOLOGY

ZY3CT11 ANIMAL PHYSIOLOGY

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

Objectives:

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

Module I. Nutrition, Digestion and Absorption **8 hrs.**

Nutrition in animals, mechanisms of food intake in different animals.

Physiology of digestion and absorption. Structural and biochemical adaptations to special dietary pattern, symbiotic digestion.

Neuronal and hormonal regulation of nutritional intake, hunger drive, thirst.

Obesity- causes and consequences, outline of hormonal involvement, Leptin: synthesis, secretion and its role in adipogenesis.

Prerequisite: *Human digestive system: structure and function, gastro-intestinal and nutritional disorders.*

Module II. Circulation **10 hrs.**

Circulatory mechanisms and fluid compartments, movement of body fluids by somatic muscles, open system, closed system, lymph channels.

Circulatory shock, Circulatory arrest.

Types of hearts- chambered heart, tubular heart, ampullar heart, lymph heart, neurogenic and myogenic heart. Pace makers and specialized conducting fibers. Cardiac cycle, cardiac output, blood pressure, effect of drugs on heart beat, effects of exercise on cardiaovascular physiology. ECG - its principle and significance. Blood buffers, Human congenital heart diseases.

Prerequesite: *Anatomy of human heart, composition of blood. Haemopoiesis*.

Module III. Respiration **8 hrs.**

Respiration in invertebrates and vertebrates.

Pulmonary ventilation, respiratory muscles, surfactants. Respiratory centers and periodic breathing. Regulation of respiration. Respiration in unusual environment – foetal and neonatal respiration, high altitude, diving. Structure and functioning of respiratory pigments. Metabolic rate : basal metabolic rate and its measurement.

Pre-requisite: *Respiratory organs with special reference to arthropods and vertebrates.*

Module IV. Osmoregulation and Excretion **6 hrs.**

Osmoregulation in fresh water, marine and terrestrial animals.

Excretion in vertebrates. Physiology and regulation of urine formation, Hormonal regulation of urine formation. Regulation of water balance, electrolyte balance and acid-base balance. Dialysis, artificial kidney, kidney transplantation.

Prerequisite*: Vertebrate kidney, Structure of nephron, excretory products, kidney disorders.*

Module V. Nerve Physiology **10hrs.**

Neuroanatomy of the central and peripheral nervous system. Electrical and chemical transmission. Synaptic transmission. Modifications of synaptic transmission during fatigue, acidosis, alkalosis, hypoxia and drugs. Mechanism of excitatory and inhibitory pathway. Neuromuscular Junction: organization and properties of neuromuscular junction, neuromodulators. Neural control of muscle tone and posture.

Prerequisite*: Structure of neuron. Neurotransmitters. EEG, MRI, memory, neural disorders in man.*

Module VI. Sensory and Effector Physiology **12 hrs.**

Classification of somatic senses and somatic receptors, exteroceptors, interoceptors, modality of sensation, secondary sense cells, transduction, relationship between stimulus, intensity and response, sensory coding.
Chemical senses: taste, smell, mechanism of reception.
Mechanoreceptors: hair cell, organs of equilibrium, vertebrate ear, mechanism of hearing, electro and thermoreceptors.
Vision: Structure of invertebrate and vertebrate eye. Physiology of vision.
Pain: pain receptors, headache and thermal senses, pain suppression (analgesia).
Tactile sensation: touch receptors, transmission of signals, special problems of premature infants, Physiological role of touch and environment in premature infants- Kangaroo care, infant massage, supportive environment.
Prerequisite: *structure of skin, eye and ear.*

ModuleVII. Muscle Physiology **8 hrs.**

Comparative physiology of skeletal, smooth and cardiac muscles. Skeletal muscle- ultra structure and molecular organization. Red and white muscles, muscle proteins. Mechanism of muscle contraction and relaxation. Energetics of muscle contraction. Effect of exercise on muscles. Catch muscle and fibrillar muscle.
Prerequisite: *simple muscle twitch, latent and refractory periods, tetanus, tonus, fatigue, oxygen debt.*

Module VIII. Thermoregulaion **5 hrs**

Comfort zone, body temperature – physical, chemical, neural regulation, acclimatization.
Impact of temperature on the rate of biological functions. Arrhinius equilibrium, Q 10.
Temperature compensation and temperature regulation in poikilotherms and homiotherms. Adaptations for extreme environments, aestivation and hibernation.

Module IX. Endocrinology **15 hrs.**

Invertebrate and vertebrate endocrine system. Endocrine glands. Synthesis, physiologic role, control and mechanisms of hormone action. Neuro-endocrine regulation of hormone action. Bioamines, Ecosanoids, Chalones, Lumones, Phytohormones, Synthetic hormones.
Prerequisite: *Hormones as messengers, hormonal control of homeostasis.*
Disorders of hormonal imbalance in Man.

Module X. Reproductive physiology **8 hrs**

Anatomy and histology of adult testis and ovary. Reproductive cycles of mammals and their hormonal control. Physiology of implantation, pregnancy, parturition, and lactation.
Impact of senescence and age on reproduction.
Prerequisites: *spermatogenesis, Oogenesis, egg-sperm interaction*

REFERENCES

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.

Brijlal Gupta and J.A. Ramsay, 1977. *Transport of Ions and Water in Animals*. Academic Press, New York.

Chatterjee, C.C. 1997. *Human Physiology.* Medical allied agency, Calcutta.

Ganong, W.F 1987. *Review of Medical physiology*. Appleton and lang, Norwalk.

Guyton, A.C. 1996. *Text Book of Medical physiology*. Prism Books Pvt.Ltd.Bangalore

Hill, W.R., Wyse, G.A and Anderson, M. 2007. *Animal Physiology* (2nd edn). Sinauer Associates Inc. Publishers, MA, USA.

Hoar, W.S. 1983. *General and Comparative Physiology*. Prentice Hall of India,New Delhi.

Hochachka, P.W. and Somero, G.N. 1984. *Biochemical Adaptation*. Princeton University Press, New Jersey.

Hochachka, P.W. and Somero, G.N 2002. *Biochemical Adaptation: Mechanism and Process in Physiological Evolution*. Oxford University Press, New York.

Ian Kay.1998. *Introduction to Animal Physiology.* Bios Scientific Publishers Ltd., Oxford, UK

Keele, C.A , Neil, E. and Joels, N. 1982. *Samson Wright's Applied Physiology*. Oxford University Press

Knut Schmidt-Neilsen. 1997. *Animal physiology: Adaptations and Environment* Cambridge University Press

Larsson, P.R. *et al.*, 2002. *William's Text Book of Endocrinology* (10th edn).W.B. Saunders, Philadelphia

Moyers, D.C and Schulte ,P.M. 2007. *Principles of Animal Physiology* (2nd edn). Benjamin Cummings,CA, USA

Prosser, C.L and Brown, F.A. 1973. *Comparative Animal Physiology.* W.B Saunders Company, Philadelphia

Randall, D., Burgrenn, W. and French, K. 1997. *Eckert Animal physiology*.W.H. freeman & Co,New York.

Squires,E.J. 2003 *Applied Animal Endocrinology*, CABI Publications,UK.

Timothy J. Bradley. 2009.*Animal Osmoregulation*. OABS, Oxford University Press, UK.

Wilmer, P., G. Stone and I .Jonston. 1997. *Environmental Physiology of Animals* (2nd edn). Blackwell Publishers, NY, USA.

■

ZY3CT12 CELL AND MOLECULAR BIOLOGY

90 Hours (5 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. Cellular Membranes **6 hrs.**

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

Prerequisite: *membrane transport – Diffusion and osmosis, Facilitated diffusion, Active transport, Bulk transport. Nucleus and nuclear membrane*

Module II. Cell junctions, Cell adhesion and Extracellular matrix **10 hrs.**

Extracellular matrix: Basal membrane and laminin, Collagen, Proteoglycan,Fibronectin. Interaction of cells with extracellular matrix: Integrins. Focal adhesion and hemidesmosomes. Interaction of cells with other cells: Selectins, Immunoglobulins, Cadherins, Adherens. Junctions and desmosomes. Tight junctions,Gap junctions and Plasmodesmata.

Module III. Cell Organelles **6 hrs.**

Endoplasmic reticulum, Golgi complex, Ribosome, Mitochondria.

Prerequisite**:** *Lysosome, Chloroplasts, Peroxisomes and Glyoxysomes*

Module IV. Cytoskeleton and Cell Motility **5 hrs.**

Microtubules, Microfilaments, Intermediate filaments, Molecular motors, Non muscle motility and contractility.

Module V. Cell Signaling **15 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, Cytokine receptors (Tyrosine kinase linked receptors).

Second messengers: Cyclic-AMP, Cyclic-GMP, Inositol 1,4,5-trisphosphate (IP3), Di-acyl glycerol (DAG).

Signaling pathways: G-protein coupled receptor (GPCR) and cyclic AMP pathway – role of protein kinase A (PKA), GPCR pathway in rod cells, Receptor protein tyrosine kinase and Ras-MAP kinase pathway, JAK-STAT pathway, Calcium phosphatidyl- inositol pathway, Phospho Inositide 3-kinase (PI-3 kinase),Transforming growth factor (TGF) signaling pathway. Regulation of signaling pathways. Convergence, divergence and crosstalk among different pathways.

Prerequisite: *Basic principles of cell communication*

Module VI. Cellular Reproduction **5 hrs.**

Cell cycle: Steps 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 and Structure of chromosome.*

Module VII. Cancer **8 hrs.**

Basic properties of a cancer cell, Types of cancer, Causes of cancer, Genetics of cancer, Tumour suppressor gene, Oncogene.

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

Module VIII. Gene Expression **20 hrs.**

Relationship between genes and proteins.Transcription in prokaryotes and eukaryotes-rRNA, tRNA and mRNA, RNA processing in prokaryotes and eukaryotes, Translation in prokaryotes and eukaryotes, initiation, elongation and termination, post transcriptional modifications, protein sorting, signal sequences and signal hypothesis.

Pre- requisite: *Gene and Genetic code*

Module XI. Gene Regulation **15 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 transcriptional, post transcriptional and translational levels, transcription factors, enhancers and silencers, Chromatin-remodelling complexes, RNA interference (RNAi).

Pre-requisite: *Fundamentals of gene regulation, Lac operon*

REFERENCES

Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K. And Walter, P. 2008. *Molecular Biology of the Cell*. Garland Science.- Taylor and Francis group, USA.

Becker, W.M.,Kleinsmith, L.J. and Hardin, J. 2007. *The World of the Cell*. Pearson, New Delhi.

Clark, D.P. 2010. *Molecular Biology*. Elsevier Publishers, London.

Cooper, G.M. and Hausman, R.E. 2009. *The cell: A Molecular Approach* (5thedn). Sinauer Associates, Inc, ASM Press, Washington DC.

Griffiths, A.J.F., Wesler, S.R., Carroll, S.B. and Doebley, J. 2008. *Introduction to Genetic Analysis*. W H Freeman and Company,USA

Hyde, D.R. 2010.*Genetics and Molecular Biology*. Tata McGraw Hill Education Private Ltd., New Delhi.

Karp, G. 2010. C*ell and Molecular Biology* (6thedn). John Wiley and Sons,Inc.NJ,USA.

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. 2011. *Lewin's Genes X*. Jones and Bartlett publishers,NY.

Lodish, H., Berk, A., Kaiser, C.A., Krieger, M., Scott, M.P., Bretscher, A., Ploegh, H. and Matsudaira, P. 2007. *Molecular Cell Biology* (6th edn). W H Freeman & Company.

Pierce, B.A. 2008. *Genetics: A conceptual approach*. W H Freeman and Company.

Pollard, T.D. and Earnshaw, W.C. 2008. *Cell Biology*. Saunders Elsevier.

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. 2009. *Molecular Biology of the Gene.* Pearson.

■

ZY3CT 13 MICROBIOLOGY AND BIOTECHNOLOGY

72 Hours (30+42) (4hrs/week) **Credit- 4**

Objectives:

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

MICROBIOLOGY 30hrs.

Module I. Introduction to Microbiology 3 hrs.

Methods of Microbiology, Main group of microorganisms, general characters.
Classification, approaches to microbial classification,outline classification, Bergey's manual.

Prerequisite: *Discovery of microorganisms. Contributions of Scientists to the field of Microbiology- Anton Von Leewenhoek, Edward Jenner, Lazaro Spallanzani, Louis Pasteur, Joseph Liter, Robert Koch and Alexander Flemming.*

Module II. Functional Anatomy of Prokaryotic Cells 3 hrs.

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 and s- layers, pili and fimbriae, flagella and motility. The endomembrane system, mitochondria and chloroplasts, cell wall and pellicle in protists.

Prerequisite: *Morphology, size, shape and cell arrangement.*

Module III. Microbial Metabolism 4 hrs.

Energy acquisition by chemotrophs and phototrophs, glycolysis (Embden- Meyerhof pathway). Fermentation, anaerobic oxidations, chemosynthesis. Photosynthesis, carbon assimilation. Regulation of metabolism.

Module IV. Nutrition and Growth 3 hrs.

Common nutrient requirements, nutritional types, growth factors, uptake of nutrients by the cell.Culture media.Reproduction and exponential growth, the growth curve.Physical requirements for bacterial growth and influence of environmental factors on growth.

Module V. Microbial Interactions and Microbial Ecology 4 hrs.

Symbiosis, commensalism. Mutualism between microbes, microbes and plants, microbes and animals. Cooperation, competition, predation, antagonism. Parasitism, plant parasites, animal parasites.

Module VI. Virology 3 hrs.

Properties of viruses**,** structure and chemical composition, genetic composition eclipse, host interaction and specificity**.**Classification, RNA virus , DNA virus, plant virus, animal virus ,bacteriophage, lysis and lysogeny, Viral replication. Virioids and prions.Nature and significance.Pathogenic virus, oncovirus.

MODULE VII. Applied Microbiology **10 hrs.**

Bacteria of air, water and soil. Microbes associated with food production and spoilage, microbiology of milk and dairy products.Epidemiology of human diseases, Mechanism of microbial pathogenicity.Normal microbial population on human body, microbial diseases, Nosocomial infections.
Medical mycology. Control of microorganism- physical,chemical and antimicrobial agents.
Biological weapons and bioterrorism.

BIOTECHNOLOGY 42 hrs.

Module 1.Introduction to Biotechnology **2 hrs.**

Historical aspects,definitions and scope of Biotechnology.Biotechnology in India.

Module II. Tools and Techniques in Recombinant DNA Technology **12 hrs.**

Vectors: cloning and expression vectors - Plasmids, Ti and Ri plasmids, cosmids, phasmids, phagemids, bacteriophage, SV40, vectors with combination features; PUC19 and Bluescript vectors, shuttle vectors, viral vectors, BAC and YAC vectors. Restriction enzymes and DNA modifying enzymes.
Polymerase chain Reaction- different types and applications. Chromosome walking, chromosome jumping, DNA foot printing. Molecular Markers and Probes-SNP, VNTR, RAPD, RFLP, SSR, STMS, FISH and GISH. DNA sequencing methods- Maxam and Gilberts chemical degradation method, Sanger and Coulson method, Automated DNA sequencers. Site directed mutagenesis, molecular chimeras.
Cloning Methodologies - Gene isolation : Shot gun method, Genome libraries, cDNA libraries, Chemical synthesis. Splicing and integration of isolated gene- cohesive end ligation, homopolymer tailing, extending linkers. Methods of rDNA transfer to host cells- $CaCl_2$ treatment, Virus delivery. Selection and screening of the transformed cells, Blue-white screening, Colony hybridization methods, Reporter genes, Fusion proteins.
Prerequisite: *Blotting techniques- Southern, Northern, Western, Dot Blot, DNA finger printing.*

Module III. Animal Biotechnology **12 hrs.**

Cell and Tissue culture: Basic techniques of mammalian cell culture, disaggregation of tissue and primary culture, maintenance of cell culture and cell separation. Growth media: Physicochemical properties, natural and artificial, Balanced salt solutions, Complete Media, Serum, Serum-Free Media and protein free media and their applications. Biology and characterization of cultured cells, measurement of viability and cytotoxicity.Manipulation of cultured cell and tissues- scaling up of animal cell culture, cell synchronization, cell transformation, organ and histotypic culture. Tissue engineering: strategies and developments in tissue engineering, Biomaterials. Contamination: Source of contamination, Type of microbial contamination, Monitoring, Eradication of contamination, Cross-Contamination. Cryopreservation - importance and process of cryopreservation, cryopreservation of embryos, Cryogenics.
Transfection Methods: $CaPO_4$ precipitation, Short Gun, Electroporation, Lipofection, Microinjection, Agrobacterium mediated gene transfer. Somatic cell nuclear transfer- reproductive cloning and therapeutic cloning. Gene knockout and knockin technology. Applications of transgenic animals.
Stem cell culture : General and historical aspects, properties and types of stem cells, advantages and disadvantages, stem cell niche, application of stem cell technology in medicine.

Module IV. Biotechnology in Healthcare **4 hrs.**

Disease prevention – DNA vaccines. Disease diagnosis - Probes, Monoclonal antibodies, detection of genetic disorders. Disease treatment - Therapeutic proteins, hormones and growth factors.RNAi, Drug targeting, Gene therapy. Forensic medicine. Biosensors-different types, applications - medical and non medical.Introduction to Biochips and their application in modern sciences.

Module V. Biotechnology in Industry and Agriculture 5 hrs.

Metabolite production. Antibiotics, Organic acids, Amino acids, Vitamins, Upstream processing, downstream processing.

Microbial enzymes and biotranformation- Microbial production of enzymes, fermentation, Enzyme engineering and applications. Food industry- Single cell protein, probiotics. Transgenic plants- Plants with resistance to Pests, plants with increased shelf life.Biofertilizers and microbial inoculants, biotechnology of nitrogen fixation, biocontrol agents, biopesticides, bioinsecticides, Terminator gene technology -concept and basics.

Module VI. Environmental Biotechnology 3 hrs.

Sewage treatment. Solid waste management. Biodegradation of xenobiotic compounds. Bioremediation and Biorestoration. Microbial leaching and mining. Biofuels. Transgenics and environment.

Module VII. 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. General guidelines for recombinant DNA research activity. Biosafety protocol 2000.

Bioethics: Principles of bioethics: autonomy, human rights, beneficence, privacy, justice, equity *etc.* Ethics in post genomic era-genetic testing and genetic screening.

REFERENCES

Microbiology

Arora,D.R. and Arora,B. 2008. *Text Book of Microbiology*. CBS Publishers and Distributers, New Delhi

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

Ingraham, J. L. and Ingraham, C. A. 2000. *Microbiology* (2nd edn). Brooks/Cole-Thomson Learning,MA,USA

Laning, M Prescot. John,P. Harley and Donald A Klein. 2008. *Microbiology* (7th edn). McGraw Hill International,NJ, USA

Talaro, Park.,Kathelee, N and Talaro,Arthur. 2002. *Foundations of Microbiology*.McGraw Hill Higher Education,NY

Wheelis, Mark. 2010. *Principles of Modern Microbiology*. Jones and Bartlett Publishers,NY,USA.

Biotechnology

Dale, Jeremy W and Schantz, Malcom V. 2002. *From Gene to Genomes*. John Wiley and Sons Ltd,NY,USA

Das, H.K. 2007. *Text book of Biotechnology*.Wiley India Pvt. Ltd. New Delhi

Doyle, Alan and Griffith Bryan J. 1999. *Cell and Tissue Culture- Laboratory Procedures in Biotechnology*.WileyInternational,NY.

Freshney, Ian, R. 2006. *Culture of Animal Cell* (5th edn).Wiley- Liss publications.

Pandian, T.T. and Kandavel, D.2008. *Text Book of Biotechnology*. I.K International Publishing House, New Delhi.

Primrose, S.B., Twyman, R.M., and Old, R.W. 2001. *Principle of Gene Manipulation (*6th edn). Blackwell Science Ltd, London.

Singh .B.D. 2006. *Biotechnology.* Kalyani Publishers, New Delhi.

Sobti, R. C. and Pachauri, Suparna S. 2009. *Essentials of Biotechnology*. Ane Books Pvt. Ltd. New Delhi.

■

ZY3CT 14 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. Overview of the Immune System **3 hrs.**

Types of Immunity- Innate and acquired, Passive and active. Pattern recognition receptors- scavenger receptors and Toll – like receptors. Humoral and cell-mediated immune responses. Haematopoiesis. B-cell and T-cell maturation and differentiation.

***Prerequisite*:** *Historical perspective and early theories of immunity, Components of immune system, cells, tissues and organs involved in immune system.*

Module II. Antigens and Antibodies **8 hrs.**

Antigen processing and presentation. Monoclonal antibodies and abzymes. Genetic model compatible with Ig structure. Multi- gene organization of Ig genes. Variable region gene arrangements. Generation of antibody diversity. Expression of Ig genes and regulation of Ig genes transcription. Antibody genes and antibody engineering.

***Prerequisite*:** *Antigen-structure and properties, Haptens, Adjuvants, Epitopes, Immunoglobulins-structure, classes and functions.*

Module III. Antigen –Antibody Interactions **2 hrs.**

Antigen- Antibody reactions. Biological consequences of antigen-antibody reaction.

***Prerequisite*:** *Types of antigen-antibody reactions - Cross-reaction, Precipitation, Agglutination.*

Module IV. The Complement System **5 hrs.**

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

Module V. Immune Effector Mechanisms **5 hrs.**

Inflammatory Cells. Types of Inflammation- acute and chronic. Chemokines. Role of cytokines in immune system. Properties and functions of Cytokines. Therapeutic uses of cytokines.

Module VI. Hypersensitivity **4 hrs.**

Allergy and hypersensitivity. Genetics of allergic response in humans.

***Prerequisite*:** *Types of Hypersensitivity*

Module.VII. Major Histocompatibility Complex **8 hrs.**

General organization and inheritance of MHC. MHC molecules and 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. Regulation of MHC expression. MHC and graft rejection. MHC and disease susceptibility. Biological significance of MHC. HLA typing

Module.VIII. Immunity in Health and Disease **15 hrs.**

Immune response during bacterial (tuberculosis),Parasitic (Malaria) and viral (HIV) infections. Congenital immunodeficiency diseases (SCID, WAS, CVI, Ataxia, CGD, LAD).Acquired Immunodeficiency Disease (AIDS).Autoimmunity. Organ- specific autoimmune diseases. Systemic auto-immune diseases. Animal

models for autoimmune disease. Evidences implicating $CD4^+$ T cell, MHC and TCR in autoimmunity. Induction of autoimmunity. Treatment of autoimmune diseases.

Transplantation immunology. Immunologic basis of graft rejection. Clinical manifestation of graft rejection. General and specific immunosuppressive therapy. Clinical transplantation. Tumour immunology. Vaccines, Whole organism vaccines, Purified macromolecules as Vaccines, Recombinant vector vaccines, Synthetic peptide vaccines, Multivalent subunit vaccines.

Module IX. Immunological Techniques **4hrs.**

Serological Reactions. Radio-allergosorbent Test (RAST).Immunoprecipitation. Immunofluorescence. Flow cytometry and fluorescence. Immunoelectron microscopy.

REFERENCES

Abbas, A.K., Lichtman,A.K and Pober , J.S. 1997. *Cellular and Molecular Immunology.* W.B. Saunders Co. New York

Ashim K. Chakravarthy. 1998. *Immunology.* Tata McGraw-Hill, New Delhi.

Chakraborty, A.K. 2006. *Immunology and Immunotechnology.* Oxford University Press,New Delhi

Darla,J, Wise & Gordeon,R.Carter. 2004. *Immunology- A Comprehensive Review*. Iowa State University Press. A Blackwell Science Co,USA

David Male,Jonathan Brostoff, David Roth and Ivan Roitt. 2006. *Immunology*. Mosby, Edinburgh,UK

Goldsby, R.A.,Kindt, T.J. and Osborne, B.A.2000. *Immunology* (4th edn.). W.H. Freeman and Co. NY,USA.

Hannigan, B. M., Moore, C. B. T. and Quinn, D. G. 2010. *Immunology*. Viva Books, New Delhi.

Helen Chappel and Maused Harney, 2006. *Essentials of Clinical Immunology* (5th edn.) Blackwell Scientific Publications

Ivan M. Roitt, 2002. *Essential of Immunology*. ELBS, New Delhi.

Khan. F.H. 2009. *The Elements of Immunolgy*. Pearson Education.New Delhi.

Kuby J, 2000. *Immunology* (7th edn.). WH Freeman & Co. New York.

Richard Coico and Geoffrey Sunshine. 2009. *Immunology: A short course*. Wiley-Blackwell,CA,USA

■

ZY3CP 15 PRACTICAL 3: CELL AND MOLECULAR BIOLOGY, MICROBIOLOGY AND BIOTECHNOLOGY

72 Hours (4hrs./week) **Credit-2**

Cell and Molecular biology and Biotechnology

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)

Preparation of Microtome section, spreading and histochemical staining of carbohydrates (PAS), Protein (Bromophenol blue), lipids (Sudan Black), DNA (Fuelgen stain).

Cell fractionation and Differential Centrifugation to isolate mitochondria and nuclei

Isolation of genomic DNA using Agarose gel electrophoresis

Isolation of Plasmid DNA.

Microbiology

Sterilization, disinfection and safety in microbiological laboratory.

Preparation of culture media

(a) liquid media – nutrient broth , peptone water

(b) Solid media – Nutrient Agar, Mac Conkey' Agar.

(c) Semi solid agar

(d) Firm agar.

Culturing of microorganism –

(a) broth culture

(b) pure culture techniques- streak plate, pour plate culture, lawn culture, stab culture

(c) serial dilution and standard plate count, calculation of Cfu/ml in water samples.

Isolation and preservation of bacterial culture.

Identification of microorganisms-

(a) Staining techniques- gram staining of mixed cultures, negative staining and spore staining.

Antibiotic sensitivity (different natural fluids)

(a) Oxidase test

(b) Catalase test

(c) Oxidation/fermentation (O/F) test

Staining and enumeration of microorganisms:

(a)using haemocytometer

(b) nephelometry/ Turbidimetry

Environmental sample analysis.

a) Coliform count in water

b) Isolation and enumeration of soil bacteria

c) Identification of symbiotic bacterioids from root nodules of leguminous plants

Bacteriological analysis of milk- methylene blue reductase test.

■

ZY3CP16 PRACTICAL 4: ANIMAL PHYSIOLOGY AND IMMUNOLOGY

72 Hours (4hrs/week) **Credit - 2**

Animal Physiology

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 Q 10
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).Graphical representation and interpretation.
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:
(1) Muscle Twitch and the Latent Period
(2) The effect of stimulus Voltage on Skeletal Muscle Contraction
(3) Tetanus
(4) Fatigue
(5) Receptor Potential
(6) The Action Potential Threshold
(7) Importance of Voltage –Gated Na+ Channels

Differential count of Human WBC
Haematocrit and ESR of Human blood
Feeding activity of paramecium
Observation on the effect of decreasing PO_2 of water on the respiratory rate of a fish and determination of the lactic acid content of the muscle
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.
Western Blotting –Demonstration
ELISA -Demonstration
Rocket Immuno electrophoresis- Demonstration
Note:
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.

■

SEMESTER IV

ELECTIVE COURSE A. : ENTOMOLOGY

ZY4A ET 01	MORPHOLOGY AND TAXONOMY
ZY 4A ET 02	ANATOMY AND PHYSIOLOGY
ZY 4A ET 03	APPLIED ENTOMOLOGY
ZY4 A E P04.	PRACTICAL – I. MORPHOLOGY, ANATOMY & TAXONOMY.
ZY4 A E P05.	PRACTICAL-II. INSECT PHYSIOLOGY & APPLIED ENTOMOLOGY.

ELECTIVE A. : ENTOMOLOGY

Objectives:

- To introduce the insect diveristy and its significance
- To study the economic and medical importance of insects
- To learn about the pests of crops and vectors of diseases and their control measures
- To provide skills for scientific study of insects
- To develop research aptitude among students by introducing frontier areas of entomology

ZY 4A ET01 MORPHOLOGY AND TAXONOMY

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

Module I. Introduction **4 hrs**

Scope and importance of insects, Origin and evolution of insects (including theories), Fossil insects.

Module II. Insect Morphology **26 hrs**

Segmentation and division of the body: General morphology of head (Opisthognathus, Prognathus, Hypognathus). Head segmentation; Head skeleton; Tentorium; Modifications in head capsule; Cephalic appendages; Antennae – Structure functions and types, Mouth parts –various modifications, feeding mechanisms.

General morphology of thorax (thoracic segmentation, thoracic skeleton and thoracic appendages); Wings – Structure, Venation, Wing articulation, Wing coupling apparatus, Wing modifications.

Legs-structure and adaptive radiation of legs, Locomotion; Morphology of abdomen and its appendages. External genitalia-structure and diversity of male and female genitalia. eg. Grasshopper, *Drosophila*, Cockroach ,Dragonfly.

Sense Organs – Structure and classification of sense organs (Hair organs, Plate organs, Campaniform organs, Compound eyes and vision.); Light and Sound Producing Organs – Structure of light producing organs, Production of light, Stridulatory organs in various insects.

Module III. Insect Classification **36 hrs**

Methods of Insect collection and preservation, Use of keys, kinds of keys, their merits and demerits.

Classification of insects up to families; General characters, Biology and habits of different orders o f insects (special emphasis on economically important insects). Vectors of human diseases (Diptera, Anoplura and Siphonoptera).

Module IV. Social Organisation and Behaviour **16 hrs**

Social organisation and behaviour with reference to Termites, Ants and Honey Bees; Study of Gall forming insects (features, Gall formation, Types of Galls – open and Closed, Common Gall pests, adaptations for Gall making habits. Economic importance); Leaf mining insects – features forms of leaf mines, feeding habits. Ecological aspects of leaf mining; Communication – Acoustic, Visual, Tactile and chemical methods; Adaptations of parasitic and predatory insects; Study of aquatic insects (factors influencing the aquatic life, food capture – modifications, anchorage, locomotion, respiration, oviposition and adaptations of swimming forms.

Module V. Insect Development **8 hrs**

Egg, structure and adaptations; General pattern of embryonic development; Polyembryony; Parthenogenesis; Paedogenesis; Metamorphosis; Diapause.

REFERENCE

Ananthakrishnan T.N. 1998. *Dimensions of Insect Plant Interactions*. Oxford and IBH Pub.Co. Pvt. Ltd. N. Delhi.

Awasthy V.B. 1998. *Introduction to General and Applied Entomology*. ELBS, London

Carde R.T. andW.J.Bell.1995.*Chemical Ecology of Insects* (2nd edn). Chapman and Hall, NY.

Chapman R.F. 1982.*The Insects Structure and Functions*. ELBS, London.

Essig E.O. 1982. *College Entomology*.(Indian Reprint) Satish Book Enterprises Agra.

Fenmore P.G. and A. Alkaprakash. 1992. *Applied Entomology*. Wiley Eastern Ltd. New Delhi.

Mani M.S. 1974. *Modern Classification of Insects*. Satheesh Book Enterprise, Agra.

Mani M.S. 1982.*A General Text Book of Entomology*. Oxford and IBH, NewDelhi.

Metcalf C.L. and Flint W.P. (revised by Metcalf R.L.) 1962. *Destructive and Useful Insects*. McGraw-Hill Book Co. NY,USA

Nayar K.K., Ananthakrishnan T.N. and Devid B.V. 1976.*General and Applied Entomology*.TATA McGrew Hill NewDelhi.

Oster G.F. and Wilson E.O. 1978.*Caste and Ecology in the Social Insects*. Princeton University Press Princeton.

Pathak S.C. Ed. 1986. *Recent Advances in Insect Physiology, Morphology and Ecology.* Today and Tomorrow Printers and Publishers, New Delhi.

Richards O.W. and Devis R.G. 1993.*Imm's General Text Book of Entomology*, 10th Edn.Vol I and II.(Indian reprint). B.I. Publications Pvt. Ltd. NewDelhi .

Ross H.H. *et.al*.1982.*A General Text Book of Entomology*.John Wiley Son's, N. York.

Snodgrass R.E. 1935.*Principles of Insect Morphology*.McGraw Hill Book Co. N. York.

Tembhare D.B. 1997. *Modern Entomology*. Himalaya Publishing House, New Delhi

■

ZY4A ET 02 ANATOMY AND PHYSIOLOGY

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

Module I. Integumentary System **4 hrs.**

Anatomy and histology, Moulting and sclerotisation, Role of hormones.

Module II. Digestive System **10 hrs.**

Anatomy and histology of gut. Modifications of gut (filter chamber).

Physiology of digestion of wood, keratin,wax and silk. Extra intestinal digestion.Role of microbe in digestion. Assimilation.

Module III. Circulatory System **8 hrs.**

Anatomy and histology of dorsal vessel,dorsal and ventral diaphragms and accessory pulsatile organs.Composition and cellular elements in haemolymph;functions. Course of circulation and control of heart beat.

Module IV. Respiratory System **10 hrs.**

Anatomy and histology of trachea, trachiole,spiracles and air- sacs.

Modifications of respiratory system-cutaneous respiration, diffusion,ventilation,control of ventilation,cyclic release of CO_2, respiratory pigments.

Module V. Muscular System **8 hrs.**

Histo-morphology of muscles,skeletal muscles and visceral muscles.

Neuromuscular junctions.Excitations of muscle fibres,role of fast and slow axons.

Module VI. Fat Body and Intermediary Metabolism **6 hrs.**

Structure of fat body, Role of fat body in storage of reserves.

Intermediary metabolism-Glycolysis,Glycerol phosphate shuttle,Trehalose-biosynthesis

Module VII. Excretory System **14 hrs.**

Anatomy and histology of Malpighian tubules (Hemiptera, Coleoptera,Lepidoptera).Nephro-rectal complex and labial glands.Physiology of excretion.

Absorption of water and ions,reabsorption of essential materials. Synthesis of uric acid, formation of excreta.

Module VIII. Nervous System **14 hrs.**

Anatomy and histology of brain,ganglia and nerves.Physiology-reception and transmission of stimuli,production and conduction of nerve impulses.

Anatomy and histology of mechanoreceptors, photoreceptors and chemoreceptors. Sound production and light production.

Module IX. Endocrine System **12 hrs.**

Histomorhology of neurosecretory cells and endocrine glands (corpora cardiaca,corpora allata and prothoracic glands). Hormones and their functions.

Types of pheromones and behavioural patterns.Pheromonal communications-allelochemicals; allomones, kairomones and synomones.

Module X. Reproductive System **4 hrs.**

Reproductive system in male insects, Reproductive system in female insects.

REFERENCES

Annual Review of Entomology (1956 onwards) All Volumes.

Beament,J.W.L. , Treherne,J.E. and V.b.Wiggleswoth.1972. *Advances in Insect Physiology*. Academic Trust London

Bursell, E. 1970. *An Introduction to Insect Physiology*. Academic Press,Cambridge.

Chapman, R.F. 1988. *The Insect : Structure and Function* (4thedn). ELBS , London.

Gilbert L.I. and G.A. Kerkut .1975.*Comprehensive Insect Physiology, Biochemistry and Physiology*. Vol 1-12. Pergamon Press, Oxford.

Pant, N.C. and Ghai (Ed.) 1981.*Insect Physiology and Anatomy* .Indian Council of Agricultural Research , New Delhi

Pathak S.C (Ed). 1986. *Recent Advances in Insect Physiology Morphology and Ecology*. Today and Tomorrow Publishers, New Delhi

Patton R. 1963. *Introductory Insect Physiology* .Saunders, USA

Richards O.W. and R.G. Davis. 1977. *Imm's General Textbook of Entomology* ,Vol I. Chapmann and Hall , London

Rockestein M.(Ed). 1964. *Physiology of Insecta Vol.1-6* . Academic Trust New York.

Simpson, Stephen. 2005. *Advances in Insect Physiology*. Elsevier,NY.

Wigglesworth V.B. 1972. *Principles of Insect Physiology*. Methuen , London.

■

ZY 4A ET 03 APPLIED ENTOMOLOGY

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

Module I. Insect Pests **8 hrs**

Kinds of pests (major and minor) – Key pests, sporadic pests, endemic pests, exotic pests, epidemic and pandemic pests, seasonal pests, occasional pests, regular pests, persistent pests. Causes of pest outbreak. Pest resurgence and replacement (secondary pest outbreak). Causes and management of resurgence and replacement. Forecasting pest outbreaks and surveillance (Short term and long term forecasting); forecasting based on observations – climatic and empirical factors.

Types of damage caused by insect pest to crops (Injury by chewing, piercing, sucking insects, internal feeders, subterranean insects, to stored products and indirect effect of feeding).

Module II. Insect Pests of Crops **16 hrs**

Life history, nature of damage and control measures of major pests of paddy, coconut, cotton, sugar cane, mango, cashew, pulses, coffee, tea, banana, pepper, cardamom, turmeric and ginger, tapioca, rubber, vegetables, stored products; Locusts –life history and migration, damage and methods of control; Termites – life history, damage and control measures.

Module III. Basic Principles of Insect Control **16 hrs**

Prophylactic methods. Curative methods- Cultural methods; Mechanical methods; Physical methods; Legal methods.

Biological control- History, ecological basis and agents of biological control – Parasites, Parasitoids, Predators; The practice of biological control (Conservation and enhancement, importation and colonisation, mass culture and release of natural enemies); Economic dimensions of biological control; merits and demerits; Important biological control projects undertaken in India against insect pests and weeds. Autocidal control – Sterile male technique and other methods, Chemo sterilants, methods of sterilisation, application advantages and disadvantages. Examples; Pheromonal control – Mode of application, pest management with pheromones. Advantages and disadvantages. Examples;

Insect growth regulators (IGRS), Insect growth hormones and mimics (brief account).

Insect repellents – Definition, features of good repellents, types, applications in pest management, advantages and disadvantages,examples. Insect anti feedants – definition, applications, advantages, disadvantages, examples.

Microbial control of crop pests by employing bacteria virus and fungi. Mode of action, applications and examples; Insect attractants – definition, types, application in pest management. Advantages and disadvantages and examples.

Pest management – concepts, definition, characteristics, pest management strategies and techniques Integrated pest management – definition, IPM in agro ecosystem, Preventive practice, therapeutic practice, guidelines for developing IPM. IPM of rice; Ecological backlash and its management (resistance of population to pest management tactics, Pest population resurgence and replacement, genetic physical and biochemical mechanisms, microbial and environmental degradation of pesticides.

Module IV. Chemical Control **12 hrs**

Insecticide formulations, Insecticide appliances and applications; Classification of insecticides – based on mode of entry, mode of action , chemical nature, toxicity.

Chemistry and mode of action of insecticides; Inorganic compounds as insecticides - Arsenic, fluoride and sulphur compounds; Synthetic organic insecticides - Organochlorine compounds (DDT, BHC, Endosulfan – heptachlor, dieldrin).

Organo phosphorous insecticides – monocrotophos, tetra ethyl pyrophosphate, parathion, carbamates – carbaryl, carbofuran.

Botanical insecticides – chemical properties, mode of action and toxicity. (nicotine, rotenone, pyrethrum and neem; Ethnobotanical traditions. Synthetic pyrethroids – definition, uses as insecticides, mode of action (pyrethrin, allethrin).

Fumigants – definition, examples, methods of fumigation, hazards, precautions, advantages; Insecticide synergists – definition, types of synergism, mode of action and examples; Pesticide impact on wildlife and human health.

Module V. Vectors of Domestic Animals and Man 10 hrs

Insect vectors of human diseases belonging to diptera, anoplura, Syphonoptera (self study systematic and biology); Identification, nature of attack, and control measures of insect pest of domestic animals – cattle, sheep and goat, fowl, dog.Acarina – Morphology, biology and control measures.

Module VI. Mode of Transmission and Epidemiology of Vector Borne Diseases 10 hrs

Malaria, Filariasis, Yellow Fever, Dengu Fever, West Nile Disease , Chickungunia, Encephalitis, Kala-azar, Plague, Typhus, Kyasanur Forest Disease, Scabies – control of vectors.Vector control measures.

Module VII. Beneficial Insects 10 hrs

Biology and rearing of Honey bees, Silk worm, lac insect; Insects of forensic importance – crime detection using entomological science. Examples of forensically important insects; DNA techniques in forensic entomology.

Module VIII. Insect Host Interactions 8 hrs

Selection of hosts (plants and animals); Evolution of phytophagy and haematophagy in insects; Insect host resistance; Insect pollinator – plant interaction. Modern findings.

REFERENCES

Apple, J.L. and R.R. Smith .1976. *Integrated Pest Management*. Plenum Press, New York.

Awasthi, V.B. 2002. *Introduction to General and Applied Entomology* (2nd edn). Scientific Publishers (India), Jodhpur.

Byrd, J.H and J.L Castner (Eds).2000. *Forensic Entomology: The utility of arthropods in legal investigations,* CRC Press,London

Dent, D.1991. *Insect Pest Management.* CAB International, UK

Ghosh M.R. 1989. *Concepts of Insect Control*. Wiley Eastern Ltd. Bangalore and New Delhi

Kettle, D.S.1995. *Medical and Veterinary Entomology*. CAB International.

Metcalf, G.L. and W.P. Flint.1962. *Destructive and Useful Insects, their habits and control.* Tata McGraw Hill Publ. Co Ltd. New york

Mullen, G. and Durden, L. (Eds).2002. *Medical and Veterinary Entomology*. Academic Press.

Nayar, K.K., Ananthakrishnan, T.N. and B.V. David. 1976. *General and Applied Entomology*. Tata McGraw Hill Publ. Co. Ltd New Delhi

Patton, W.S. and Crag, F.N. 1973. *A Textbook of Medical Entomology*. International Books and Periodicals, New Delhi

Pedigo, L.P. 1996. *Entomology and Pest Management Practice*. Hall India, Pvt. Ltd. New Delhi

Ramakrishna Ayyer, R.V. 1963. *A Handbook of Economic Entomology of South India*. Govt of Madras Publications

Service, M.W.1996.*Medical Entomology for Students.* Chapman and Hall, UK

Smith, K.V.G.1986. *A Manual of Forensic Entomology*. British Museum Natural History.

Rao, V.P. Ghani, M.A., Sankaran T and Mathur, K.C. 1971. *A Review of Biological Control of Insects and Other Pest in South East Asia and Pacific region.* CAB, England.

Srivastava, K.P.1996. *A Textbook of Applied Entomology Vol. I and II*. Kalyani Publishers, Ludhiana, New Delhi

Thacker, J.R.M. 2002. *An Introduction to Arthropod Pest Control*. Cambridge University Press, UK

Wall, Richard and Sheares, David.1998. *Veterinary Entomology*. Chapman and Hall.

Walter G. 2003. *Insect Pest Management and Ecological Research*. Cambridge University Press, UK.

Yazdani, S.S. and Agarwal, M. L.1997. *Elements of Insect Ecology*. Narosa Publishing House, New Delhi.

Ananthakrishnan, T.N. (1992) *Dimensions of Insect – Plant Interactions.* Oxford and IBH Publishing Co.Ltd. New Delhi.

Atwal, A.S. 1986. *Agricultural Pests of India and South East Asia.* Kalyani Publications New Delhi.

Fenemore, P.G. and Prakash A. 1992. *Applied Entomology.* Wiley Eastern Ltd. New Delhi.

Hill, D.S. 1983. *Agricultural Insect Pests of Tropics and Their Control.* Cambridge University Press Cambridge.

Matsumura, F. (Ed). 1975. *Toxicology of Insecticides.* Plenum Press New York.

Nair, M.R.G.K. 1986. *Insects and Mites of Crops in India.* ICAR New Delhi.

Nair, M.R.G.K. 1978. *A Monograph of Crop Pests of Kerala and Their Control.* Kerala Agricultural University.

Pradhan, S.1969. *Insect Pests of Crops.* National Book Trust of India, New Delhi.

■

ZY 4A EP04 PRACTICAL – I MORPHOLOGY,ANATOMY AND TAXONOMY

90 hours. (5 hrs./week) **Credit- 2**

Study of mouthparts in insects (Grasshopper,plantbug,mosquito,honeybee, house fly)
Study of different types of antennae, genitalia and legs.
Sting apparatus –honeybee
Wings and wing venation in insects of 5 orders.
Study of sexual dimorphism in insects
Preparation of dichotomous keys with reference to various insect orders
Dissection of alimentary canal and associated glands of different insects (plant bug,honey bee,oryctes, grasshopper.
Dissection of nervous system in different insects (plantbug,honeybee,oryctes,grasshopper)
Dissection of reproductive system in insects (cockroach,oryctes ,grasshopper, Plant bug)
Dissection of stomatogastric nervous system –cockroach
Collection and preservation of insects (students are required to submit an insect collection belonging to 50 families-dry collection,wet collection, whole mounts and slides) at the time of practical examination.

Field Study Report:
Visit to two institutions engaged in entomology research and different ecological niches other than local area for collection of insects. The field study is for 3-4 days. Report the study conducted and submit a 10 page write up/ print out giving the dates, daywise itinerary, methodology, results and references. Include photgraphs of the activities. Group and individual assignments shall be preferred.

ZY 4A EP 05 PRACTICAL – II INSECT PHYSIOLOGY AND APPLIED ENTOMOLOGY

90 Hours (5 Hours/week) **Credit-2**

Survey of digestive enzymes –amylase,invertase,protease and lipase in different parts of the gut in cockroach,grasshopper, dragonfly
Dye transport by Malpighian tubule using dyes
Identification of free aminoacids (at least 3) in haemolymph by paper chromatography.
Haemocytes –staining and identification.
Collection and identification of insect pests of different crop plants,fruit trees,vegetables and stored products
Collection and identification of insect vectors of man and domestic animals.
Collection and preservation of economically important insects, their life stages, products, damaged parts.
Collection and identification of insect damages to crop plants.
Insecticide appliances.
Determination of LC_{50} using probit analysis.
Collection – Students are expected to submit a collection consisting of insect pest of different crops, stored products, domestic animals and man. Useful insects, their life stages and products, parasites and predators

■

SEMESTER IV

ELECTIVE COURSE B : FISHERY SCIENCE

ZY4B ET 01	ICHTHYOLOGY
ZY4B ET02	FISHERY RESOURCES & MANAGEMENT
ZY4B ET03	FISHERY TECHNOLOGY
ZY4B EP04	PRACTICAL –I. TAXONOMY, ANATOMY, PHYSIOLOGY & PATHOLOGY
ZY4B EP05	PRACTICAL-II . FISHERY BIOLOGY & TECHNOLOGY

ELECTIVE B - FISHERY SCIENCE

Objectives:

- To learn fish diversity, fish habitats, and fishery resources
- To tmpart knowledge regarding fish biology
- To understand the various aspects of inalnd and marine fisheries
- To equip the students with the techniques of aquaculture and fish processing
- To provide professional enterprneurship skills in fishery science

ZY4B ET01 ICHTHYOLOGY

90 Hours (5hrs./week) **Credit:4**

Module 1. Taxonomy, Evolution and Distribution **10 hrs.**

Origin and evolution of fishes, Classical taxonomy – morphometrics, meristics.
Methods employed in phylogenetic studies and fish identification, fish barcoding.
Classification up to orders.Biogeographical distribution of fishes.

ModuleII. Body Form and Locomotion **10 hrs.**

Body shape, body musculature**.**Swimming and non-swimming locomotion and buoyancy regulation-propulsive systems, hydrodynamic analyses, swimming modes, fish bio-modelling, bioenergetics, strategies for buoyancy regulation.Fins- types, structure, modifications and functions.Theories of origin of median and paired fins.Integument and Exoskeleton.
Colouration-chromatophore pigments and colouration.Physiology of colour change.

Module III. Food and Feeding **6 hrs.**

Structure of alimentary canal.Food, feeding habits and adaptations.Physiology of digestion and absorption.

ModuleIV. Blood Vascular System and Defense Mechanisms **10 hrs.**

Circulatory system - modifications in blood circulation in relation to air breathing.
Defense mechanism–immune system, cells and tissues of the fish immune system, modulators of fish immune responses, humoral and cell mediated immune defense, fish antibody molecules and their effector functions.

ModuleV. Respiratory System **6 hrs.**

Gill structure and Physiology of gill respiration.Accessory respiratory organs and mechanism of air breathing in fishes.Swim bladder , structure and function.Weberian ossicle.

ModuleVI. Excretory System **4 hrs.**

Structure and functions of kidney. Nitrogenous products and patterns of their excretion.

ModuleVII. Nervous System and Sense Organs **10 hrs.**

Structure and functions of central and peripheral nervous systems.Structure and functions of sense organs.-visual,chemoreception,statoacoustic,mechanoreceptors,thermoreceptors, and electroreceptors.

ModuleVIII. Specialized Characters **6 hrs.**

Sound production and detection, Acoustic communication.Electric organs, Luminescent organs, Venomous fishes.

Module IX. Endocrine System and Reproduction **10 hrs.**

Functions of the endocrine organs and tissues-Pituitary, Thyroid, Gonad,Adrenals,Corpuscles of stannous, Endocrine pancreas, Ultimobranchial. Sexuality, hermaphroditism, (gonochorism), Modes of reproduction

– oviparity, aplacentalviviparity and placental viviparity. Reproductive cycles and Breedingbehaviour.Nest building and parental care.Hormonal and environmental regulation of reproduction.

Module X. Ecology of Fishes **8 hrs.**

Adaptations to special conditions of life – deep sea, cave, hill-stream fishes.Aestivation and hibernation.Migrations and orientation.Homing and territorial recognition.Schooling.

ModuleXI. Fish Pathology **10 hrs.**

Fish diseases and their causes.Viral diseases.Bacterial infections.Fungal infections.Protozandiseases.Helminth parasite infections.Crustacean parasite infections.Ulcers and tumours.Prophylactic and therapeutic measures.

REFERENCE

Aline, W. 1980. *Fish Diseases*. Springer,Berlin, Germany.

Ali, M.A. (Ed) 1980. *Environmental Physiology of Fishes*. NATO Advanced study institutes series A: Life science volume. Plennum Press, New York

Axelrod, H.R. and Sweenen, M.E., 1992.*The Fascination of Breeding Aquarium Fishes*.TFH publication Inc.

Austin, B. and Austin, D.A. 1987. *Bacterial Fish Pathogens (Diseases in Farm and Wild).* Ellis Horward Pub. UK

Bakeson, B.A 1984. *Fish Migration*. Chapman and Hall, London.

Carl, J. Sindermann, 1990. *Principal Diseases of Marine Fish and Shelfish*.Vol. I & II, Second Edition.Academic Press.

Chris Andrews, Adrian Excell and Neville Carrington 1988.*The Manual of Fish Health*. Salamander Books Ltd., London.

Evans, D. H. and Claiborne, J. D. 2006. *The Physiology of Fishes*. Taylor and Francis Group, CRC Press, UK.

Felix, S. Riji John, K, Prince Jeyaseelan. 2011. *Fish Disease Diagnosis and Health Management*. Publication by Fisheries College and Research, Institute, T.N. Veterinary and Animal Sciences.

Geroge Iwama and Teruyuki Nakanishi (Eds.) 1996. *The Fish Immune system – Organism, Pathogen and Environment.*Academic Press Publication.

Ronald J. Roberts (Ed.) 1989. *Fish Pathology* (2nd Edn.). Baillere Tindall, London.

Schaperclaus, W. 1986. *Fish Diseases* (Vol. I & II). Oxonian Press Pvt. Ltd.

Valerie Inglis, Ronald J. Roberts and Niall R. Bromage 1993. *Bacterial Diseases of Fish*. Blackwell Scientific Publication, London.

Wedmeyer, G. Meyer, F.P. and Smith, L., 1999. *Environmental Stress and Fish Diseases.* Narendra Publishing House, Delhi.

Woo, P.T.K.and Bruno, D.W. (Eds.) 1999. *Fish Diseases and Disorders*. Vol. 3- *Viral, Bacterial and Fungal Infection*. CAB International Publishing.

■

ZY4B ET02 FISHERY RESOURCES AND MANAGEMENT

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

Module I. Inland Fishery Resources **15 hrs.**

Freshwater and brackish water fishery resources – Pond, Lakes, Tanks, Estuaries, brackish water lagoons, wetlands and mangroves.Major riverine fisheries in India.Peninsular rivers and its fishery diversity with special reference to endemic species in Kerala.Reservoir fisheries – classification of reservoirs.Methods of enhancement of productivity.Reservoir fisheries of Kerala.Estuarine fisheries – Status and potential of estuarine fisheries, Backwaters of Kerala.Scope of Inland fisheries in Kerala.

Module II. Problems and Management of Inland Fishery **20 hrs.**

Approaches to management of Inland fisheries resources for sustainable development – Activities of FIRMA and Matsyafed.Management challenges of riverine fisheries and fishes.Management of estuarine fisheries.Biodiversity and Management of inland waters with special reference to Vembanad lake and Sasthamkotta lake.Mangrove ecosystem – Degradation and its problems on coastal fisheries.Invasive species and its effect on fish diseases. Derelict water bodies – problems and management aspects.Protection and restoration of fish movements – different types of fish passesand enhancement of fish migration.Effects of dams on riverine fisheries**.**Sand mining and its impact on fisheries.

Module III. Marine Fishery Resources and Oceanography **15 hrs.**

Coastal Resources:coastal biological resources - finfish, shellfish, seaweeds, sea grasses. Ecological subdivisions of the sea-continental shelf, continental slope, ocean base.

Physicochemical properties of sea water-salinity, pH, temperature, light penetration, pressure, dissolved gases, minerals, nutrients and their cycles.Plankton and productivity. Mud banks - formation and significance.Exclusive Economic Zone (EEZ).Indian Antarctica expedition.

Module IV. Climatic Factors and Fishery **10hrs.**

Critically important climatic factors (temperature, rainfall and wind pattern / monsoon influencing aquatic (inland and marine) productivity and production.Remotely sensed SST, Chlorophyll and Wind pattern features of Indian seas used in locatingPotential Fish Zones (PFZ).Influence of rainfall intensity, its seasonal and annual variations on fish migration, breeding.

ModuleV. Marine Biodiversity and Conservation **15hrs.**

Marine biodiversity and its threats. Endangered Species, IUCN, Criteria, Red Data Book. Coral Reefs and their sustainability and conservation.Conservation and Restoration of marine protected areas-Marine parks.Coastal Tourism.

Module VI. Remote Sensing and GIS for Fisheries Management **15 hrs.**

Basic terms and Concepts- Electromagnetic radiation and its properties, atmospheric interactions, target interactions.Sensor platforms – boats, balloons, air-crafts and satellites, Sensor systems – global acquisition systems and sequential acquisition system.Environmental satellites – The Landsat series, NOAA & IRS; Digital image processing and interpretation; Elements of GIS, Application of remote sensing and GIS to fisheries and aquaculture planning and development. Study of satellite information,interpretation of Satellite pictures for resource management, case studies in remote sensing and GIS application.

REFERENCES

Bal, D.V and K.V. Rao. 1989. *Marine Fisheries*. Tata Macgraw Hill publishing company, New Delhi.

Benson, P.1998. *Deveolopment of Marine Fishery Science in India*. Daya Publishing House, New Delhi.

Butler, Mouchot, Barele and LeBanc,1988. *The Application of Remote Sensing Technology to Marine Fisheries.* www.marifish.net.

Dholakia,A.D. 2001.*Fisheries and Aquatic Resources of India.* Daya Publishing House, New Deihi

Dodds, W.K., 2002. *Freshwater Ecology: Concepts and Environmental Applications*. Academic Press, New York

Jhingran. *et al.,* 1983. *Contributions to the Fisheries of Inland Open Water System in India.* IFSI, Mumbai.

Misra,S.R. 2006. *Inland fiheries in India:Issues and concerns*.Concept publishing company.

Pillai ,NGK.2011. *Marine Fisheries and Mariculture in India ,*ICAR, New Delhi.

Rilov, G. and Jeffrey, A. C.2009. *Biological Invasions in Marine Ecosystems: Ecological, Management and Geographic Perspectives*. Springer-Verlag, Germany

■

ZY4B ET03 FISHERY TECHNOLOGY

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

Module I. Introduction **3hrs.**

Major Fishing nations of the world, Major fishing regions.

Module II. Methods of Fishing **15 hrs.**

Crafts and gears used for fishing in inland and marine waters. Gears–Types of gears-design, operation and efficiency. Destructive and prohibited fishing practices. Recent advances in fishing methods. Fishing using electricity,light.Bycatch reduction devices : Definition, types of bycatch reduction devices and the principles of operation. Fish finders (echo sounders and sonar) and their use.Turtle Excluder Devices: Definition, Types of TEDs.Advanced communication Systems – VHF, SSB, Inmarsat system.Vessel Monitoring Systems (VMS): Importance, uses, role in fisheries management.Satellite navigation system: GPS : Components of GPS, working, functions, hand held GPS,important applications of GPS in fisheries and aquaculture. Fishing harbours: Classification, facilities, layout of a typical fishing harbour.

.

Module III. Freshwater Culture Fisheries **22 hrs.**

Methods of culture and cultivable fishes (Carps, Catfishes, Murrels, Prawn). Fish food organisms (Algae, Artemia, Zooplankton). Induced breeding of fishes through hypophysation with special reference to Indian major carps.Management of freshwater fish farm - survey of site, layout, soil, water quality requirements.Soil and waterquality management in aquaculture.Pond Fertilization-different kinds of fertilizers and manures, Bio-fertilizers, use of treated sewage for pond fertilization.Aquatic weed management.Algal bloom control, Eutrophication, Waste watertreatment practices. Role of microorganisms in fish production, microbial load and algal blooms.

Fish seed collection and Preservation technology - natural collection, bundh breeding, induced breeding, cryopreservation of gametes. - transport of eggs, fry, fingerlings and adults.

Nutrition of aquatic animals - nutritional requirements of commercially important finfish and shellfish, dietary requirements of larvae and brooders, feed types, manufacture and ingredients, , use of attractants and growth stimulants in fish feeds, alternative protein sources in aquaculture diets, feeding techniques, role of probiotics in nutrition.

Role of genetics in aquaculture– gynogenesis, androgenesis, triploidy, tetraploidy, hybridization, sex reversal and breeding, production of transgenic fish, impact of GMOs on aquatic biodiversity.

Methods of culture of Indian major carps (Rohu, Catla and Mrigla), exotic carps (common carp, grass carp and silver carp) and Tilapia.Culture of air breathing fishes *(Heteropneustes fossils, Clarius batrachus, Channa*sps, and *Anabas testudineus*). Sewage – fed culture of carps, Tilapia and air breathing fishes. Integrated fish culture (Paddy – cum-fish, fish –cum-duck and fish-cum pig). Composite fish culture**.**

Module IV. Sustainable Aquaculture **8hrs.**

Present scenario and problems: Trends in global and Indian aquaculture; Differentfarming systems; intensive systems and constraints.

Environmental degradationand disease outbreaks.Organic farming; integrated farming; responsible aquaculture; rotational aquaculture; bioremediation; role of biotechnology. Economic viability: export vs. domestic marketing, value addition.

Module V. Brackishwater Culture and Mariculture **8 hrs.**

Methods of culture of Mugilsps.,*Chanoschanos*, milk fish,mullets, crabs, shrimps.Methods of prawn culture- Traditional (Bheries, Pokkali), modern.Culture of pearl oyster, edible oyster and sea mussels.

Module VI. Preservation and Fishery Byproducts 10 hrs.

Post-mortem change and rigor mortis in fish.Assessment of freshness in fish-physical, chemical and microbial evaluation of freshness.Fish spoilage- bacterial and chemical. Fish preservation-handling and cleaning of fresh fish, chilling, freezing, quick freezing, use of chemicals and antibiotics, irradiation, salting, drying, freeze drying, smoking, canning and pickling. Traditional fishery by -products- fish meal and fish oil-preparation and uses. Processing wastes-prawn heads, chitin, Chitosan, Fish protein concentrate(FPC) preparation and Uses of shells, isinglass, glue, guano, fins and leathers.Packaging, storage and transport of fish products.

ModuleVII. Quality Control in Processing Industry and Fishery Export 6 hrs.

Quality factors of food, tests for quality. Plant sanitation and hygiene.Standards for quality of by-products-Indian and international.Wateranalysis.Inspectionsystem.Prospects for augmenting fishery exports.

ModuleVIII. Fisheries Education (Self study) 5 hrs.

Objectives and functions of Institutes: Central Institute of Fisheries Education (CIFE, Bombay), Central Inland Capture Fisheries Research Institute (Barrackpore), Central Marine Fisheries Research Institute (CMFRI, Kochi), Central Institute of Fisheries, Nautical and Engineering Training (CIFNET, Kochi), Central Institute of fisheries Technology (CIFT, Kochi), National Institute of oceanography (NIO, Dona Paula and Kochi).

Module IX. Statistical Methods 9 hrs.

Fisheries statistics-scope and objectives.Fish population-population structure and estimation.Population dynamics, recruitment.Stock assessments.Estimation of yield and optimum yield.Length- weight relationship.

Module X. Aquarium Management 4 hrs.

Aquaria and their uses.Setting up and maintenance of an aquarium.Ornamentalfishes.Setting up of marine aquaria.Selection of compatible species, breeding of aquarium fishes.

REFERENCE

Alikunhi, K. 1957. Fish culture in India. *Farming Bulletin* 20. ICAR, New Delhi.

Bardach, E.J. Rhyther, J.H. & W.O. Mc. Larney. 1972: *Aquaculture. The Farming and Husbandry of freshwater and Marine Organisms.* John Wiley and Sons. New York.

Dunham, Rex A. 2011. *Aquaculture and fisheries technology: Genetic approaches* (2nd edition), CAB International.

ICAR, 2006. *Handbook of Fisheries and Aquaculture, Indian Council of Agricultural Research*, DIPA, New Delhi, India.

James P. Mc Vey. 1983. *Handbook of Mariculture.* Vol. I. CRC Press.Inc. Florida.

P.V.G.K. Reddy, S. Ayyappan, D.M. Thampy and GopalKrishna. 2005. *Text book of fish genetics and biotechnology.* Indian Council of Agricultural research publication, New Delhi.

Pillay T.V.R and M.N.Kutty. 2005. *Aquaculture Principles and Practices*,Weily-Blackwell Publishing, USA.

Takeo Imai, 1978: *Aquaculture in shallow seas. Progress in shallow sea culture*. Amerind Publishing Co. Pvt. Ltd. New Delhi.

Zijpp, V. D., Verreth, J. A. J., Tri, L. Q., van Mensvoort, M. E. F., Bosma, R. H., and Zeveridge, M. C. M., Wageningen, 2008. *Fishponds in Farming Systems*. Academic Publishers, Netherlands.

■

ZY4B EP04 PRACTICAL 1 ANATOMY, TAXONOMY, PHYSIOLOGY AND PATHOLOGY

90 Hours (5 hrs/week) **Credit - 2**

Anatomy

Study of anatomy of a teleost (Cat fish/Carp).External features and gills.

Dissection and display of Viscera, Digestive system, urinogenitalsystem.Branchial blood vessels.Brain and cranial nerves.Dissection of swim bladder, weberianossicles.Skeleton-skull and vertebrae.

Dissection of air-breathing organs and their blood supply of *Anabas, Clarius, Saccobranchus* and *Channa*.

Study of the anatomy of elasmobranchs.Dissection of branchial blood vessels.Brain and cranial nerves.Dissection of internal ear.Preparation of stained mounts of Ampulla of Lorenzini, otolith, scales and gill filaments

Taxonomy

Study of distinguishing features (morphometric and merisitic).

Identification and classifications of at least 20 species(5 marine, both bony and cartilaginous, 5 fresh water, 5 cultivable, 5 aquarium fishes) using manuals.

Identification and classification of distinguishing features of commercially important crustaceans (3 prawns).

Physiology

Determination of the rate of ammonia and urea excretion in fish.

Determination of the haemoglobin content in fish blood.

Identification of blood cells of a teleost.

Study of the effect of epinerphrine, NaCI and KCI on fish chromatophores.

Pathology

Identification of common external and internal parasites of fish

Identification of any 4 fish diseases.

ZY4B EP 05 PRACTICAL II FISHERY BIOLOGY AND TECHNOLOGY

Fishery Biology

Study of feeding habits of fish through qualitative and quantitative analysis of gut contents of herbivore, carnivore and omnivore species.

Study of the scale, vertebra and otolith for determination of age.

Determination of gonadosomatic index.

Estimation of fecundity.

Measurement of ova diameter.

Length-weight relationship.

Study of theprincipal stages in the life history of prawn.

Methodology of induced breeding of fish through hypophysation.

Dissection, collection and preservation of pituitary gland.

Preparation of pituitary extract.

Dosage and technique of injecting pituitary extract(demonstration)

Fishery Technology

Estimation of total protein and identification of amino acids in fish muscle(two directional chromatography).

Extraction and estimation of liver and body oil from commercially important fishes.

Fishing crafts and gears-identification of various components of a mechanized fishing craft from actual specimen/model/drawing.

Study of principal types of fishing gears from actual specimen/model/drawing.

Identification of fishing gear materials:twines, ropes, floats,sinkers,buoys and anchors. Identification of fishery by-products.

Collection and identification of aquatic weeds and aquatic insects.

Formulation and preparation of artificial fish food for Indian major carps and Prawns.

Fish spoilage

Estimation of trimethyl amine

Field work and study tour:

Three to four days tour to study various fishery activities at selected centres/sites; visit to a fish seed production farm. Freshwater/Brackish water aquaculture.Fishing operations, fish landing, packing, transport. Fish preservation and processing chain. Boat building yard and net making plant. NIO, CIFT, CIFNET, CIMFRI *etc*. Report the study conducted and submit a 10 page write up/ print out giving the dates, daywise itinerary, methodology, results and references. Include photgraphs of the activity.
Group and individual assignments shall be preferred.

Each student should submit:

A collection of 15 Fishes/Crustaceans (5 Freshwater, 5 Marine, 5 Aquarium fishes).

■

SEMESTER IV

ELECTIVE COURSE C. : ENVIRONMENTAL SCIENCE

ZY4C ET 01	ENVIRONMENTAL SCIENCE: CONCEPTS AND APPROACHES
ZY4C ET02	ENVIRONMENTAL POLLUTION AND TOXICOLOGY
ZY4C ET03	ENVIRONMENTAL MANAGEMENT AND DEVELOPMENT
ZY4C EP04	ENVIRONMENTAL SCIENCE: PRACTICAL –I
ZY4C EP05	ENVIRONMENMTAL SCIENCE PRACTICAL-II

ELECTIVE C : 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

ZY4C ET 01 ENVIRONMENTAL SCIENCE: CONCEPTS AND APPROACHES

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

Module 1. Introduction to Environmental Science **2 hrs**

Definition, Principle and Scope of environmental Science- its relation to other sciences.

Prerequisite: *Basic concept of ecosystem, abiotic and biotic factors.*

Module II. Earth System and Biosphere **4 hrs**

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

Prerequisite: *Biomes and distribution of life on earth.*

Module III. The Physical Environment **22 hrs**

Lithosphere - Weathering and soil formation, - soil colloids, adsorption and exchange of anions and cations, role of microbes in soil, types of soil, soil profile, classification of rocks, folds, faults and dykes and other geological formations and their environmental significance. Geomorphological processes-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 between earth and the atmosphere, Global water balance, ice sheets, origin and composition of sea water, sea level changes, River basins and watershed. Physico-chemical characteristics of water- diffusion of oxygen from the atmosphere to surface waters. Influence of pH, turbidity and light on aquatic life.

Prerequisite: *Physical and chemical properties of soil, Biomes and distribution of life on earth.*

Module IV. Weather and Climate **12 hrs**

Definitions and scope of climatology, weather and climate, 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.

Global climatic phenomena-*El Nino* and *La Nina*, causes and factors of climate change. Effect of climate change on ecosystems and human welfare. Organisms and microclimate.

Module V. Climate of India **4 hrs**

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

Module VI. Landscape Ecology **12 hrs**

Land and Landscape processes; Hierarchy: ecosystems to land units; ecological principles at work with Landscapes ; Human dimensions and 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. Ecological assessment of landscape for vegetation and habitats. 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; case studies on corridor selection problems.

Module VII. 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, IPRs, 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.

Module VIII. Biological Invasions **10 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.

Module IX. Evolutionary Ecology **4 hrs**

Darwin's ecology and evolution, Evolutionary trees, natural selection and environment, molecular evolution, speciation and extinction.

REFERENCES

Alongi, D. M. 1998. *Coastal Ecosystem Processes*. CRC Press, New York.

Chapman, G.P. 1977. *Human and Environmental Systems: A Geographer's Appraisal*. Academic Press, London.

Chapman, J.L. and Reiss, M.J. 2005. *Ecology: Principles and Applications.* Cambridge University Press, London.

Elton, C.S. 1958. *The Ecology of Invasion by Plants and Animals.* Methuem, London.

Forman, R.T. 1995. *Land Mosaics: The Ecology of Landscapes and Regions.* Cambridge Univ. Press, Cambridge, UK.

Forman, R.T.T. and Godron, M. 1986. *Landscape Ecology.* John Wiley & Sons, New York.

Fox, C.W., Roff, D.A. and Fairbairn, D.J. 2001. (Eds.). *Evolutionary Ecology: Concepts and Studies.* Oxford University Press.

Krebs, C.J. 2008. *Ecology: The Experimental Analysis of Distribution and Abundance*. (6th edn.). Benjamin Cummings Publ., USA.

Krishnamurthy, K.V. 2004. An Advanced Textbook on Biodiversity: Principles and practice. Oxford and IBH. Publ. Co. New Delhi.

Kurian Joseph and Nagenddran, R. 2004. *Essentials of Environmental Studies*. Pearson Education(Singapore) Pvt.Ltd.New Delhi.

Levin, S. A. 2000. (Ed.). *Encyclopedia of Biodiversity*. Academic Press.

Mayhew, P.J. 2006. Discovering Evolutionary Ecology: Bringing Together Ecology and Evolution. Oxford University Press.

Miller, G.T. 2004. *Environmental Science.* Thomson, California.

Odum, E.P. and Barrett, G. W. 2005. *Fundamentals of Ecology*. Thomson Asia Pvt. Ltd., Singapore

Primack, R.B. 1998. *Essentials of Conservation Biology*. Sinauer Associates.

Pullin, A.S. 2002. *Conservation Biology*. Cambridge University Press, UK.

Ray,J.G. 2010. *Basic Principles of Ecology and Environment.* Pratibha Publications, Changanacherry, Kerala.

Ramakrishnan, P.S. 1991. *Ecology of Biological Invasion in the Tropics*. International Scientific Publications, New Delhi.

Ramakrishnan, P.S. 1992. *Shifting Agriculture and Sustainable Development*. UNESCO, MAB, Paris.

Rana, S.V.S. 2005. *Essentials of Ecology and Environmental Science*. Prentice Hall of India, New Delhi

Rose, M.R. and Mueller, L.D. 2006.*Evolution and Ecology of the Organisms.* Pearson Prentice Hall.

Singh, J. S., Singh, S. P. and Gupta, S. R. 2006. *Ecology, Environment, and Resource Conservation.* Anamaya Publ., New Delhi.

Smith, T.M. and Smith, R.L. 2006. *Elements of Ecology*. (6th edn.). Pearson. New Delhi

Soule, M.E. 1986. (Ed.). *Conservation Biology*. Sinauer Associates, New York.

Steiner, F. 1999. *The Living Landscape: An Ecological Approach to Landscape Planning*. (2nd edn.). McGraw Hill, Inc., New York.

Steiner, F. 1999. The Living Landscape: An Ecological Approach to Landscape Planning, 2nd Edition. McGraw Hill, Inc., New York.

Williamson, M. 1996. *Biological Invasion*. Chapman & Hall, London.

■

ZY4C ET02 ENVIRONMENTAL POLLUTION AND TOXICOLOGY

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

Module I. Introduction **3 hrs.**

Brief history of human civilization, industrialization and urbanization. Definition of pollution. Different types of pollution- Air, Water and soil and their local, regional and global aspects.

Module II. Air Pollution **12 hrs.**

Sources and classification of air pollution ; particulates and gaseous pollutants in the atmosphere. 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, $C0_2$, CO, NO_x, $S0_2$, H_2S, oxidants, ozone and hydrogen fluoride.

Control of gaseous emission: adsorption by liquids, adsorption by solids, combustion and condensation. Control of $S0_2$, NO_x, CO, CO_2 and hydrocarbons.

Pre requisites: *GHGs, climate change, carbon foot print and carbon trade*

Module III. Water Pollution **15 hrs.**

Sources of water pollution-Domestic (municipal sewage), industrial and agricultural. Health effects of water pollution. Water borne and water related diseases. Effects of water pollution on aquatic system. Water quality standard for potability - Pollution parameters, BOD, COD, Coliform bacteria.

Treatment of water for potable purpose (mixing, sedimentation, coagulation, filtration and disinfection) Primary and secondary treatment. Sludge disposal. Biological treatment: Kinetics of Biological growth - activated sludge treatment - trickling filters - anaerobic digestion, combined aerobic and anaerobic treatment process, aerobic process.

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. Water pollution treatment using constructed wetlands Bioremediation; traditional water purification techniques.

Module IV. 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 studies on soil pollution in wetland and Highland soils in Kerala. Control of soil pollution. Soil quality parameters and test methods.

Module V. 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; Biodigesters (Biogas plants); incineration, pyrolysis, plasma pyrolysis; sanitary land fills and open dumping yards. Management of plastic and e-waste. Better management strategies (any two model case studies). 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 of Hazardous Chemicals Rules 1989 - Biomedical Waste (Management and Handling) Rules 1998 - Plastic Act 1999. Extended producer rersponsibility.

Module V. Noise, Thermal and Oil Pollution **7 hrs.**

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

Module VI. Radiation Pollution **8 hrs.**

Radiation pollution- Definition, Radioactivity, Radionuclide, Radiation emissions, sources, Radioactive decay and buildup. Biological effects of radiation. Radioactive pollution impacts on ecosystem. Nuclear reactor disasters (Any two case studies), safety standards.

Module VII. Toxicology **20 hrs.**

Definition, scope and history of toxicology, Acute and chronic toxicity, selective toxicity, dose, synergism and antagonism.
Dose – Response relationships – Graded response, quantal response, Time action curves, Threshold Limit value (TLV); LC_{50}; Margin of safety; Toxicity curves; Cumulative toxicity and LD_{50} and CTF.
Toxic chemicals in the Environment – Biochemical aspects of As, Cd, Pb, Hg, Cu, O_3, PAN, pesticides, MIC and other carcinogens. Bio accumulation and biomagnification.
Occupational toxicology- hazardous chemicals, disorders from chemical exposure at work, assessment of occupational hazards.
Toxicity testing; Bioassay – Definition, purpose, criteria for selection of test organism, methodology, estimation of LC_{50}, Limitation and importance of bioassay, acute toxicity (single); sub acute toxicity; chronic toxicity; teratogenicity, carcinogenicity and mutagenicity.
Bio-monitoring of toxic chemicals - objectives, programs and parameters, concepts of bio indicators.
Bio-transformation of Xenobiotics (Selective Toxicity).

REFERENCES

APHA-AWWA-WPCF, 1989. *Standard Methods for the Examination of water and Waste water.* (17th edn.). Publishers.

Butter, G.C.1988. *Principles of Ecotoxicology.* John Wiley and Sons.

Cockerham, G.L. and Shane, B.S. 1994. (Eds.). *Basic Environmental Toxicology*. CRC Press.

Eisenbude, M. 1998. *Environmental Radioactivity*. Academic Press , NY.

Fellenberg, G.1999.*Chemistry of Pollution*. John Wiley and Sons, New Delhi

Hayes,W.A.2001. *Principles and Methods of Toxicology*.CRC Press,NY.

James, P. Lodge, J.R, Year. *Methods of Air sampling and Analysis* (3rd Edn.). ISc Lewis Pub., INC.

Klaassen,C.D and J.B.Walkins. 2003. *Essentials of Toxicology*. Mc Graw –Hill Professional New Delhi

Lutgens, F.K. and Tarbuek, J.E.1992.*The Atmosphere*. Prentice Hall, New Jersey.

Niesink, R.J.M., De Vries, J. and Hollinger, M.A. 1996. (Eds.).*Toxicology- Priniples and Applications.* CRC Press.

Oehme, W.F. 1989. *Toxicity of Heavy Metals in Environment.* Marcel Dakkar Inc., New York.

Purnima,B.b., A.K.Janin and Arun.K.Jain.2011.*Waste Water Engineering Including Air Pollution*. Laxmi Publications (P) Ltd. New Delhi

Samuel, G.1990. *Nuclear Engineering.* Academic Press, N.Y.

Wilber, C.G.1989. *Biological aspects of Water Pollution.* Charles C. Thomas Publishers, Ilinois, USA.

■

ZY4C ET03 ENVIRONMENTAL MANAGEMENT AND DEVELOPMENT

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

Module I. Environmental Management **20 hrs.**

Basic principles: Management of physical, social, and economic environment. Concepts and scope of environmental planning,regional planning and management. Cost-benefit analysis and Resource economics. Environmental modeling- simulation modeling, input-output modeling, Linear programming, Software and resource management.

Tool box for environmental management – An over view of Ecological foot prints,SEA, Ecological Economics, conflict resolution strategies. Eco funds.

Environmental auditing and standards Eco labeling 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.**

An overview Population, Resources and ecosystem management Exponential growth in human numbers and the implications.

Major management concepts and methodologies The five basic laws of Ecology and their relevance for ecosystems management; paradigm shifts in the management of Ecosystems- influence of economics in ecology.

Management practices for various ecosystems: grasslands, forests, mountains, wetlands and coastal areas. Environmental planning and management of – waste lands, reclaimed lands, mining areas, human settlements,industrial lands and agricultural lands.

Eco restoration/remediation; local knowledge and management systems; environmentally sound management of Biotechnologies; the common property resources and their management.

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-E1A Processes, Stages, E1A Statement Environment management plan- Risk assessment and disaster management programme. National Policy on EIA and Regulatory Framework: Environmental Impact Assessment Notification 2006 and Coastal Zone Notification 1991; Environmental Clearance Process in India;Legislative requirements (discharge requirements and area restrictions); Environmental Appraisal procedure for mining, industrial , thermal power, nuclear power and multipurpose river valley projects; Central and state pollution control boards for environmental protection. EIA case studies. Life Cycle Assessment (LCA) and its significance.

Module IV. Remote Sensing and GIS* **15 hrs.**

Principles and concepts of Remote Sensing, Electromagnetic spectrum; spectral characteristics of surface features (rocks, soils, vegetations, water). Space Imaging Landsat, SPOT, IRS, NOAA, Seasat, ERS, RADARSAT, INSAT. Satellites and their sensors, geometry and radiometry, Digital Image Processing: Principles, Image Rectification and restoration, Image enhancement and Mosaicing. Image classification. Supervised, Unsupervised, Ground truth data and training set manipulation, Classification accuracy assessment. Geographical Information System (GIS): Basic principles and terminologies, Raster and vector data, Map projection, Topology creation, Overlay analysis, Data structure and Digital cartography; Software used in GIS Surveying: Leveling, Triangulation, Geodetic survey; Global Positioning System (GPS) Basic principles, Applications to environmental studies.

Module V. Environment Vs Development **5 hrs**

Dominance of Man on earth. Limits of growth. Industrial revolution and resource utilization,environmental consequences. Modern agriculture and green Revolution- environmental impacts. Conflicts of interest - environment and development. Tragedy of the commons.

Module VI. Sustainable Development **10 hrs**

Our common future and the idea of Sustainable Development - concepts and dimensions. Basic needs-Imperatives relating to sustainable development. Johannesberg Conference 2002 and follow up Conference on sustainable development. Securing Sustainable futures Millennium Development Goals and Strategies (MDG & S); the earth charter; need and scope for evolving participatory, community based environmental management strategies. Education for sustainability. Building sustainable societies and lifestyles. Ecological Foot Print 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.

REFERENCES

Agarwal, N.K. 2004. *Essentials of GPS*. Spatial Networks Pvt. Ltd., Hyderabad.

Agarwal, S.K. 2002. *Eco informatics*. APH Publishing Corporation, Hyderabad.

Asit K. Biswas *et.al.*, 1987. *EIA for Developing Countries*. United Nations University, Tokyo.

Carter,L.1996. Environmental Impact Assessment. McGraw Hill,New Delhi

Coronel, C., Morris, S. and Rob, P. 2009. Database Systems: Design, Implementation and Management.9th edn., Course Technology.

Eagles, P.F.J.1987. *The planning and Management of Environmentally Sensitive areas*. Longman Group Ltd., USA.

Elachi, C. 1978. *Introduction to Physics and Techniques of Remote sensing.* John Wiley Pub., N.Y.

Ewing B., D. Moore, S. Goldfnger, A. Oursler, A. Reed, and M. Wackernagel. 2010.

Floyd F., and Sabins Jr.,W.H. 1987. *Remote Sensing, Principles and Interpretation*. Freeman & Company, New York, 2nd Ed., 1987.

Gadgil, M. and Guha, R. 1995. *Ecology and Equity- The Use and Abuse of Nature in Contemporary India,*.Penguin India.

Gadgil, M. and Guha, R.1998. *The Fissured Land; An Ecological History of India*; Oxford University Press, New Delhi.

Goldsmith, B. 1992. (Ed.) *Monitoring for Conservation and Ecology.* Chapman and Hall, London.

Jorgensen, S.E. 1996. *Applications of ecological modeling in environmental management.* Elsevier Sci. Co., London.

Jorgensen, S. E., Chon, T S. and Recknage, F. A., 2009. *Handbook of Ecological Model in and Informatics.* WIT Press

Kang-tsung, C. 2000. *Introduction to GIS*. Tata Mc Graw Hill, New Delhi.

Knight, R L and White, L. 2009. *Conservation for a New Generation Redefinig Natural Resources Management*. Island Press, USA

Kurian Joseph and Nagenddran, R. 2004. *Essentials of Environmental Studies*. Pearson Education (Singapore) Pvt.Ltd. New Delhi.

Lawrence, D.P. 2003. *Environmental Impact Assessment: Practical Solutions to Recurrent Problems.* John Wiley and Sons, New Delhi.

Lillesand, T.M. and Kiefer, R.F. 1994. *Remote Sensing and Image interpretation*. John Wiley & Sons, New York.

Maguire, D., Batty, M., Goodchild, M., (Eds.) 2005. *GIS, Spatial Analysis, and Modeling,* Esri Press, USA

Meadows, D., Randers, J. and Meadows, D. 2004.*Limits to Growth: The 30 Year Update* London, Earthscan.

Meffe, G. K., L. ,Nielsen, R. ,Knightand Schenborn. 2002. *Ecosystem Management: Adaptive, Community Based Conservation*.Plenum Press.

Miller. G.T., Jr. 2004. *Environmental Science*. Thomson, California.

Milner Gulland,E.J. and J Marcus Rowcliffe, 2007. *Conservation and Sustainable Use a handbook of Techniques.* Oxford University Press

Muralikrishna, I.V. 2001. *Spatial Information Technology- RS and GIS*. Vol.I and II BS

Peter Calow. 1998. (Ed.) *Handbook of Environmental Impact Assessment*. Mc Graw Hills Inc., New Delhi

Pullin, A.S. 2002. *Conservation Biology*. Cambridge University Press, UK.

Rao,D.P (Ed).1998. *Remote Sensing for Earth Resources*. Association of Exploration Geophysicist,Hyderabad

Simon Dresner 2008. The Principles of Sustainability Solutions. Earthscan paperbacks,

The Ecological Footprint Atlas 2010. Oakland: Global Footprint Network.

Tyler Miller, G Jr, 2005. *Advantage Series: Sustaining the Earth An Integrated Approach* (with CD ROM and Info Trac). 7th Edition., Thomson/Brooks Cole, USA

UN General Assembly.2010. *Keeping the promise: a forward-looking review to promote an agreed action agenda to achieve the Millennium Development Goals by 2015.* Report of the Secretary General.

Westman W.E 1995. *Ecology, Impact Assessment and Environmental Planning*. John Wiley and sons. NY,USA.

World Commission on Environment and Development.1987. '*Our Common Future'*, New York: Oxford University Press

Web Resources

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

■

ZY4C EP04 ENVIRONMENTAL SCIENCE: PRACTICAL –I

90 Hours (5 hrs/week) **Credit - 2**

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.
Determination of Calcium Carbonate in Egg shell- (Three different types of egg; calculate the mean value and the standard deviation, and compare it with the standard values).
Estimation of primary productivity in two different aquatic ecosystems and interpretation of the results. Compare the results of Dark and Light bottle method and Chlorophyll method.
Identification of trophic levels from gut analysis (Fish or insect)
Study of biodiversity in Forest/Grass land and Pond/River and report the species richness, abundance and animal interactions. Calculate frequency, abundance, eveness and diversity indices *(This can be done as part of the three / four day field study compulsory for this elective).*

ZY4C EP05. ENVIRONMENMTAL SCIENCE PRACTICAL-II

90 Hours(5 hrs/week) **Credit -2**

Water Quality Analysis:
a. Determination pH, Electrical conductivity, Alkalinity, Salinity, Hardness, Nitrate, Phosphate and Silica
b. Determination of total dissolved salts (TDS)
Toxicity Analysis of Water: For Chlorine, H_2S, Ammonia, Copper and Chromium
Estimation of BOD and COD of polluted water
Determination of LC_{50} for fish (pesticide) using Probit analysis (use of appropriate software is suggested to find out the value)
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).
Isolation and Enumeration of microorganisms in soil (TBC or TMC).
Bacteriological quality testing of water and wastewater.
(a). Presumptive coliform test
(b). Confirmatory coliform test

Field Study Report: (Three /four days)
Visit to Institutions engaged in environment /conservation research; a sanctuary/national park and an industrial /polluted area. Report the study conducted and submit a 10 page write up/ print out giving the dates, daywise itinerary, methodology, results and references. Include photgraphs of the activity. Group and individual assignments shall be preferred.
(*The activity suggested in Practical -1 can be clubbed with this field study).*

SEMESTER IV

ELECTIVE COURSE D: MEDICAL MICROBIOLOGY

ZY4D ET 01	GENERAL MICROBIOLOGY & PARASITOLOGY
ZY4D ET02	BACTERIOLOGY, VIROLOGY & MYCOLOGY
ZY4D ET03	CLINICAL MICROBIOLOGY
ZY4D EP04	PRACTICAL –I. GENERAL MICROBIOLOGY & PARASITOLOGY
ZY4D EP05	PRACTICAL-II . CLINICAL MICROBIOLOGY

ELECTIVE D.: MEDICAL MICROBIOLOGY

Objectives:

To introduce the diversity of microbial world

To learn various patyhogens, parasites and related diseases of man

To familiarise with various tools and techniques in the study of microbes and to manage a microbial laboratory

To provide skills and competency in the field of clinical microbiology

ZY4D ET01 GENERAL MICROBIOLOGY AND PARASITOLOGY

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

Module 1. Historical Introduction to Microbiology **3 hrs.**

History, scope, relevance and future of microbiology.

Module II . Nomenclature and Identification of Bacteria **12 hrs.**

Identification and nomenclature of bacteria - common biochemical tests for the identification.

Serological identification. Classification of bacteria and salient features according to Bergey's manual of determinative Bacteriology. Microbial diversity in different ecosystems (halophiles, mesophiles, thermophiles, acidophiles, alkalophiles, barophiles and other extremophiles). Identification and classification using molecular techniques.

Module III. Sterilization and Control of Microbial Growth **20 hrs.**

Control of microorganisms by physical methods: heat, filtration and radiation; Sterilization equipments: Hot air oven and Pasteurization, Tyndallization.

Autoclaves- principles, precautions and applications; Filtration- types and methods

Sterilization by radiation.

Chemical methods: phenolics, alcohols, halogens, heavy metals, quartenary ammonium compounds, aldehydes and sterilizing gases; Disinfectants and their mechanisms of action.

Evaluation of antimicrobial agent effectiveness. Antibiotics- types, mechanism of action. Determination of MIC and MBC

Antibiotic sensitivity tests, antibiogram.

Antimicrobial agents (bacterial, viral and fungal).

Module IV. Microbial Growth and Cultivation of Bacteria **10 hrs.**

Growth and nutritional requirements of bacteria. Autotrophs, heterotrophs - enrichment culture - growth curve - Kinetics of Growth - Mathematical expression of exponential growth phase; Measurement of growth and growth yields - Culture media, culture methods; Batch Culture - Synchronous growth - Techniques of pure culture.

Module V. Study of Morphology of Bacteria **20 hrs.**

Microscopy, different types of microscopy.

Morphology and arrangement of bacteria, ultrastucture of bacteria. Cellular components of bacteria - sporulation and its mechanics.

Staining: Principle and Methods. Simple Staining and Differential staining, Common differential staining - Gram staining, Acid –fast staining (Ziehl-Neilson Method), Staining of Specific Structures, Spore staining (Schaeffer-Fulton Method), Capsule staining, staining of volutin granules, Negative staining.

Examination of bacterial motility.

Epidemiology of bacterial infections, Guidelines for the collection, Transport, Processing analysis, isolation of bacterial pathogens and reporting of cultures from specimens for bacterial infections.

Module VI. Microbiology of Water, Milk and Food Substances 5hrs.

Microbial contamination of water- types, sources, threats. Microbial contamination of milk. Food poisoning. Major food borne diseases. Methods of detection of mirobial contamination of food, water and milk. Microbial standards of drinking water.

Module VII. Parasites and Vectors 20 hrs.

Study of Parasites- parasitism,types, origin and theories.

Structure and life cycle of the following parasites and pathogenesis of diseases caused: Also study their laboratory diagnosis, treatment and prevention, antiparasitic agents and susceptibility test (of each).

Protozoan parasites-*Entamoeba histolytica, Plasmodium* sp*., Lieshmania, Trypanosoma, Trichomonas*, *Giardia.*

Taenia; Trematodes: *Schistosoma; Paragonimus*;

Helminthes – *Ascaris lumbricoides,* Hook Worm, Pin worm, Filarial Parasites.

Arthropod vectors of medical importance: defenition, types, importance. Major vector borne diseases and their pathogens.

A brief study of the following insects, the major diseases they transmit, epidemiology of such diseases, control and preventive measures:

Mosquito, Sand fly, House fly, Tse-Tse fly, Fleas, Louse, Bed bug, Ticks, Mites

REFERENCES

Ananthanarayanan R. And C.K. Jayaram Panicker, 2006. *Text book of Microbiology*.Orient Long Man,New Delhi

Case T.F, *et al.,* 2011. *Microbiology an Introduction* (9th edn.). The Benjamin/Cummings Publishing Company. Inc. NY, USA.

Davis, D. and E. Ginsberg, 1990. *Microbiology* (4 edn.).Harper and Row Publishers, Singapore.

England P.T. and A.Sher. (eds). 1988. *The Biology of Parasitism- A Molecular and Immunological Approach*. Alar. R. Liss.New York

Ketchum P.A. 1988. *Microbiology -Concepts and Applications*. Oakland University Press. NZ.

Markell, E.K., Voge, M and D.T. John. 2002. *Medical Parasitology*. W.B. Saunders, Philadelphia.

Prescott M.C, J.P.Hardley and D.A. Clean.2001. *Microbiology.* ASM, USA

Ross,N.E. and J.D.Mclaren (eds). 1986. *Pathophysiological Responses to Parasites*. British Society for parasitology, London.

■

ZY4DET02 BACTERIOLOGY, VIROLOGY AND MYCOLOGY

90 Hours (5hrs/week) **Credits- 4**

Module I. Pathogenesis **5 hrs.**

Mechanism of pathogenesis- bacterial and viral.
Prophylaxis of communicable diseases.

.

Module II. Pathogenic Bacteria **25 hrs.**

Study of important properties, pathogenicity and laboratory identification of: *Staphylococci, Streptococci, Pneumococcus, Corynebacterium diphtheriae, Bacillus anthracis, Clostridium Neisseria, E.coli, Proteus, Klebsiella, Shigella* and *Salmonella*. *Vibrio, Pseudomonas, Haemophilus, Brucella.*
Study of important properties, pathogenicity and laboratory identification of: *Mycobacterium, Treponema, Leptospira, Yersinia, Bordetella, Mycoplasma*, Actinomycetes, Rickettsiae and Chlamydiae A brief study of bacteria *viz*. *Borrelia, Listeria, Campylobacter, Helicobacter* and *Legionella.*

Module III. Bacterial Infections of Human Body **15 hrs.**

Bacterial infections of respiratory tract, Bacterial infections of gastro intestinal tract and food poisoning, Bacterial urinary tract infections, Bacterial infections of genital tract and reproductive organs, Bacterial infections of central nervous system, Skin and soft tissue infections, Bone and joint infections, Eye ear and sinus infections, Cardiovascular infections, Tissue samples for culture, Anaerobic infections, Zoonotic infections.
Infections associated with immunodeficiency and immune suppression, Pyrexia of unknown origin.

Module IV. Virology **20 hrs.**

Study of properties of viruses *viz*., Alpha virus, Pox, Herpes Virus, Adeno, Orthomyxo virus, Paramyxo virus and Papova. Pathogenesis and laboratory diagnosis of diseases caused by these viruses.
Sudy of properties of.viruses *viz.* Polio, Influenza, Rabies, and Rubella viruses, Hepatitis viruses, HIV and AIDS.
Pathogenesis of these viral diseases
Oncogenic viruses, Slow viruses and Prion diseases
Immunology of viral infections

Module V. Control of Viruses and Emerging Viruses **5 hrs.**

Control of viral infections through vaccines, interferons and chemotherapeutic agents.
Structure, genomic organization, pathogenesis and control of Human immunodeficiency virus.
Emerging viruses

Module VI. Bacteriophages **10 hrs.**

Structure and life cycle patterns of T-even phages; one step growth
curve and burst size; Bacteriophage typing; Structure of Cyanophages, Mycophages.
General principles of phage-bacterium interaction and growth cycle studies of RNA and DNA phages. The biochemistry of phages infected bacterium. Phage genetics.

Module VII. Mycology **10 hrs.**

Introduction, Classification of fungi, General techniques used in mycology. Cultivation of fungi, Staining of fungi.
Mycosis in man-Classification, pathogenesis and clinical findings in various superficial, cutaneous and systemic fungal infections. Oppurtunistic mycoses;
Immuno compromised situation and mycological infections; emerging diseases.
Antifungal agents (specific to disease to included in course) and their susceptibility test.

REFERENCES

Ananthanarayan and Jayaram Panicker. 2002. *Text Book of Microbiology.* Orient Longman.

Belsche, R.B., 1991. *Text Book of Human Virology* (2nd edn.). Mosby, St.Louis.

Dimock, N and L.Primrose.1987. *Introduction to Modern Virology* (3rdedn.). Oxford Blackwell.

Duerdon, D.L.and Dresser, B.S. (eds).1991. *Anaerobes in Human Disease*. London Arnold.

Emmons *et al.,* 1997. *Medical Mycology.* Lea and Febiger ,Philadelphia.

Goodfellow, M and R.G. Board (ed).1989. *Microbiological Classification and Identification.*

Grady F.O, H.P. Lambert, R.G. Finch, G. Greenwood.1997. *Antibiotic and Chemotherapy; Anti-infective Agents and their Use in Therapy* (7th edn).Churchil Livingstone, NY.

Kwon-Chung, K.J and J.E. Bennet.1992.*Medical Mycology*. Lea &Febiger,Philadelphia,

Larone,D.H.1980. *Laboratory Handbook of Medical Mycology.* Academic press New York.

Mims C.A. and D.O. White,1994.*Viral Pathogenesis and Immunology.* Oxford Blackwell.

Monica Cheesbrough 1991. *Medical Laboratory Manual for Tropical Countries.* Vol.2.ELBS

Panicker, CKJ.1998. *Text book of Medical Parasitology*, Jaypee, New Delhi.

Szaniszlo,P.J. (edn) 1985.*Fungal Dimorphism; with Emphasis on Fungi Pathogenic for Humans.* Plenum, NY.

Topley W.W.C. and G. Wilson. 2002. *Principles of Bacteriology, Virology and Immunity. Systematic Bacteriology*: (8th edn.). BWW Publishers.

White, D.C. and F.J. Fenner.2004. *Medical Virology.* (4rdedn.) Academic Press, New York.

■

ZY4D ET03 CLINICAL MICROBIOLOGY

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

Module I. Introduction **5hrs.**

History of development of Medical Microbiology, Contributions made by eminent scientists.
Safety in Clinical Microbiology laboratory. Good laboratory practices. Microbiological safety cabinets-Types. WHO safe code of practice for a clinical microbiology laboratory.

Module II. Epidemiology **15hrs.**

Factors predisposing to microbial pathogenicity Infections. Sources of infections. Mode of transmission of infections, nosocomial infections, opportunistic infections, Normal microflora of human body.
Identification of pathogens- cultural, biochemical, serological and molecular methods.

Module III. Laboratory Procedures for Microbiology **30hrs.**

Collection, transport, processing and microbiological examination of Blood, Sputum, stool, urine, Cerebrospinal fluid, genital specimens, throat and mouth specimens, nasopharyngeal swabs and aspirates, ear discharges, eye specimens, pus from wounds, abcesses, burns and sinuses, and effusions.

Module IV. Diagnosis of Viral Diseases **10hrs** .

Laboratory Diagnosis of Viral diseases
Specimens for viral diagnosis,Viral isolation and growth,Cell culture for viral detection
Detection of viral proteins, Detection of viral genetic material,Viral serology

Module V. Diagnosis of Fungal Diseases **10hrs.**

Laboratory diagnosis of fungal diseases.
Diagnostic procedures, Superficial, Cutaneous and Systemic mycosis.

Module VI. Laboratory Studies of Parasites **15hrs.**

Laboratory methods for diagnosis of parasitic infections.
Identification of animal parasites,Collection of specimens for the detection of parasites
Intestinal protozoans,Blood protozoans,intestinal helminthes,blood helminthes

Module VII. Handling of Laboratory Animals **5hrs.**

Care and management of laboratory animals. Legal requirements for animal experiments. General aspects of organization of animal experiments- Preparation of animals, common experimental procedures, Humane methods of killing animals. Handling of common laboratory animals: Rabbit, guinea-pig, mouse and rat.

REFERENCES

Baron E.J, L.R.Peterson and S.M. Finegold.1994. *Bailey and Scott's Diagnostic Microbiology.*ASM, Washington,DC

Cowan, S.T. and K.J.Steel.1985. *Manual for the Identification of Medical Bacteria.* Cambridge University Press, London.

D.C. Kloss, W.E., and T.L. Bannermann.1995. ..*Manual of Clinical Microbiology* (6th edn.), American Society for Microbiology, Washington,USA

Goodman and Guilman's Pharmacological Basis of Therapeutics, 2000.Tenth Edition.

Gradwohl's clinical laboratory methods voII.1981.Academic Books, London.

Howard B.J, J.F.Keiser. T.F.Smith, A.S. Weissfeld, R.C. Tolton, .2002. *Clinical and Pathogenic Microbiology.*

Koneman E.W. D.Stephen, William A, Janda 2008. *Color Atlas and Textbook of Diagnostic Microbiology*. Tata McGraw Hill, NY.

Mackie and Mccartney, 2008. *Practical Medical Microbiology* (14th edn). Churchill Livingstone,UK.

Monica Cheesbrough, . *Medical Laboratory Manual For Tropical Countries.* Vol.II. Microbiology. ELBS.

P.R.Murray, E.J.Baron, M,Patrick R. M,K.S.Rosenthal, G.S. Koayashi and M.A.Ptaller,1997. *Medical Microbiology.*

Sherris Jc.,1990.*Medical Microbiology, An Introduction to Infectious Diseases*. Ed.2. New York.

■

ZY4D EP04 PRACTICAL I - GENERAL MICROBIOLOGY, PARASITOLOGY AND MYCOLOGY

90 hours (5 hrs./week) **Credit - 2**

Preparation of stains and various staining methods
Simple Staining, gram's staining, Acid fast staining, Albert's staining
Sterilization-various Techniques: Autoclave, Hot air oven; Laminar flow chamber
Disposalof contaminated materials and Laboratory refuse.
Preparation of Antibiotic disc
Antibiotic sensitivity test-Kirby Bauer test and Tube dilution Method
Estimation of MIC
Test for Beta Lactamase.
Testing of disinfectants
Bacteriological test for water, air and food.
Examination of faces for:
Amoeba and cyst
Eggs,larva and adult helminthes
Examination of blood for plasmodium and Filariasis.
Collection of Specimen for Fungi
Preparation of special medium.
Inoculation, Incubation and Identification of Fungi-*Candida albicans.*
Slide culture Techniques.

ZY4D EP05 PRACTICAL 2 - BACTERIOLOGY, VIROLOGY AND CLINICAL MICROBIOLOGY

90 hours (5 hrs./week) **Credit - 2**

Study of Morphological, cultural and Biochemical reactions of following organisms.
Staphylococcus aureus, *Streptococcus Species*, *E.coli*, *Klebsiella*, *Proteus*, *Salmonella Schigella*,*Pseudomonas*.
Slide agglutination
Anaerobic culture methods; Mcintosh Method
Slide Identification
Neisseria gonoerrhoea, *Mycobacterium*, *Tuberculosis*, *Mycobacterium leprae*, *Clostridium botulinum*, *C.tetani*.
Viral Haemagglutination
Heamagglutination Inhibition test
Precipitation of serum and preservation for short and long term.
Widal test.
Immonodiffusion.
Various antigen-antibody reactions
Agglutination, Precipitation, Complement fixation, Passive Haemagglutination- latex agglutination test (RA,ASO,CRP AND TRUST ANTIGEN)
ELISA

Field Study Report: (Three to four days)
1. Visit to Institutions engaged in microbiology/virology research (*e.g.*, Vector Control Research Institute, Cherthala/ Virology Institute,Alapuzha/ Sree Chithra Institute, Thiruvananthapuram) ; 2. hospital with Pathology laboratory (e,g., Government Medical College Hospital), 3. Visit a polluted area and document microbial diveristy. Report the study conducted and submit a 10 page write up/ print out giving the dates, daywise itinerary, methodology, results and references. Include photgraphs of the activity.
Group and individual assignments shall be preferred. ■

MAHATMA GANDHI UNIVERSITY
PRIYADARSHINI HILLS
KOTTAYAM-686560

MASTER DEGREE PROGRAMME IN ZOOLOGY
Restructured under credit semester system
(M.Sc. Zoology CSS Programme)
w.e.f. the academic year 2012-2013

Members of the Board of Studies in Zoology (PG) 2010-13
Mahatma Gandhi University
Kottayam

1. **Dr. Shaju Thomas**, Nirmala College, Muvattupuzha (Chairman)

2**. Dr. Jameela Beevi K.S**, Maharaja's College, Ernakulam

3. **Dr. Issac Thomas,** S.B. College, Changanacherry

4. **Dr. Joseph John,** St. Thomas College, Kozhencherry

5. **Dr. Sebastian, P.A,** S.H.College, Thevara

6. **Prof. Philomina C.J**, Alphonsa College, Pala

7. **Dr. Gopakumar, P.S,** N.S.S Hindu College, Changanacherry

8. **Dr. Abraham Samuel K,** C.M.S.College, Kottayam

9. **Dr. Vijayakumari K.N,** Maharaja's College, Ernakulam

10. **Dr. Sunil M.S,** Catholicate College, Pathanamthitta

11. **Prof. Mathew M. Oommen,** University of Kerala, Trivandrum

The Board of Studies (BoS) wishes to record sincere thanks to the following Professors and Faculty Members for their involvement and contributions in the revision and restructuring of the Zoology (PG-CSS) curriculum 2012

Prof. Dr. A.P. Thomas, Director, Advanced Centre of Environmental Studies and Sustainable Development, MG University, Kottayam

Prof. Dr. M.A.Akbarsha, Director and Gandhi-Gruber-Doerenkamp Chair MGDC, Bharathidasan University, Tamilnadu

Dr. Jyothis Mathew, Director, School of Biosciences, MG University

Prof. Johnson Samuel, and Dr. Kurien Mathew Abraham, Dept of Zoology, Mathoma College, Tiruvalla

Dr. Elizabeth M.J. Dept.of Zoology, Catholicate College, Pathanamthitta

Dr. Sarala, S. Nair, Dept. of Zoology, N.S.S. Hindu College, Changanacherry

Dr. Nelson P. Abraham and Dr. Roy George, K. Dept of Zoology, St. Thomas College, Kozhencherry

Dr. Punnen Kurian, Dept. of Zoology, St. Mary's College, Manarcadu

Dr. Claramma Jacob, Dept. of Zoology, Alphonsa College, Pala

Dr. Rema L.P. Dept. of Zoology, Maharaja's College, Ernakulam

Dr. M.L. Joseph, Dept. of Zoology, St. Alberts College, Ernakulam

Dr. Joe Prasad Mathew and Mr. Philip Litto Thomas, Dept. of Zoology, S.B. College, Changanacherry

Dr. Nagendra Prabhu, **G.** Dept. of Zoology, S.D.College, Alleppey

Prof. Kunhikrishan, E. Dept. of Zoology, University College, Trivandrum

The faculty members listed below attended and contributed in the deliberations during the workshop conducted from 8th to 10th February 2012 at SES, MUG, Kottayam for the revision and restructuring of the curriculum.

Alphonsa College, Pala - Prof. Sobhana Mathew, Dr. Claramma Jacob, Prof. Molly, K.S, Dr. Agi M.Thomson, Dr. Jansamma Thomas, Sr. Manju Elizabeth Kurivalla.

CMS College, Kottayam – Dr. Nisha P. Aravnid, Dr. Jobin Mathew

Catholicate College, Pathanamthitta - Dr. Sunilkumar, Prof. Wilson Varkey, Dr. Elizabeth M.J, Dr. Mary John, Dr. Manu Oommen

Maharajas College, Ernakulam - Dr. Shyamala M.V, Dr. Rema, L.P.

Marthoma College, Tiruvalla - Prof. Johnson Samuel, Dr. Kurian Mathew Abraham

Nirmala College, Muvattupuzha - Prof. Laly Mathew, Prof. Sasikala K. Joseph, Prof. Mary,P.C, Prof. Dilmol Varghese, Dr. Anu Anto, Prof. Jisha Jacob, Dr. Gigi K. Joseph

N.S.S.Hindu College, Changanacherry - Prof. Ampili M.

S.B. College, Changanacherry - Dr. Joe Prasad Mathew, Dr. Jomon K.V, Prof. Philip Litto Joseph

S.H.College, Thevara - Dr. Samson Davis Padayatty, Prof. Raju M.K.

S.N.M.College, Maliankara- Prof. Mukundan,T.K.

St. Albert's College, Ernakulam - Dr. M.L. Joseph, Dr. Vincent Terrence Rebello, Dr. K.J.Benny.

St. Thomas College, Kozhencherry - Dr. Shirly Anne Oommen, Dr. Nelson P.Abraham, Dr. Roy George,K.

St. Mary's College, Manarcadu - Dr. Punnen Kurian