

BHARATHIAR UNIVERSITY: COIMBATORE – 641 046
M. Sc. ZOOLOGY (CBCS – Univ. Dept.)
(For the students admitted during the academic year 2014-2015 batch and onwards)
SCHEME OF EXAMINATION

Semester	Core/Elective /Supportive Paper	Subject Code 14ZOOA	Title of the Paper	Instructional Hours/week	Internal	External	Total Marks	Total Credits
I	Core-I	13A	Biochemistry and Biophysics	4	25	75	100	4
	Core-II	13B	Molecular Cell Biology	4	25	75	100	4
	Core-III	13C	Microbiology	4	25	75	100	4
	Core-IV	13D	Endocrinology	4	25	75	100	4
	Core Practical- I	13P	Practical – I (Biochemistry and Biophysics, Molecular Cell Biology, Microbiology and Endocrinology)	6	25	75	100	4
	Elective-I	1EA	Aquaculture and Fisheries	4	25	75	100	4
	Supportive-I	---	Offered to other Department	4	12	38	50	2
II	Core-V	23A	Animal Physiology	4	25	75	100	4
	Core-VI	23B	Experimental Embryology	4	25	75	100	4
	Core-VII	23C	Economic Zoology	4	25	75	100	4
	Core-VIII	23D	Conservation Biology	4	25	75	100	4
	Core Practical-II	23P	Practical – II (Animal Physiology, Experimental Embryology, Economic Zoology and Conservation Biology)	6	25	75	100	4
	Elective-II	2EA	Global Warming – Animal Migration and Behaviour	4	25	75	100	4
	Supportive-II	---	Offered to other Department	4	12	38	50	2
III	Core-IX	33A	Immunology	4	25	75	100	4
	Core-X	33B	Environmental Biology and Toxicology	4	25	75	100	4
	Core-XI	33C	Molecular Genetics	4	25	75	100	4
	Core-XII	33D	Bioethics and Biosafety	4	25	75	100	4
	Core Practical-III	33P	Practical – III (Immunology, Environmental Biology and Toxicology, Molecular Genetics and Bioethics and Biosafety)	6	25	75	100	4
	Elective-III	3EA	Molecular Taxonomy	4	25	75	100	4
	Supportive-III	----	Offered to other Department	4	12	38	50	2

IV	Core-XIII	43A	Nanobiotechnology	4	25	75	100	4	
		4PV	Project Work & Viva-voce	Dissertation	----	----	100	100	4
				Viva-voce	----	----	50	50	2
		4FV	Field Trip* (Institution, Research Labs. and Industries etc.)		----	----	----	25	1
		4SD	Skill Development* (Summer training programme)		-----	----	----	25	1
Total				----	---	----	2250	90	

* To be submitted along with Project Work. **Note:** 75% attendance is compulsory in each subject.

Supportive papers offered for other Department students:

Semester	Subject Code 14ZOOA	Title of the Paper	Instructional Hours/week	Internal	External	Total Marks	Total Credits
I	GS1	Introduction to Conservation Biology	2	12	38	50	2
	GS2	Introduction to Toxicology	2	12	38	50	2
II	GS3	Human Health and Hygiene	2	12	38	50	2
	GS4	Introduction to Bioethics	2	12	38	50	2
III	GS5	Marine Biotechnology	2	12	38	50	2
	GS6	Value Added Fishery Products	2	12	38	50	2

Practical Components:

The M.Sc. Zoology Core Practical Examination having the following Marks:

Internal Marks: 25

Major Practical	10 Marks
Minor Practical	5 Marks
Spotters (A, B, C & D)	4x21/2 = 10 Marks

Total	= 25 Marks

External Marks: 75

Major Practical	20 Marks
Minor Practical	15 Marks
Minor Practical	10 Marks
Spotters (A, B, C & D)	4x5 = 20 Marks
Record	10 Marks

Total = 75 Marks

Theory Components:

The M.Sc. Zoology Core and Elective theory Examination having the following Marks:

Core and Elective Papers: Maximum Marks – 100

Internal Marks: 25

Test - 15 Marks; Assignment - 5 Marks; Seminar - 5 Marks

External Marks: 75

Section A - 10x1=10 Marks (Question No. 1 to 10)

Choose the best Answer type. Answer all questions. All questions carry equal marks.

Section B – 5x5 = 25 Marks (Either or type – Question No. 11 to 15)

Answer all questions. All question carry equal marks. Each answer should not exceed 2 pages.

Section C – 5x8 = 40 Marks (Either or type – Question No. 16 to 20)

Answer all questions. All Question carry equal marks. Each answer should not exceed 4 pages.

Supportive Papers: Maximum Marks - 50

Internal Marks: 12

Test - 6 Marks; Assignment - 3 Marks; Seminar - 3 Marks

External Marks: 38

Section A – 5x1=5 Marks (Question No. 1 to 5)

Choose the best Answer type. Answer all questions. All questions carry equal marks.

Section B – 3x3 = 9 Marks (Either or type – Question No. 6 to 8)

Answer all questions. All Question carry equal marks. Each answer should not exceed 1 page.

Section C – 4x6 = 24 Marks (Either or type – Question No. 9 to 12)

Answer all questions. All Question carry equal marks. Each answer should not exceed 2 pages.

Core - I - 13A

BIOCHEMISTRY AND BIOPHYSICS

The objective of the course is to provide a concise and unifying approach to physical chemistry, biochemistry and biophysics. It also provides the structure, function and interactions of bio molecules, how biological processes occur at the molecular level and to understand these processes with strong backgrounds in chemistry, biology, and physics.

Unit – I

Structure of atom, molecules, ionic bonds, covalent bonds, hydrogen bond, Vander Vaal's forces, Intermolecular forces, electrolytes, pH and buffer capacity in the cell environment.

Unit – II

Amino acids: Structure, classification, properties, isoelectric point and zwitter ions. **Proteins:** Classification based on chemical structure, function and solubility; properties, primary, secondary and tertiary, Helix, principles of isolation and purification, Synthesis of polypeptides.

Enzymes: Classification, Kinetics, Co-factors, Enzyme inhibition, Enzyme substrate compounds.

Unit – III

Nucleic acids: DNA structure and properties, DNA as a genetic material, DNA synthesis – mechanism of replication (semi conservative and reverse transcription), nucleotides. **Different types of RNA:** mRNA and rRNA.

Lipids: Classification, properties – saturated and unsaturated fatty acids – plant waxes, steroids, cholesterol and lecithin.

Carbohydrates: Classification, structure and properties of functional groups.

Unit – IV

Bioenergetics: Laws of thermodynamics, concept of free energy, oxidation reduction (redox) reactions. Energy coupling reactions, energy rich compounds, ATP cycle, standard free energy, membrane potentials, and negative entropy changes in living systems, enzyme catalysis.

Unit – V

Analytical techniques: Principle and application of Chromatography (Paper, thin-layer, column and GLC), Centrifugation (RPM and G, Ultra centrifugation), Spectroscopic techniques (UV, visible spectroscopy, X-ray crystallography, NMR, IR, fluorescence & atomic absorption), Isotopes and their importance (GM counters & Scintillation counting).

Reference Books:

1. Biochemistry, by D.Voet and J.G. Voet, 2004. John Wiley & Sons, USA
2. Biochemistry, by R.H. Garrett and C.M. Grisham, (3rd Edition) 2007. Saunders College Publishers.

3. Principles of Biochemistry by A.L. Lehninger. 1984. CBS Publishers and Distributors, New Delhi.
4. Physical Biochemistry by D. Friefelder, (2nd edition) 1982. W.H. Freeman & Company.
5. The Physical Basis of Biochemistry, by Peter R. Bergethon, Springer-Verlag, 1998.
6. Biophysics-An Introduction, by C. Sybesma, 1989, Kluwer Academic Publisher.
7. Cellular Biophysics I and II, by Thomas F. Weiss, 1995, MIT Press.
8. Basic Biophysics for Biology, by E. K. Yeagers, 1992, CRC press.
9. Principles of Biochemistry by Albert L. Lehninger (4th edition) 2004. CBS Publishers & Distributors, New Delhi.
10. Biochemistry by Lubert stryer (4th edition) 2000. Freeman International Edition.
11. Biochemistry by Keshav Trehan, 1990. Wiley Eastern Publications.
12. Fundamentals of Biochemistry by J.L.Jain et. al. (4th edition) 1994. S.Chand and Company.
13. Textbook of Organic Chemistry (A Modern Approach) Ist edition) 2002. McGraw Hill.
14. The Biochemistry of Nucleic acid – Tenth Edition-Roger L.P.Adams, John T. Knowler and David P.Leader, 1992. Chapman and Hall Publications.
15. Essentials of Biophysics by Narayanan, P (2000), New Age Int. Pub. New Delhi.
16. A Text Book of Biophysics by Roy R.N. (1999), New Central Book Agency.
17. Biochemistry. S. C. Rastogi, 2nd edition. 2003. Tata McGraw Hill Publishing Company Ltd., N. Delhi.

Core - II – 13B

MOLECULAR CELL BIOLOGY

Unit-I: Basic concepts

Cell organization, Sub-cellular structures of prokaryotic and eukaryotic cells. Synthesis and sorting of plasma membrane.

Unit-II: DNA and RNA regulatory mechanisms

Evidence of basic targets, Enzymes, Mechanisms of DNA replication in eukaryotes. Mechanisms RNA splicing in eukaryotes. t-RNA, m-RNA, r-RNA and hn-RNA structures and folding.

Unit-III: Protein synthesis

Ribosomes, Genetic code, General control of DNA, RNA and protein synthesis, Post-translational modifications, Protein targeting.

Unit-IV: Cell signaling and molecule transport

Signaling at the cell surface, Types of signaling pathways that control gene activity, Integration of signals and gene controls. Movement of proteins into membranes and organelles, Vesicular traffic, secretion and endocytosis, Metabolism and movement of lipids.

Unit-V: Cell culture

Regulation of the Eukaryotic cell cycle, Cell birth, Lineage and cell death. Cancer/ oncogenes, Cell markers, Cellular morphology, Primary and established cell lines, Kinetics of cell growth, Genetics of cultured cells. Stem cell culture, embryonic stem cells and their applications. Cell culture based vaccines. Somatic cell genetics.

Suggested Reference Books

1. Cell and Molecular Biology, (8th edn)., De Robertis, E.D.P. and De Robertis, E. M.F. 1995, B.I.Waverly Pvt. Ltd., New Delhi.
2. Essential Cell Biology, B. Albert et al., 1998. Garland Publishing, Inc. New York.
3. Principles of Cell and Molecular Biology. (2nd edn.)., Kleinsmith, L. J. & Kish, V.M. 1995.
4. McLaughlin, S., Trost, K., Mac Elree, E. (eds.), Harper Collins Publishers, New York.
5. Molecular Biology of the Cell. (3rd edn.)., Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K., Watson, J.D. (eds.) 1994. Garland Publishing, Inc., New York.
6. Molecular Cell Biology (5th Edn.), H. Lodish et al., 2004. W.H. Freeman and Company, New York.
7. Molecular Biology of the gene, J.D. Watson. 1977. (3rd Edn.) W.A. Benjamin Inc. London.
8. An Introduction to Genetic Analysis (7th Edn.), A.J.F. Griffiths et al., 2000. W.H. Freeman & Co.
9. Principles of Biochemistry, A.L. Lehninger. 1984. CBS Publishers , New Delhi.

10. Principles of Genetics (6th Edn.), R.H. Tamarin, 1996. WCB/ McGraw-Hill, New Delhi.
11. Lewin, B. Genes VIII Oxford University Press, Oxford, New York, Tokyo.
12. Darvell, J. *et. al.*, Molecular Cell Biology – Garland Publishing inc.,, New York.
13. Culture of Animal Cells, (4th Edition), R. Ian Freshney, 2000, Wiley-Liss.
14. Animal Cell Culture-Practical Approach, Ed. John R.W.Mesters, Oxford.
15. Cell Growth and Division: A Practical Approach, Ed, R.Basega, IRL Press.
16. Methods in Cell Biology, Vol.57, Animal Cell Culture Methods. Ed. Jenni P Mathur and David Barnes. Academic Press.
17. Molecular Cell Biology (Sixth Edition) by W.H Freeman and Company 2008. ISBN: 10:L0-7167-7601-4
18. Molecular genetics (First Edition) by J.T. Hancock 2000. University of the west of England, Bristol, UK. ISBN: 81-309-0604
19. Fundamentals of Molecular Biology (First Edition) by Jayanta K.Pal 2009. First published in India by Oxford, University press. ISBN: 10: 0- 19.569781.2

Core - III - 13C

MICROBIOLOGY

Unit – I

Introduction– Scope and History of microbiology –Classification of bacteria, fungi, yeast and virus. Structure and functions of bacteria and virus. Reproduction in bacteria – Transformation, conjugation, transduction. Mapping in bacterial genomes.

Unit – II

Cultivation and control of microorganism – Methods of collection of sample – methods of estimation of microorganism in soil, water and air – Isolation and identification of bacteria. Methods of sterilization and disinfection – Microbial control – Physical and chemical – techniques of pure culture – Method of cultivation of bacteria – Phases of growth .

Unit – III

Microbial Ecology: Distribution of microorganism in soil, water and air –Role of microorganisms in the cycling of nutrients – carbon, nitrogen, phosphorous and sulphur cycle.

Unit – IV

Food Microbiology: Sources, types incidence of microorganism in vegetables, meats, poultry, seafood and dairy products – spoilage of food, fruits, vegetables, meat, poultry, seafood, caned products – Factors influencing spoilage – Methods of detection of spoilage, principles of food preservation and prevention of food spoilage.

Unit – V

Microbial Technology: Genetic engineering of food and additives – Single Cell Protein (SCP) production – Production of organic acids (acetic acid), ethanol – Antibiotics – Microbial toxins – Fermentation products.

References:

1. Burden, K.L. and R.P. Williams (6th Ed.) 1968. Microbiology. The Macmillan Co., London P. 818.
2. Dawes, E.A. (Ed.) 1986. Energy conservation in bacterial photosynthesis. In: Microbial energetics. Blackie & Son Ltd., Glasgon, 133-144pp.
3. Doelle, H.W. (Ed.) 1969. Fermentation acetic acid bacteria and lactic acid bacteria. In: Bacterial metabolism. Academic Press. New York, London. 256 – 351 pp.
4. Hay, J.M. (Ed.) 1986. Modern Food Microbiology. CBS publishers, Delhi. 622 pp.
5. Reed, G. (4th Ed.) 1983. Prescott & Dunn's Industrial Microbiology. AVI Publishing Co., Inc. Connecticut, 883. pp.
6. Roberts, T.A. and F.A. Skinner (Eds.) 1983. Food Microbiology: Advances and Prospects, Academic Press, Inc. London, 393 pp.
7. Selle, A.J. (Ed.) 1967. Fundamental Principles of Bacteriology. Tata McGra – Hill Publishing Company Ltd., New Delhi, 822 pp.

Core – IV - 13D

ENDOCRINOLOGY

The study of hormones and their influence on body metabolisms plays important role in every of medicine. Metabolic processes are involved in formation, maturation and function of body tissues and in pathology of many diseases.

Unit - I

Nature, function and classification of hormones – Feedback control of hormone secretion – Organisation and functions of neuroendocrine systems- Hypothalamo– hypophyseal interactions- Bioactive peptides.

Unit - II

Thyroid gland – Structure, function and biosynthesis of thyroid hormone - Parathyroid – Structure and PTH – Calcitonin – Role of hormones in calcium and phosphate metabolism.

Unit - III

Gastrointestinal hormones - their secretion, control and function – Insulin and glucagons – Adrenal hormones and Stress management – Catecholamines as emergency hormones- their role in the regulation of carbohydrate, protein and lipid metabolisms.

Unit - IV

Adrenal gland – Structure and role played its hormones in glucose metabolism – Aldosterone and the rennin- angiotensin system – Pineal gland- structure and its influence on reproduction and pigmentation – Thymus gland – Structure and thymic hormones – their functions in brief.

Unit - V

Steroid hormone biosynthesis in the ovary and testis – Hormonal regulation of ovarian cycles in mammals – Folliculogenesis, ovulation, corpus luteum formation and regression – Hormones in pregnancy and lactation. Gonadal steroid action on spermatogenesis and spermiogenesis – Role of hormones in sex accessory gland growth and functions.

References:

1. Williams, R H. 1981. Text book of Endocrinology, Ed. 6th W. B. Saunders Company, Philadelphia, London.
2. De Groot. 1979. Endocrinology, Vol. 1-3, Grune and Stratton, New York.
3. Astwood, E. B. 1968. Clinical Endocrinology, Grune and Stratton, New York.
4. Bondy P.K. and Rosenberg L.E. 1974. Duncan's disease of Metabolism – Genetics, Metabolism and Endocrinology. W. B. Saunders Co., Philadelphia, London.

**Core Practical – I - 13P BIOCHEMISTRY AND BIOPHYSICS, MOLECULAR CELL
BIOLOGY, MICROBIOLOGY AND ENDOCRINOLOGY**

Biochemistry and Biophysics

1. pH: Structure and operation of pH meter
2. Preparation of buffers: Phosphate buffer and citrate buffer.
3. Colorimetric/Spectrophotometric estimation of the following biomolecules.
 - a) Total free amino acids (Ninhydrin reagent method)
 - b) Protein (Lowry *et al.*, 1951 method)
 - c) Total soluble carbohydrates (Anthrone reagent method)
 - d) Total cholesterol (Zlatkis *et. al.* method)
 - e) Estimation of sodium, potassium and chloride in blood

Molecular Cell Biology

1. Principles of microscopy and optics.
2. Cell size determination
3. Microtomy and photography.
4. Mounting of polytene chromosomes.
5. Preparation of mitosis in Onion root tip.
6. Cell division in Grasshopper testis.
7. Cell counting and cell viability using trypan blue dye exclusion assay

Microbiology

1. General rules of microbiology laboratory.
2. Preparation of Non-selective and selective culture media.
3. Estimation of bacteria from soil and water using plate count method.
4. Observation of morphological characters of bacteria (temporary wet mount technique).
5. Staining methods: Preparation of smears for staining - simple staining, negative staining, gram staining.

Endocrinology

1. **Spotters:** Transverse section of Pituitary, Thyroid, Pancreas, Adrenal, Thymus, Ovary and Testis.
2. Preparation of Haemin crystals.
3. Estimation of urea and uric acid.
4. Blood glucose – Oral Glucose Tolerance Test.

Elective- I - 1EA

AQUACULTURE AND FISHERIES

Unit - I

Introduction, present scenario of aquatic biotechnology-Scope and importance-constraints and recent advances in aquaculture biotechnology.

Unit - II

Aqua farm engineering-selection of site, designing, layout and construction of aqua farms-basic introduction to culture techniques-modern approach of composite fish culture-Integrated fish farming-prawn culture.

Unit - III

Feed formulation and Technology –live feeds-ingredients and their selection- formulation and preparation of feeds-addition of probiotics and probiotics in formulated feeds.

Unit - IV

Hormonal and genetic approach to modern aquaculture-fish genetics- gynogenesis and androgenesis-Induced polyploidy-fish breeding and hybridization-molecular markers and their application in fisheries-Hormones and modern techniques of fish seed production-brief account of Ovaprim, Ovotide and induced breeding.

Unit - V

Development of new techniques for aquaculture cryopreservation techniques for sperms- Application of remote sensing in conservation of management of fish faunal diversity-vaccines for aquaculture-Identification of Bacterial and viral pathogen.

References:

1. Fisheries research planning and Management in developing countries- V.R.P.Sinha- International Books and Periodicals services (IBS)-New Delhi.
2. Live feeds in Marine Aquaculture-L.A.McEvoy and J.G.Stottrup-Blackwell publishing company, UK.
3. Aquaculture Principles and Practices-T.V.R.Pillay, Fishing News Books, USA.
4. Fish and fisheries of India-V.G.Jingran-Hindustan publishing Corporation, Delhi.
5. Biology of finfish and shellfish-SCSC publishers-Howrah.

Core - V - 23A

ANIMAL PHYSIOLOGY

This study helps in understanding how the body functions adapts with respect to its external and internal environment, related to nervous integration, sensation, metabolism and reproduction.

Unit –I

Locomotion and Nutrition: Types of muscles – Ultra-structure – Mechanism of contraction of skeletal muscles – Nervous control of muscles. Nutritive requirements – General. Organization of alimentary canal – Role of salivary glands, liver, pancreas and intestinal glands in digestion.

Unit – II

Digestion and Excretion: Absorption of digested food-hormonal control of digestion - Introduction to intermediate metabolism –Structure of mammalian kidney – Urine formation – acid base regulatory mechanisms; endocrine regulation of water and mineral balance.

Unit – III

Circulation and Respiration: Composition of blood, blood groups in man, coagulation – Structure of mammalian heart, open and closed system of circulation, blood pressure and its regulation.

Unit – IV

Nervous integration and sense Organs: Organization of Nervous system – nerve conduction – synapse – neurotransmitters – nervous co-ordination – coding information to sensory organs – Chemoreceptor – Mechanoreceptor – Thermoreceptor – Photoreceptor.

Unit – V

Reproduction: Functional morphology of reproductive organs, gametogenesis, parthenogenesis, reproductive cycles – Pheromones.

References:

1. Ganong, H, Review of Medical Physiology, 1989. 14th edition, Appleton & Lange publisher, New York
2. Physiology: A regulatory system approach, Fleur, and Strand, (1978). Macmillan Publishing Company, New York; Collier Macmillan Publishers, London.
3. Shier, D., Butler, J. and Lewis, R., Hole's Human Anatomy and Physiology, (10th edition) 2003. WCB/McGraw Hill, Boston. 2003.
4. Animal Physiology, Eckert, R (5th edition), 2002. W.H.Freeman.
5. Williams S. Hoar (1991) General and Comparative Physiology 3rd edition. Prentice Hall of India- New Delhi.
6. Neilson, K.S. Animal Physiology, 1997. Cambridge University Press, Pergamon Press, Oxford.
7. Prosser, C.L. and Brown-Jr. F.A.: Comparative Animal Physiology, 1961. W.B. Saunders, Philadelphia.

Core - VI – 23B

EXPERIMENTAL EMBRYOLOGY

Experimental embryology is an experimental science, which provides understanding of the processes of early embryonic development, to analyze the mechanisms of development by experimental manipulation of developing embryos and to review current methodologies for conducting research in the field of embryology. It also emphasizes on current experimental approaches utilized in research of normal and abnormal development of the mammalian embryo.

Unit – I

Introduction and scope – Gametogenesis: Spermatogenesis: Origin of Primordial germ cells – Differentiation of spermatozoa – structure and motility of sperm – egg activation – acrosomal reaction. **Oogenesis:** Development of Oocytes – types of eggs – Biochemical changes during Oogenesis.

Unit – II

Fertilization process: Activation of sperm and egg– interaction of sperm and egg – Sequence of events in sperm entry – Egg surface changes. **Post–fertilization changes:** changes in the organisation of the egg cytoplasm caused by fertilization.

Unit – III

Cleavage: Cell division and chemical changes during cleavage – pattern of cleavage – Distribution of cytoplasmic substances in the egg – role of egg cortex - morphogenetic gradient in the egg cytoplasm. **Gastrulation:** Principles and patterns of gastrulation – Fate map.

Unit – IV

Organizer: Spemann's primary organizer – analysis of nature and mechanism of induction; **Organogenesis:** Cellular interaction – differentiation and organogeny. **Embryonic adaptation:** Extra embryonic membrane structure in Reptiles and Birds. **Placenta:** Classification, structure and physiology.

Unit – V

Post embryonic developmental events: Metamorphosis (Insects and amphibians); Regeneration in various animals. Asexual reproduction: Occurrence and forms of asexual reproduction. Cryo-preservation of gametes and embryos – in-vitro fertilization and embryo transfer – sperm banking – Fertility control and regulation.

Recommended Readings:

1. Berril, N.T. : Developmental Biology, 1971. McGraw Hill Co., New York.
2. Berril, N.T., Karp, G. : Development, 1988. Tata McGraw Hill Co., New York
3. Patten's Foundation of Embryology, Bruce M Carlson . Tata McGraw Hill Co., New York
4. Waddington, G.H. : Fundamentals of Embryology, 1949. George Allen and Unwin.
5. Huxley De Beer: The Elements of Experimental Embryology, 1934. Cambridge Univ. Press, Cambridge, Hafher Publishing Co.
6. Rover, C.P. : An Outline of Developmental Physiology (1968). Pergamon Press.

7. Austin, C.R. : Fertilization (1966). Prentice Hall.
8. Austin, C.R. : Ultrastructure of Fertilization (1967). Holt Reinhart and Winston.
9. Hay, E.D. : Regeneration (1970). Holt Reinhart and Winston.
10. Nelson, G.F. : The Comparative Embryology of Vertebrates (1979). Blackinston and Co.
11. Balinsky, B.I. : An Introduction to Embryology (1960). W. B. Saunders Co., Philadelphia
12. Bodemer, C. : Modern Embryology (1968). Hold, Rinehart and Winstorn, Inc, New York.
13. Trampush, HAL and Kiotsis, V. : Regeneration and Related Problems (1972). North Holland Publishing Co.,
14. Vorontsova, M.A. and Liosner, L.D. : Asexual Propagation and Regeneration (1960). Pergaman Press.
15. Monray, A. Chemistry and Physiology of Fertilization (1978). Halt Reinhart and Winston.

Core – VII – 23C

ECONOMIC ZOOLOGY

Unit- I: Agricultural Zoology

Beneficial insects: spider, mantis, ladybird beetle, damselfly, mealybug destroyer, soldier beetle, green lacewing, syrphid fly, tachinid fly, ichneumon wasp and trichogramma wasp - Harmful insects: migratory locust, colorado potato beetle, boll weevil, rhinoceros beetle, aphids, mosquitoes and cockroach - Pests of major crops, their injuries and control: paddy, sugarcane and groundnut - Economic importance of rodents, snakes, owls and bats - Apiculture - Sericulture - Lac culture – Vermiculture.

Unit- II: Medical Zoology

Infectious/ communicable diseases: small pox, hepatitis, AIDS, influenza, tuberculosis, plague, cholera, amoebiasis, malaria, dengue, chikungunya, trypanosomiasis, and elephantiasis.

Unit- III: Veterinary Zoology

Important livestock – cattle, goat, sheep, dog, deer and rabbit. Livestock diseases – tetanus and anthrax. Livestock parasites – helminthes, flies, ticks, lice and mites. Dairy and Poultry industries - Animal breeding - Establishment of Zoo and its importance.

Unit –IV: Aquaculture

Aquaculture in India: an overview – nutritional value and food security - Site selection and preparation of culture ponds - Fish culture: carps, marine fish and ornamental fishes. Prawn culture: Freshwater prawns and marine shrimps. Fattening of crabs. Crayfish and Lobster - Molluscs: mussels, clams, chanks and oysters including pearl oyster. Live feeds: micro algae, micro-invertebrates (Rotifers, *Artemia*, Copepods etc.) – Water quality management and maintenance of sanitation - Plant and animal nutrients - Balanced diet (iso-nitrous and iso-caloric) - Artificial feed formulation – Low cost feed formulation - Aquatic weeds.

Unit-V: Food Processing

Freshness criteria and quality assessment of fish and prawn – Spoilage and control - Methods of preservation: Canning, Freezing, Drying, Salting, Smoking and Curing - Quality control of processed fish and prawn- Fish and prawn processing industries in India - Processing of poultry meat and eggs - Byproduct utilization - Important microorganisms and the factors affecting their growth and survival in foods.

Suggested Reference Books

1. Economic Zoology, G.S. Shukla, V.B. Upadhyay (2006)
2. Text Book of Applied Zoology, Pradip. V Jabde (2005)
3. Textbook of Animal Diseases, Ashok Kumar (2009)
4. Medical Zoology, R.C. Sobti (1991)
5. Modern Textbook of Zoology, R. L. Kotpal (2000)
6. Processed Meats, AM. Pearson & TA Gillett (1996)
7. Egg and poultry meat processing, W.J. Stadelman, V.M. Olson, GA. Shemwell & S. Pasch S (1988)
8. Fish as Food, Vol 1 & 2, HA. Bremner (2002)

Core – VIII – 23D

CONSERVATION BIOLOGY

Unit I - BIODIVERSITY; SPECIES CONCEPTS; ANIMAL DIVERSITY

Components of Biodiversity (Ecosystem, Genetic and Species diversity) - Assigning values to biodiversity - Species concepts - **Animal diversity**: (Distribution inventory, species richness) - Biodiversity Hotspots (Western Ghats, Indo-Burma region). Biogeography of India - patterns and distribution of ecosystems, ecological succession, biotic and abiotic factors of an ecosystem. Conservation ethics and values of wildlife.

Unit II - LOSS OF ANIMAL DIVERSITY, STATUS OF SPECIES

Extinctions: Past rates of Extinctions - Concepts of Island biogeography and extinction rates on Islands - Human induced, Modern and local extinctions - Population reduction-threats to wildlife (examples) - Habitat loss, degradation and fragmentation. Threats to animal diversity in India - **Status of species**: Rare, endemic and threatened species - Measuring status of species in the wild - IUCN Red list (Assessments and methodologies) - Status of Indian animals.

Unit III - CONSERVATION TOOLS

In situ conservation of Indian animals (Case studies). *Ex situ* : Captive breeding programme - people participation in conservation - Successes and failures of conservation actions in India (Case study) - **Tools in Conservation**: GIS - remote sensing - Landscape model - PVA - VORTEX. Red listing process: categories and criteria, SIS. Wildlife conservation in India-importance of conservation - methods of wildlife conservation.

Unit IV - ANIMAL LAWS AND POLICIES IN INDIA; ECONOMICS OF BIODIVERSITY CONSERVATION

Wildlife (Protection) Act of India (1972) - Protected Area network - forest policy – Prevention of cruelty to Animal Act - Convention on Biological diversity, International Trade in endangered species - Zoo policy- Laws and their applications in Zoological parks, wildlife sanctuaries and biosphere reserves - Economics of biodiversity conservation. The world Conservation Unit (IUCN) - World wildlife fund (WWF) - Indian Board for Wildlife (IBWL).

Unit V -CONSERVATION EDUCATION, AWARENESS AND IMPLEMENTATIONS

Wildlife / Animal magazines, Journals- How to write popular and Scientific articles - Magazine and Journal information - Wildlife, nature, environment games (examples) - Role of NGO's and Government organizations in wildlife conservation - Wildlife celebration days in India.

Selected References:

1. R. B. Primack 1993. Essentials of Conservation Biology, Sinauer Associates, USA
2. G. K. Meffe and C. R. Carroll 1994. Principles of Conservation Biology, Sinauer Associates, USA
3. B. Groom bridge 1992. Global Biodiversity. Status of the Earth's Living Resources. Chapman and Hall, London.
4. R. A. Mittermeier, N. Meyers, P.R. Gil and C. G. Mittermeier 2000. Hotspots: Earth's Biologically richest and most endangered Terrestrial Ecoregions. Cemex/Conservation International, USA

5. M.E. Soule 1986. Conservation Biology: The Science of Scarcity and Diversity, Sinauer Associates Inc., USA.
6. M. L. Reaka - Kudla, D. E. Wilson and E. O. Wilson 1997. Biodiversity II: Understanding and Protecting our Biological Resources. Joseph Henry Press, Washington, DC.
7. T. W. Clark, R. P. Reading and A.L. Clarke 1994. Endangered Species Recovery: Finding the Lessons, Improving the process. Island Press, Washington, DC.
8. <http://www.redlist.org>
9. W. V. Reid and K.R. Miller 1989. Keeping options Alive. World Resources Institute.
10. Anon. 1997. Wildlife (Protection) Act of India, Nataraj Publishers, Dehradun
11. K. J. Gaston 1996. Biodiversity: Biology of numbers and Difference. Blackwell Science, Oxford.

Core Practical – II – 23P ANIMAL PHYSIOLOGY, EXPERIMENTAL EMBRYOLOGY, ECONOMIC ZOOLOGY AND CONSERVATION BIOLOGY

Animal Physiology

1. Influence of pH on salivary amylase activity.
2. Biochemical analysis (Qualitative) – carbohydrate, proteins and fats.
3. Estimation of haemoglobin (Sahli's method), RBC and WBC.
4. Estimation of differential leucocyte count.

Experimental Embryology

1. **Spotters** :
 - a) Oogenesis, Spermatogenesis
 - b) **Frog**: Four cell stage, Late cleavage, Blastula, Gastrula, Gastrula yolk plug stage,
 - c) **Chick**: 36 Hours stage, 48 Hours stage, 56 Hours stage, 72 Hours stage, 96 Hours stage.
2. Serial sections of chick embryo.
3. Mounting of chick Blastoderm.

Economic Zoology

1. Parasitic protozoa – Amoeba, Plasmodium and Trypanosoma.
2. Helminthes worms – Liver fluke, Tape worm and Filarial worm.
3. Insect pests – Trips, Nematode, Caterpillar and Rhinoceros beetle.
4. Value added products of dairy, poultry and fishery.
5. Methods for the microbiological examination of water and foods.
6. Predators and parasites in aquaculture.
7. Prawn diseases and their pathology.

Conservation Biology

1. Inventories/Surveys – collection and preservation.
2. Field Techniques.
3. Identification and use of keys – reference specimen.
4. Wildlife photography and documentation.

5. Introduction to computerized techniques – Remote sensing GIS and their modules for conservation.
6. IUCN Red List Exercise, VORTEX and SIS.
7. Statistical analysis/interpretation.
8. Technical writing and reporting of field studies.
9. Public presentation.
10. Field Project/ Report – visit to Zoological parks, wildlife sanctuaries and biosphere reserves.

Elective - II – 2EA GLOBAL WARMING – ANIMAL MIGRATION AND BEHAVIOUR
Unit - I

Introduction to global warming: Basics of Green house gases -- Climatic change and its Significance and Causes - Impact of global warming on eco- system - Fossil fuel in Global warming- present and future trends.

Unit - II

Climatic change: Acid rain-ozone depletion-Green house effect –forest fire-GIS, RS and its application.

Unit - III

Impact on Biodiversity: Behavioral Adaptation - Threats to biodiversity – IPPC and migration of species –biodiversity of land, aquatic and polar ecosystem – Climate change Human Health.

Unit – IV

Green house gases – impact behavior impact behavior: Transgenic Plants and behavior of insects – Prey Predator and parasitoid system – Climate change and Vector prevalence – Vector Borne diseases - Carbon sequestration.

Unit – V

Conservation and management: Threatened and Endangered Species - wild animals and plants – Global conservation organizations - Deforestation and Defaunation - integrated conservation strategies.

Reference:

Ecology (Individuals, population and Communities) by Michael Begon, John L. Harper Colin R. Townsend.

Environmental politics and policy by Walter A. Rocenbaun

The text book of Animal behaviour by Hoshang S. Gunderia and Hare Govind Shingh.

Environmental planning and management by John H. Balduim

Environmental protection and the law by K. Khitoliyan

Animal Behaviour by John Alcolh

Development and Animal Behaviour by Dr. Amila Sarhan.

Core - IX- 33A

IMMUNOLOGY

Unit - I

Outlines of Immunology: Basics of Immunity – Types of Immunity - Structure and Types of Immune system - Lymphoid organs.

Unit – II

Antigens, Antibiotics and Complements: Antigens – Antibody reaction – Immunoglobulin-structure of Immunoglobulin - Structure, function and biological properties of Immunoglobulin classes - Salient features and Biosynthesis of Complement.

Unit - III

Immunopathology: Hypersensitivity - Types of hypersensitivity - Major Histocompatibility Complex (MHC) and its significance.

Unit - IV

Immunological disorders: Immunodeficiency diseases – Transplantation immunology - Types of graft - Mechanism of allograft rejection.

Unit - V: Immunotechnology

Active immunization - Passive immunization – Principles and Methods of vaccine preparation – Immunological techniques - RIA, ELISA, Immunocytochemistry and Immunoblotting.

Reference:

1. Immunology, S.K. Gupta (1999). Narosa Publishing House, New Delhi.
2. Essential Immunology (8th Edition), Ivan Roitt, 1994. Blackwell Scientific Publication. Immunology W.H. Freeman and Company.
3. Abdul .K. Abbas. Andrew .K. Litchmen and Jordan, 1997, Cellular and Molecular Immunology, 3rd Edn. W.B. Saunder Company.
4. Weir, D.M. and Stewart, J., 1997, Immunology, 8th Edn., Churchill Livingstone, New York.
5. Eryl Liddell and Ian Weeks., 1995, Antibody Technology, BIOS Scientific Publishers.
6. Bruce Alberts, Dennis Bray, Julian Lewis, Martin Raff, Keith Roberts and James D. Watson.(Eds.), 1994, Molecular Biology of the cell, 3rd Edn., Garland Publishing Inc., New York.
7. Immunology, George Pinchuk (2004). Tata McGraw-Hill Publishing Company Limited, New Delhi.

Core - X- 33B ENVIRONMENTAL BIOLOGY AND TOXICOLOGY

Environmental Biology course is designed to provide fundamental ecological principles that provide a in-depth understanding of our natural world, the scientific basis for understanding how environmental systems work, the environmental issues, environmental problems, effects and solutions. This course also provides detailed information about environmental toxicology, which provides a sound basis for understanding and formulating various measures to protect the health and welfare of human population in the world. The course content of this paper is designed to give a basic understanding of various aspects of environmental toxicology.

Unit – I

Ecosystem: Review of the concept of ecosystem – pond and Forest as examples of natural ecosystem. Energetics in an ecosystem – Energy flow, Trophic level and structure in ecosystem, Food chain, Ecological pyramids- Review of Bio-geo Chemical cycles.

Unit – II

Limiting Factors: Concept of Limiting factors - Liebig's law of the minimum – Shelford's law of tolerance. **Population and Community Ecology:** Natality, Mortality, Growth rate as factors determining the population density- Population interactions. Types of community - Structure – Community Succession, Homeostasis.

Unit – III

Habitat Ecology: Freshwater habitat – Marine habitat – Estuarine habitat – Terrestrial habitat.

Unit – IV

Resource Ecology and Management: Concept – classification – Non-Renewable and Renewable resources- Conventional and Non- Conventional source and energy – Conservation and management.

Unit – V

General Principles of Toxicology: Introduction – Definition – Types - Scope of toxicology – Recent developments – Types of environmental pollution and their biological effects – Air, Water, Soil, Noise and Radiation pollution. **Routes of Entry and Testing Procedures:** Introduction - Absorption – distribution – Excretion – Bio-transformation-Bioassay – Acute toxicity - Chronic toxicity. Assessment of safety /risk.

Recommended Readings:

Fundamentals of Ecology by Eugene P. ODUM (1972), W.B. Saunders Company, London.
Environmental Biology by Michael Reiss and Jenny Chapman, 2000. Cambridge Press, UK.
An Introduction to Ecology and Population by Emmel THOMAS, C. (1973), Notron, NY.
Fundamentals of Ecology by DASH, M.C., 1993. Tata McGraw-Hill Publishing Company.
Principles of Ecotoxicology by BUTLER, O.C., 1978. John Wiley & Sons, USA.

Core - XI – 33C

MOLECULAR GENETICS

Unit-I: Structure and functions of genetic materials

Chromatin structure and nucleosome concept, Organization and function of genetic material, Gene paradox, Repetitive DNA, Satellite DNA, Overlapping genes, Split genes, Pseudogenes. Chromatin, nuclear and mitochondrial genome organization, Structures of DNA and RNA, Stereochemistry of bases and secondary structures. Genetic structure analyses of eukaryotic genomes.

Unit-II: Genetic Engineering

Recombinant DNA technology, Isolation and purification of DNA/ genes, DNA sequencing. Concept of restriction and modification - Restriction endonucleases, DNA modifying enzymes, Ligases. Host-vector system - Cloning vectors for *E. coli*, Cloning vectors for Eukaryotes. Genomic libraries, cDNA libraries, Genome project, Gene tagging. DNA forensics, DNA finger printing and paternity decisions.

Unit-III: Gene expression

Gene regulation in eukaryotes, Gene clustering, Mechanism of positive and negative control of gene expression. Translational and transcriptional control of regulatory mechanism of gene expression, Environmental effects on gene regulation. Epigenetics.

Unit-IV: Chromosomal genetics

Linkage and crossing over - Chromosome mapping - Gene mapping – Ploidy - Genetic diseases (gout, hypercholesterolemia, cystic fibrosis, phenylketonuria, hemophilia, and muscular dystrophy), syndromes (Down, Klinefelter, and Turner), and congenital anomalies.

Unit-V: Mutation

Mutagens-mutagenesis, types of mutation, mutator genes, sickle-cell anemia, forward and reverse mutation, frame shift mutation, site directed mutagenesis, transposable elements and transposition, and evolutionary significance.

Suggested Reference Books

1. Genetics (3rd Edition), Strickberger, M.W. 1996, Printice Hall, India Ltd., New Delhi.
2. Molecular Biology of the Cell (3rd Edition), Alberts, B. et. al., 1994, Garland Publishing Inc., New York.
3. Genes VIII. Levine, B., 2004, Oxford University Press.
4. Genetics: Analysis of Genes and Genomes (5th Edn.), Hartl, D.L. & Jones, E.W., 2001, Jones and Bartlett Publishers, Sadbury, Massachusetts.
5. Gene Cloning and DNA Analysis, (5th Edn.), T.A. Brown, 2001, Blakwell Science Ltd.,

6. Genetics. The Continuity of Life, D.J. Fairbanks & W.R. Andersen, 1999. Books/ Cole Pub. Company.
7. An Introduction to Genetic Analysis (7th Edn.), A.J.F. Griffiths et al., 2000. W.H. Freeman & Co.
8. Principles of Genetics (6th Edn.), R.H. Tamarin, 1996. WCB/ McGraw-Hill, New Delhi.
9. Genetic Engineering, Boyer.H.W and Nicosia. S. 1978. Elsevier/North Holl and Biomedical press, Amsterdam
10. Genetics of Industrial Microorganism, Seberk.O.K and Laskin.A.I., 1979. American Society of Microbiology, Washington.
11. Principles of gene manipulation, 3rd Edn., Old & Primrose, 1989, Publishers Busines Service.
12. Recombinant DNA Technology, (2nd Edn.), J.D. Watson, M. Gilman, J. Witkowski & M. Zoller, 1992, Scientific Americans books, Newyork.
13. Molecular Biotechnology, S. Maulik and S.D. Patel, 1997, Wiley. Liss
14. r - DNA technology and Biotechnology, K. Kreuzer & A. Massey, 1996, ASM Press, Washington. D.C
15. Dealing with genes, D. Berg & M. Singer,1992, Blackwell Scientific Publication
16. Techniques for Engineering Genes, Butterworth. Heinemann, 1993, Open Universiteit Nederland.
17. Human Molecular Genetics (2nd Edn.), T. Strachan and A.P. Read, 1999. John Wiley & Sons.
18. Molecular Biology Techniques An intensive Laboratory course by Walt Ream and Kathatory G.Field, 2008. Academic Press, San Diego, London ISBN: 13: 987-0-12-583990-7
19. Molecular Biology-Genes to Proteins (First Indian Edition) by Jones and bartleth, 2012. Oregam State University, Corvallis, ISBN: 987-93-80853-49-9
20. Advances in Gene Technology: Molecular Genetics of Plants and Animals (First Indian Edition) by Katheelan Downey, Richard W. Voellmy, 1983. Academic press, New York, London. ISBN: 0-12-221480-3.

Core – XII – 33D

BIOETHICS AND BIOSAFETY

Unit – I

Introduction to Bioethics in Biotechnology- Ethics – Bioethics - Biotechnology – Positive effects – Negative effects - Ethics in biotechnology- Biotechnology examples – Rice with Vitamin A - Slow Ripening Fruits- Saving the Banana- Virus Resistant Crops - Building with Silk- Educated Need for Fertilizers- More from the Sun- Toxic Soils- Biological Pest Controls – Fast Growing Trees- Fast Growing fish- The Monarch Butterfly Story- Consumer traits – food safety- Environmental concerns- Economic and Social Concerns.

Unit – II

Biosafety Regulations- National and International Guidelines.

Introduction – Regulation framework in various countries – USA- European Union-Canada- Australia- South Africa- Asian Region- International Guidelines.

Unit –III

CPCSEA Guidelines for Laboratory Animal Facility

Goal- Veterinary care- Animal procurement- Quarantine, Sterilization and separation – Surveillance, diagnosis, treatment and control of disease- Animal care and technical personnel- Personal hygiene- Animal experimentation involving hazardous agent- Multiple surgical procedures on single animal- Duration of experiments- Physical restraint- Physical plant- Physical relationships of animal facilities to laboratories – Functional areas- Physical relationship of animal facilities to laboratories- Functional area- Physical facilities- Environment- Animal husbandry- Activity – Food- Bedding- Water- Sanitation and cleanliness- Assessing the effectiveness of sanitation – Waste disposal- Pest control- Emergency , weekend and holiday care.

Unit – IV

GLP and Bioethics- Introduction – National Good Laboratory Practice (GLP) Programme- The GLP authority functions- Why follow Good Laboratory Practices?- The Aspiration – Who is responsible? – The IT Way- Role of a Sponsor- What are the quality standards for Clinical Trials?- Why is India a favorite destination for Clinical Trials worldwide?

Unit – V

Intellectual Property Rights - An introduction- Origin of the Patent Regime- Early patterns Act & Indian Pharmaceutical Industry – History of Indian Patent System- The Present Scenario – Basis of Patentability –Patent Application Procedure in India- Patent Granted Under Convention Agreement- Who can apply for a patent?- Patent Procedure – Opposition to Grant of Patent- Grant and Sealing- Exclusive Rights – Grant of Exclusive Rights- Special Provision for selling or distribution – Suits relating to infringements – Compulsory License- Termination of Compulsory License – Case study- Compulsory Licenses- Relief under TRIPS agreement.

Reference Books:

1. Bioethics, by Shaleesha A. Stanley (2008). Published by Wisdom Educational Service, Chennai.

Core Practical – III – 33P IMMUNOLOGY, ENVIRONMENTAL BIOLOGY AND TOXICOLOGY, MOLECULAR GENETICS AND BIOETHICS AND BIOSAFETY

Immunology

1. Structure of immunoglobulins – IgG, IgA, IgM, IgD, IgE
2. Structure of primary and secondary lymphoid organs in humans
3. Blood group determination by slide agglutination; Rh factor determination by agglutination reaction.
4. Flowchart of ELISA
5. Flowchart of Hybridoma Technology
6. Study of bone marrow cells.

Environmental Biology and Toxicology

1. Determination of pH, dissolved oxygen, salinity and free CO₂ in water
2. Determination of carbonates and bicarbonates in water
3. Estimation of dissolved solids in water
4. Visit to drinking water treatment plants
5. Visit to Forest ecosystem – Maruthamalai Forest ecosystem
6. Visit to a Pond ecosystem – Kurichi pond – Ukkadam

Molecular Genetics

1. Preparation of genomic DNA from animals/ human.
2. Preparation of drumstick chromosome in human blood.
3. Pedigree analysis.
4. Peripheral blood leukocyte culture for chromosomal studies.
5. Chromosomal disorders- numerical and structural.

BIOETHICS AND BIOSAFETY

1. Visit to Research institutes holding animal house facility.
2. Visit to pharmaceutical industry and report submission.
3. CPCSEA, GLP, IPR- Group discussion - report submission.

Elective - III – 3EA

MOLECULAR TAXONOMY

Unit –I: Basic concepts

Introduction and history of taxonomy - species concept - zoological classification - theories of classification - taxonomic ranks – hierarchy - nomenclature codes: binomial nomenclature, trinomial nomenclature - taxonomical keys: key to the species - Linnaean taxonomy and classical taxonomy - level of taxonomy.

Unit-II: Modern concepts

Kingdoms and domains - Genomic DNA: nuclear, chloroplast and mitochondrial genomes – DNA and RNA based taxonomy in animals - DNA and RNA based taxonomy in plants - Representative genes in modern taxonomy: COI, cytb, 16s, 18s, 28s rRNA, *matK*, ITS1, ITS2, rDNA, and *trnL-F* - Key features of DNA based phylogeny.

Unit-III: Genomic data bases

Role of genomics in taxonomy - Primary nucleotide sequence databases: GenBank, EMBL, DDBJ and BOLDs. Genome Database: Bioinformatic Harvester, SNPedia, Corn, National Microbial Pathogen Data Resource, Zebrafish Information Network, RGD Rat Genome Database, and VectorBase.

Unit-IV: Tools and Software

Tools for sequence annotation: FASTA, BLASTn, BLASTx, ORF finder, CDS finder, PHYLIP, pair-wise analysis and multiple sequence analysis - Software: MEGA, DNA SP, BIO EDIT, PAUP, and Chromas Lite.

Unit-V: Phylogeny and Evolution

History and theories of evolution - Phenetics and cladistics phylogeny - Evolutionary taxonomy - Phylogenetic nomenclature - Geographical variations - Genetic variations -Phylogenetic analysis: methods in phylogenetic reconstruction, distance, maximum parsimony, maximum likelihood, Bayesian probability, Bootstrapping and neighbor joining -Problems and errors in phylogenetic reconstruction - Tree constructions.

Suggested Reference Books

1. Darwin, C. 1859. On the Origin of Species. London: John Murray (always seek out the first edition, facsimile version, and avoid later editions).
2. Dobzhansky, T. 1937. Genetics and the Origin of Species. New York: Columbia Univ. Press (there are several later editions, and the title changed in the last).
3. Fisher, R. A. 1930. The Genetical Theory of Natural Selection. Oxford: Oxford Univ. Press (there is a later edition).
4. Hennig, W. 1966. Phylogenetic Systematics. Urbana: Univ. Illinois Press (an English translation of a book published earlier in German).

5. Hall, B. J. (ed.). 1994. Homology, the Hierarchical Basis of Comparative Biology. San Diego: Academic Press (a collection of essays by many authors).
6. Sober, E. 1984. The Nature of Selection, Evolutionary Theory in Philosophical Focus. Cambridge, MA: MIT Press.
7. Gillespie, J. H. 1992. The Causes of Molecular Evolution. New York: Oxford Univ. Press.
8. Kimura, M. 1983. The Neutral Theory of Molecular Evolution. Cambridge: Cambridge Univ. Press.
9. Li, W-H. and D. Grauer. 1991. Fundamentals of Molecular Evolution. Sunderland, MA: Sinauer.
10. Hillis, D., C. Moritz, and B. Mable. 1996. Molecular Systematics, second edition. Sunderland, MA: Sinauer.
11. Genetics: Analysis of Genes and Genomes (5th Edn.), Hartl, D.L. & Jones, E.W., 2001, Jones and Bartlett Publishers, Sudbury, Massachusetts.
12. An Introduction to Genetic Analysis (7th Edn.), A.J.F. Griffiths et al., 2000. W.H. Freeman & Co.
13. Genetic Engineering, Boyer.H.W and Nicosia. S. 1978. Elsevier/North Holl and Biomedical press, Amsterdam.
14. Principles of Gene Manipulation, 3rd Edn., Old & Primrose, 1989, Publishers Busines Service.
15. Molecular Biotechnology, S. Maulik and S.D. Patel, 1997, Wiley. Liss
16. Evolution (Second Edition) by, Monroe W. Strickberger, 1990. Museum of vertebrate zoology, University of California, Berkeley. ISBN: 0-867820-20-892-9

Core – XIII – 43A

NANOBIOTECHNOLOGY

Unit -1. Introduction to Nanotechnology

What is nano?, nanoparticles, nanocomposites, nanoscience and nanotechnology? Importance of nanoscience and nanotechnology in biomedical applications. Types of chemical bonds. Types of solid and powder crystals. Interaction between biomolecules and nanoparticles. Applications of nanotechnology in biotechnology: killing cancer cells, providing oxygen and artificial mitochondria. Nanobiosensors.

Unit -2. Nanomaterials for biology

Carbon based nanomaterials - carbon nanotubes for biomedical applications, SWCNT and MWCNT. Magnetic nanoparticles - Quantum dots - Quantum dot biomolecular tags. Conjugation of quantum dots with biomolecules. Si nanowires. Nanobiomaterials: Biocompatibility; Antibacterial activity; DNA and Peptide based nanomaterials; Polymer nanostructures; DNA nano structures; DNA based nano mechanical devices; DNA based computation; DNA biochips.

Unit -3. Synthesis of nanoparticles

Top-Down approach, Bottom-Up approach, Nano-Lithography, PVD, CVD, Wet deposition techniques, Microemulsion method, Sol-gel processing. Biological synthesis of nanoparticles - Use of bacteria, fungi, Actinomycetes for nanoparticle synthesis, Magnetotactic bacteria for natural synthesis of magnetic nanoparticles; Mechanism of formation; Viruses as components for the formation of nanostructured materials; Synthesis process and application, Role of plants in nanoparticle synthesis. Use of biological design strategies as removable scaffolds and templates for the bottom-up assembly of nanomaterials.

Unit -4. Characterization of nanobiomaterials

Basic principles, operations and applications of UV-Visible spectroscopy, FI-IR spectroscopy, SEM, TEM, STM, Atomic and Molecular spectroscopy, Photoacoustic spectroscopy, Fluorescence spectroscopy, Fluorescent resonance energy transfer (FRET), computations, AFM of DNA, STM of DNA and Confocal microscopy.

Unit -5. Environmental Nanotechnology

Nanotoxicology, Environmental and Health impacts of nanomaterials, Waste remediation, Nanoporous polymers and their application in water purification, Energy conversion. Photocatalytic fluid purification, Current status of nanobiotechnology, Future perspectives of nanobiology and safety measures of nanomaterials.

REFERENCE BOOKS

1. Nanotechnology by Mark Ratner and Daniel Ratner, Pearson Education.
2. Nanomaterials by A.K. Bandyopadhyay; New Age International Publishers.

3. Bionanotechnology: Lessons from Nature by David S. Goodsell.
4. Nanomedicine, Vol. IIA: Biocompatibility by Robert A. Freitas.
5. Handbook of Nanostructured Biomaterials and Their Applications in Nanobiotechnology - Hari Singh Nalwa.
6. Nanobiotechnology; ed. C.M.Niemeyer, C.A. Mirkin.
7. Nanocomposite Science & Technology Ajayan, Schadler & Braun.
8. BioMEMS (Microsystems) - Gerald A. Urban.
9. Introduction to Nanoscale Science and Technology (Nanostructure Science and Technology) –Massimiliano DiVentra.
10. Nanosystems: Molecular Machinery, Manufacturing, and Computation - K. Eric Drexler.
11. Springer Handbook of Nanotechnology - Bharat Bhusha.
12. Nanobiotechnology; ed. C.M.Niemeyer, C.A. Mirkin.
13. Nano Materials- A.K.Bandyopadhyay/ New Age Publishers.
14. Introduction to Nanotechnology”, C. P. Poole and F. J. Owens, Wiley.
15. “Nano Materials”, A. K. Bandyopadhyay, New Age International Publishers.
16. “Nano Essentials”, T. Pradeep, TMH.
17. “Nanotechnology: A Gentle Introduction to the Next Big Idea”, M. Ratner and D. Ratner, Pearson Education.
18. “Nanotechnology – Science, Innovation, and Opportunity”, L. E. Foster, Pearson Education.
19. “Nanotechnology – the fun and easy way to explore the science of mater’s smallest particles”, Richard Booker and Earl Boysen, Wiley.
20. Nanotechnology: Content and Context, Christopher Kelty and Kristen Kulinowski.
21. *The Chemistry of Nanoparticles (Synthesis, Properties and Applications)* by C.N.R. Rao, A. Muller, A.K. Chutham. Vol 1 & Vol 2: –WILEY-VCH.
22. *Tissue, cell and organ engineering*, by Challa Kumar :Vol 9 WILEY-VCH, 2006.
23. *Nanomaterials for Medical Diagnosis and Therapy – Vol 10* by Challa Kumar, WILEY-VCH, 2007.

SUPPORTIVE PAPERS:

GS1 INTRODUCTION TO CONSERVATION BIOLOGY

Unit –I - BIODIVERSITY; SPECIES CONCEPTS; ANIMAL DIVERSITY

Components of Biodiversity (Ecosystem, Genetic and Species diversity) - Assigning values to biodiversity - Species concepts - inventory survey methods in Animal diversity - Biodiversity Hotspots (Western Ghats, Indo - Burma region).

Unit - II - LOSS OF ANIMAL DIVERSITY, STATUS OF SPECIES

Extinctions: Past rates of Extinctions - Threats to animal diversity in India - Status of species: Rare, endemic and threatened species - Measuring status of species in the wild - IUCN Red list exercise - Status of Indian animals.

Unit - III - CONSERVATION: TOOLS IN ANIMAL CONSERVATION

In situ and *Ex situ* conservation of Indian animals (Case studies) - Project Tiger and Elephant - Captive breeding program - Peoples participation in conservation - Tools in Conservation: GIS, Remote sensing – PVA - vortex.

Unit - IV - ANIMAL LAWS AND POLICIES IN INDIA; ECONOMICS OF BIODIVERSITY CONSERVATION

Wildlife (Protection) Act of India (1972) - Protected Area Network - Zoo policy - Laws and their applications in Zoological parks, Wildlife sanctuaries and Biosphere reserves - Economics of biodiversity conservation.

Unit - V - CONSERVATION EDUCATION AND AWARENESS

Wildlife / Animal magazines, Journals - How to write popular and Scientific articles – Public Presentation - Designing educational resource materials – wildlife, nature, environmental games - Role of NGO's and Government organizations in wildlife conservation - Wildlife documentation.

References:

1. R. B. Primack 1993. Essentials of Conservation Biology, Sinauer Associates, USA
2. G. K. Meffe and C. R. Carroll 1994. Principles of Conservation Biology, Sinauer Associates, USA
3. B. Groom bridge 1992. Global Biodiversity. Status of the Earth's Living Resources. Chapman and Hall, London.
4. R. A. Mittermeier, N. Meyers, P.R. Gil and C. G. Mittermeier 2000. Hotspots: Earth's Biologically richest and most endangered Terrestrial Ecoregions. Cemex/Conservation International, USA
5. M.E. Soule 1986. Conservation Biology: The Science of Scarcity and Diversity, Sinauer Associates Inc., USA. *M.Sc. Animal Biotech (Univ. dept) 2010-11 Page 26 of 26*
6. M. L. Reaka - Kudla, D. E. Wilson and E. O. Wilson 1997. Biodiversity II: Understanding and Protecting our Biological Resources. Joseph Henry Press, Washington, DC.
7. T. W. Clark, R. P. Reading and A.L. Clarke 1994. Endangered Species Recovery: Finding the Lessons, Improving the process. Island Press, Washington, DC.
8. W. V. Reid and K.R. Miller 1989. Keeping options Alive. World Resources Institute.
9. Anon. 1997. Wildlife (Protection) Act of India, Nataraj Publishers, Dehradun
10. K.J. Gaston 1996. Biodiversity: Biology of numbers and Difference. Blackwell Science, Oxford.

GS2 INTRODUCTION TO TOXICOLOGY

Unit -I

General Principles of Toxicology: Definition – Scope of toxicology – Recent developments – Absorption – distribution – Excretion – Bio-transformation.

Unit – II

Toxic substances Found in Water Soil, Water, Air and Food: Introduction – Inorganic poisons – organic compounds – Aromatic compounds – Heterocyclic compounds – Poisonous substances of plant and animal origin – detergents – pesticides.

Unit – III

Testing Procedures: Introduction – Bioassay – Acute toxicity, sublethal toxicity – Determination of LC 50, EC 50 and LT 50.

Unit – IV

Target Organs: Gill- Liver – Lung – Skin – Kidney – testing procedures – evaluation – antidotes

Unit – V

Risk Assessment and Applications of Toxicology: Risk assessment: Introduction – Acceptable daily intake (ADI) – Mathematical model – other procedures. **Applications:** Forensic – clinical – occupational and regulatory toxicology – toxicology and law.

Reference Books:

1. Frant C.L.V. 1991, Basic Toxicology II (Eds.), Hemisphere publishing corporation, Washington, London
2. Casarett and Doull's 1980. Toxicology: The Basic Science of Poisons.. II (Eds.) Macmillan publishing co., Inc, New York.
3. Butler, G.C. 198\78, Principles of Ecotoxicology. John Wiley and Sons, Chichester.
4. Fumi Matsumura, 1980. Toxicology of Insecticides. Plenum Press, New York and London.
5. Foster L. Mayer, Donald J. Versteeg, Michael, J. McKee and Barnett A. Ratlner, 1992, Biomarkers, physiological and non-specific biomarkers. Lewis publishers, London.
6. Sambasiva Rao K.R.S. 1999. Pesticide impact on fish metabolism. (Eds.) Discovery Publishing House, New Delhi.
7. Gupta, P.K. 1985. Modern toxicology Vol. II. Metropolitan Book co. (P) Ltd., New Delhi.
8. Thomas J. Haley and William O. Berndt, 1987. Handbook of toxicology. Hemisphere Publishing Corporation, Washington.
9. Bio-pesticides in Insect Pest Management 1999. S. Ignacimuthu and Alok Sen, Phoenix Publishing House Pvt., Ltd., New Delhi.
10. Water Toxicology V.V. Metelev, Kanaev, N.G. Dzasokhova-Amerind Publishing Co., Pvt., Ltd., New Delhi.

GS3

HUMAN HEALTH AND HYGIENE

Unit -I

Introduction to food nutrition and health. Cereals, Rice, Wheat and Millets (Ragi, Maize, Barley and Oats) structure, composition and nutritive value. Recommended dietary allowances for Indian. Role of diet in the development of chronic diseases such as cardiovascular disease, cancer and diabetes.

Unit – II

Fruits and vegetables – Composition, nutritive value, pigments and flavor component. Composition and medicinal value of Garlic, Ginger, Black pepper, Cumin, Coriander and Turmeric.

Unit – III

Human diseases – Factors responsible for the spread of communicable diseases – Mode of transmission of chicken pox, typhoid fever, malaria, leprosy and filariasis.

Unit – IV

Symptoms and management of intestinal diseases – Diarrhea, inflammatory bowel disease, ulcerative colitis, constipation, irritable bowel syndrome.

Unit – V

Herbal cosmetics – advantages and disadvantages – Herbal skin and hair care – Home recipes – Herbal shampoo, hair tonic, face glow, removing dark circles, facial hair control and herbal tooth powder.

GS4 INTRODUCTION TO BIOETHICS

Bioethics is the philosophical study of the ethical controversies brought about by advances in biology and medicine. This course provides an introduction to the ethical questions that arise in the relationships among life sciences, biotechnology, and medicine. The goal of the study is ethical decision making in the context of biological information and technology.

Unit – I

Introduction to Bioethics in Biotechnology- Ethics – Bioethics - Biotechnology – Positive effects – Negative effects - Ethics in biotechnology- Biotechnology examples – Rice with Vitamin A - Slow Ripening Fruits- Saving the Banana- Virus Resistant Crops - Building with Silk- Educated Need for Fertilizers- More from the Sun- Toxic Soils- Biological Pest Controls – Fast Growing Trees- Fast Growing fish- The Monarch Butterfly Story- Consumer traits – food safety- Environmental concerns- Economic and Social Concerns.

Unit – II

Biosafety Regulations- National and International Guidelines.

Introduction – Regulation framework in various countries – USA- European Union-Canada- Australia- South Africa- Asian Region- International Guidelines.

Unit –III

CPCSEA Guidelines for Laboratory Animal Facility

Goal- Veterinary care- Animal procurement- Quarantine, Sterilization and separation – Surveillance, diagnosis, treatment and control of disease- Animal care and technical personnel- Personal hygiene- Animal experimentation involving hazardous agent- Multiple surgical procedures on single animal- Duration of experiments- Physical restraint- Physical plant- Physical relationships of animal facilities to laboratories – Functional areas- Physical relationship of animal facilities to laboratories- Functional area- Physical facilities- Environment- Animal husbandry- Activity – Food- Bedding- Water- Sanitation and cleanliness- Assessing the effectiveness of sanitation – Waste disposal- Pest control- Emergency , weekend and holiday care.

Unit – IV

GLP and Bioethics- Introduction – National Good Laboratory Practice (GLP) Programme- The GLP authority functions- Why follow Good Laboratory Practices?- The Aspiration – Who is responsible? – The IT Way- Role of a Sponsor- What are the quality standards for Clinical Trials?- Why is India a favorite destination for Clinical Trials worldwide?

Unit – V

Intellectual Property Rights - An introduction- Origin of the Patent Regime- Early patterns Act & Indian Pharmaceutical Industry – History of Indian Patent System- The Present Scenario – Basis of Patentability –Patent Application Procedure in India- Patent Granted Under Convention Agreement- Who can apply for a patent?- Patent Procedure – Opposition to Grant of Patent- Grant and Sealing- Exclusive Rights – Grant of Exclusive Rights- Special Provision for selling or distribution – Suits relating to infringements – Compulsory License- Termination of Compulsory License – Case study- Compulsory Licenses- Relief under TRIPS agreement.

Reference Books:

1. Bioethics, by Shaleesha A. Stanley (2008). Published by Wisdom Educational Service, Chennai.

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MARINE BIOTECHNOLOGY

Unit-I

Basics of Aquaculture: Introduction to Marine Biotechnology - scope and its utility in Aquaculture - Indian and World Aquaculture-Role, Status and Importance of Aquaculture, Marine ornamental fishes of India.

Unit –II

Marine Biodiversity: Marine Biodiversity - Defining and Measuring diversity, - -Marine food web dynamics - Primary, secondary and tertiary Production.

Unit – III

Principles of Oceanography and Live feed culture: Living resources of Indian sea - Marine food analysis -Live feeds in Marine Aquaculture- Artemia, Rotifers, Microalgae and Copepods.

Unit-IV

Marine Biotechnology and its Potential: Probiotics bacteria and their importance in aquaculture – Vaccines for aquaculture -PCR and other techniques for identification of bacterial and viral pathogen in aquaculture

Unit-V

Biotechnology in aquaculture: Cryo-preservation techniques- Application of cryo preservation in aquaculture - Applied genetics of cultivated fishes –. Application of ocean remote sensing in Aquaculture.

References:

1. Biological Oceanography, (1999) Lalli, C.M.
2. Textbook of Marine Ecology (1989) Nair, N.B and Thampis
3. An Introduction to Marine Sciences (1988). Medius, P.S & Campell, J. J.
4. General Oceanography- An introduction (1980) Sielder, G.
5. Recent Advances in Marine Biotechnology.Vol.2 (1998) Nagabhushan.R
6. Biotechnology and Biodegradation (1990), D. Chakaraborthy.
7. Chemical Oceanography (1992). Millero & Saha, M.C.
8. Fish Genetics and Endocrinology (2007) R.Ghosh
- 9..Live feeds in Marine Aquaculture (2003)Josianne G.Stottrup and Lesley A.McEvoy
- 10.Marine Biology (2005)S.K.Dubey.

GS6

VALUE ADDED FISHERY PRODUCTS

OBJECTIVE

To develop knowledge on fish processing essential for value adding of fish that would create a chance of earning.

Unit-I

Introduction to value added products: Food Science and Technology - Food Laws and Associated Bodies - Technical assistance and financial supports for fish growers and processors.

Unit-II

Preparation of value added fishery products: Fish deboning, smoking, fish sizzling, sausage - fish ball, fish roll, dry fish, fish and prawn pickle - some instant preparations.

Unit-III

Sea food products: Fish oil, Nutritional and Economic importance of sea food.

Unit-IV

Quality control: Identification of spoil fish - Deteriorative factors and their control - Quality criteria of an entrepreneur - Quality assurance, regulations, codes, grades and standards.

Unit-V

Marketing: Sanitation standard operating procedures - Good Manufacturing Practices - Developing Brand Name - Packaging - Marketing strategies.

Reference books

1. I. S. Singh, 2011. Food Processing. *Westville publishing house, New Delhi.*
2. S. S. Marwaha and J. K. Arora, 2000. Food Processing: Biotechnological Applications. *Asiatech Publishers Inc. New Delhi.*
3. Meenakshi Paul, 2007. Biotechnology & Food Processing Mechanics. *Gene-tech Books New Delhi.*
4. P. T. Kalaichelvan and I. Arul Pandi. 2007. Bioprocess Technology. *MJP publisher Chennai.*
