SEMESTER – V			
Part III	**Core Elective I: Aquaculture**		
Code:15UZOE51	**Hrs/ Week: 5**	**Hrs/ Sem:75**	**Credits: 5**

Objectives

- To enumerate aquacultural potential and practices in India
- To impart knowledge on fish culture techniques to augment food production from aquatic resources.

Unit I **Culturable Species**

Scope of aquaculture – aquaculture in India – fresh water, coastal and marine aquaculture. Culturable organisms and their qualities.
Fin fishes – carps , cat fishes and others
Shell fish- shrimp, prawn, crab – edible mussel, pearl oyster.
Cultivable sea weeds

Unit II **Culture Methods and Farm Management**

Extensive, semi - intensive and intensive, monoculture, polyculture, integrated fishfarming – paddy - cum fish culture, animal husbandry - cum fish culture, sewage- fed fish culture. Pond construction and management.

Unit III **Culture Techniques**

Fin fish - culture of Indian major carps
Shell fish - culture of marine prawn, edible oyster, pearl oyster

Unit IV **Fish feed and Disease management**

Fish feed – artificial feed - feed formulation, live feed and their culture- artemia, rotifers, microalgae.
Diseases – bacterial, viral and fungal diseases , ectoparasites and endoparasites - prevention and management, nutritional deficiency diseases.

Unit V **Preservation and Marketing**

Fish preservation – freezing, canning, dry curing, salt curing, smoke curing, irradiation, special cured products.
Marketing- marketing techniques, Government participation-CMFRI, CIFA, CIBA, CIFNET, MPEDA, FSI, Marine biological station, hydro-biological research station, FFDA, NABARD, IDBI

Text Books

1. Santhana Kumar and Selvaraj,A.M. 2006 Concepts of Aquaculture, Mac ram Publications, Nagercoil.

Books for Reference

1. Jhingran,V.G . 1982. 2nd edition. Fish and Fisheries of India, Hindustan Publishing Corporation, Delhi.
2. Khanna,S.S .An Introduction to Fisheries. Central Book Depot, Allahabad.
3. Santhanam,R.M, Sukumaran and Natarajan,P. 1987. A Manual of Freshwater Aquaculture. Oxford & IBH publishing Co Pvt Ltd, Janpath, New Delhi.
4. Dinabandhu Sahoo, S.Z. Qasim. 2009. Sustainable Aquaculture. A.P.H Publishing Co, NewDelhi.
5. Agarwal, S.C. 1994. A Hand book of Fish Farming. Naranda Publishing House, Delhi.
6. Chaudhuri , A.B. 2009. Aquaculture Resurgence Birth of Blue Revolution. Daya Publishing House, Delhi.
7. Sailendra Ghosh. 2009. Fisheries and Aquaculture Management. Adhyayan Publisher & Distributors, NewDelhi.

SEMESTER- V			
Part –III Core Elective II: Biotechnology			
Code : 15UZOE52	Hrs/Week : 5	Hrs/Sem : 75	Credits : 5

Objectives

- To familiarize with basic concepts and techniques of biotechnology.
- To understand the applications of scientific and engineering processes.
- To gain an insight on the link between biotechnology and welfare of mankind

Unit I **Cloning Vectors**

Introduction – scope and importance of biotechnology – cloning vehicles – bacterial plasmid vectors - pBR 322 and Ti plasmid – bacteriophage vectors - lambda and M13- animal viral vector - SV40 – role of restriction and modification enzymes.

Unit II **Gene cloning and Screening**

Gene cloning – methods of introduction of cloned genes into host cells – transformation – liposome mediated transfer – electroporation – particle bombardment gun – viral vector method – DNA library – hybridization technique – blotting techniques - Southern, Northern and Western.

Unit III **Animal Cell, Tissue and Organ Culture**

Culture media – cell culture techniques - monolayer culture and immobilized culture of cell lines – techniques and applications of human embryonic stem cell culture - organ culture – techniques – tissue engineering of artificial skin and cartilage.

Unit IV **Environmental and Bioprocess Technology**

Biotechnological methods for sewage and waste water treatment – bioremediation – degradation of xenobiotic (hydrocarbons and pesticides) – role of genetically engineered microbes – biomining – bioleaching – industrial production of penicillin and ethanol.

Unit V **Biotechnology and Human Welfare**

DNA probes and diagnosis of genetic disorders – DNA finger printing technique – gene therapy and treatment of genetic diseases – vaccines – recombinant DNA vaccines and viral vaccines – Human Genome Project – types – methods of sequencing – potential benefits to mankind.

Text Books

1. Kumaresan, V. 2010. Animal Biotechnology, Saras Publication, Nagercoil.
2. Kumaresan, V. 2009. Applied Animal Biotechnology, Saras Publication, Nagercoil.

Books for Reference

1. Singh, B.D. 2005. Biotechnology, Revised edition, Kalyani Publishers, Chennai.
2. Dubey, R.C. 2006. Text Book of Biotechnlogy, 4th edition, S. Chand and Co Ltd, New Delhi.
3. Rema, L.P. 2009. Applied Biotechnology, MJP Publishers, Chennai.
4. Shailendra Singh, 2007. Applied Biotechnology, 1st edition, Campus Books International New Delhi.
5. Clark and J. Pazdernik. 2009. Biotechnology, Elsevier Academic Press, California, USA.
6. Ramadass, P. 2009. Animal Biotechnology – Recent Concepts and Development. MJP Publishers, Chennai.

SEMESTER - VI			
Part - III	Core Elective III	Sericulture	
Code : 15UZOE61	Hrs / week : 6	Hrs / sem : 90	Credits : 5

Objectives

- To know the importance of sericulture
- To give an insight about the art of sericulture and
- To explore the scope for sericulture to adopt it as a vocation after their graduation.

Unit I **Introduction**

Scope of sericulture - sericulture in India – role of Central Silk Board (CSB), Central Sericultural Research and Training Institute(CSRTI) – Silkworm Seed Technology Laboratory(SSTL).

Unit II **Moriculture**

Commercial varieties of mulberry - mulberry cultivation – cultivation practices - biofertilizers – foliar spray for mulberry - triacontanol and seriboost.
Diseases of mulberry - bacterial – viral – fungal – nematode and deficiency diseases - pests of mulberry – symptoms and control measures.

Unit III **Silk worm rearing**

Mulberry silk worm – morphology - development – silk gland. Silk worm rearing – rearing house – rearing appliances – rearing operations – chawki rearing – rearing of late age worms – application of sampoorna.

Unit IV **Cocoon Mounting and Marketing**

Mountages - mounting methods – harvesting of cocoons – transport of cocoons – physical characters of cocoons – defective cocoons – moth emergence - cocoon markets.Silkworm diseases - bacterial, fungal and viral diseases - pests – symptoms and control measures.

Unit V **Silk reeling**

Cocoon stifling – methods of stifling – storage of cocoons – deflossing cocoon cooking – realing operations. reeling appliances – cottage basin – filature units - raw silk testing – silk marketing - by-products of sericulture - uses of silk.

Text Books

1. Ganga G. and J. Sulochana Chetty. 1991. An Introduction to Sericulture. Oxford & IBH Publishing Co Pvt. Ltd. New Delhi

Books for Reference

1. Krishnaswami S.1990. New Technology of Silkworm Rearing. Published by Central Silk Board, Bangalore.
2. Hisao Aruga. 1990. Principles of Sericulture. Published by Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi

3. Tammanna N.Sonwalker. 1993. Hand Book of Silk Technology. Published by Wiley Eastern Ltd. Madras.
4. Dr.Manjeet S. Jolly. 1987. Appropriate Sericulture Techniques. Published by Director, International Centre for Training and Research in Tropical Sericulture, Mysore.
5. Kamal Jaiswal, Sunil P. Trivedi, B.V. Pandey and P.N.Pandey 2009. Indian Sericulture. ALFA Publication, New Delhi

SEMESTER III			
Part – III	**Skill Based Elective: Basics of Computers**		
Code : 15UZOS31	**Hrs/Week :2**	**Hrs/Sem : 30**	**Credits: 3**

Objectives

- To develop skills relevant to computer technology
- To be well equipped with up to date knowledge on computer operations and applications.

Unit I **Introductions to World of Computers**

Computers – types – applications – input and output devices – meaning of hardware and software.

Unit II **MS-Word Basics**

Creating documents – saving files - opening documents - printing files –spelling and grammar check – word art.

Unit III **MS – Excel Basics**

Spread sheet – data entry – creating charts and graphs.

Unit IV **MS-Power Point Basics**

Creating Power Point presentation – clip Art – saving – running a slide show

Unit V **Information Network**

Basics of internet communication –Internet browsing – search engines – E -Mail advantages and disadvantages.

Text Books

1. Arumugam N.2010 Introduction to Computers,SarasPublications ,Nagercoil.

Books for Reference

1. Rajaraman V. 1985 Fundamentals of Computers, Prentice Hall of India.
2. Peter Norton, 2009. Introduction to Computers 6th edition, Tata McGraw Hill, New Delhi

SEMESTER IV			
Part - III	**Skill Based Elective : Vermitechnology**		
Code : 15UZOS41	**Hrs/Week : 2**	**Hrs/Sem: 30**	**Credits : 2**

Objectives

- To get a basic knowledge of various aspects of vermicomposting.
- To develop skills in vermicomposting for self-employment.

Unit I **Vermiculture Technique**

Definition- need for vermiculture-species selection -vermiculture process

Unit II **Vermicomposting Technology**

Selection of suitable species of earthworm, preparation of worm bed – maintainance of vermicomposting bed- harvesting the worms

Unit III **Vermicomposting Methods**

Pit method- bin method, windrow method, vermiwash- preparation- composition- applications

Unit IV **Vermicompost**

Vermicompost- chemical composition, physical and biological features- applications.

Unit V **Economic Importance of Earthworm**

Earthworm - as bait- as food - in agriculture - in medicines- in laboratory research purpose- benefit to society.

Text Book

1. Gupta P. K. 2012. Vermicomposting for Sustainable Agriculture 2nd Revised Edition, Agrobios, India.

Books for Reference

1. Talashilkar S. C. and Dosani 2005 Earthworm in Agriculture First edition Agrobios Publications, Jodhpur
2. Renganathan L. S. 2006. Vermibiotechnology from Soil Health to Human Health. First edition, Agrobios, India.
3. Prakash Malhotra, Economic Zoology, 2008 First edition. Adhyayan Publishers and Distributers, New Delhi.

SEMESTER-V			
Part – III Skill Based Elective – Medical Nutrition Therapy			
Code : 15UZOS51	**Hrs/Week : 4**	**Hrs/Sem : 60**	**Credits : 3**

Objectives

- To disseminate information on basic aspects of diet therapy.
- To inculcate aptitude for the planning and preparation of therapeutic diets.
- To instill the spirit of caring sick.

Unit I **Diet Therapy**

Introduction – principles of diet preparation – normal diet in the hospitals – liquid – semiliquid – light – soft diet – bland diet – regular diet – different types of feeding – oral feeding – tube feeding – IV feeding.

Unit II **Therapeutic Diet for Liver and Kidney Diseases**

Causes – types – symptoms and principles of dietary management in infective hepatitis and cirrhosis of liver – glomerulonephritis – chronic renal failure - diet in dialysis and renal transplantation.

Unit III **Therapeutic Diet for Diabetes and Cardiovascular Diseases**

Risk factors – symptoms – principles of planning diet and management of Diabetes mellitus – atherosclerosis – hypertension – congestive heart failure.

Unit IV **Therapeutic Diet in Febrile Conditions and Allergy**

Febrile condition – short duration – typhoid – long duration – tuberculosis – diet in allergy – definition – classification – common food allergy – test of allergy – diet therapy.

Unit V **Therapeutic Diet for Cancer and Burns**

Cancer – etiology – symptoms and dietary guidelines – burns – degree of burns – principles of dietary management.

Practical Experience

- Planning, preparing and serving diet.
- Visit to cancer care centre.
- Observation of patients in kidney care and diabetic care centres.

Text Books

1. Mudambi, S.R. and M.V.Rajagopal 2009. Fundamentals of Food, Nutrition and Diet Therapy. New Age International Publishers, 5th edition, New Delhi.

Books for Reference.

1. Gopalan, C.Ramashasthri, B.V. and Balasubramanian 1998. Nutritive Value of Indian Foods, NIN, ICMR.
2. Blank, F.C. 2009. A Handbook of Foods and Nutrition Agrobios (India) Jodhpur, India.
3. Srilakshmi, B. 2009. Human Nutrition (for B.Sc. Nursing Students). New Age International Publisher, New Delhi.
4. Srilakshmi, B. 2010. Dietetics. 6th edition, New Age International Publishers, New Delhi.

SEMESTER V			
Core VIII: Animal Physiology			
Code: 18UZOC52	**Hrs/Week: 5**	**Hrs/Sem: 75**	**Credits: 4**

Vision

Understand the physiological processes that regulate body functions and the regulation of organ systems and develop independent thinking skills and written and oral communication abilities

Mission

Apply knowledge of a physiological mechanism to explain how the physiological processes occur in an animal.

Course outcome

CO.No	**Upon completion of this course, students will be able to**	**PSO addressed**	**CL**
CO – 1	compare the structure and functions and co-ordination of organs and organ systems	1	Un
CO – 2	assess the causes, diagnosis, prevention and treatment of illnesses	2	Ev
CO – 3	develop personal healthy life style	6	Cr
CO – 4	demonstrate the different lab experiments	5	Un
CO – 5	experiential learning, analysis and drawing conclusion	4	Cr
CO-6	find way for scientific investigation	6	Ev
CO-7	develop various skills which will be helpful in expressing ideas and views clearly and effectively	7	Ap
CO-8	imbibe ethical, moral and social values in personal and social life leading to highly cultured and civilized personality	8	Cr

SEMESTER V			
Core VIII: Animal Physiology			
Code: 18UZOC52	**Hrs/Week: 5**	**Hrs/Sem: 75**	**Credits: 4**

Unit I **Digestion and Nutrition**

Intracellular and extracellular digestion – role of enzymes in digestion of carbohydrates, proteins and lipids – absorption of digested food materials – malnutrition.

Unit II **Respiration and Circulation**

Respiration: Types of respiratory pigments – transport of respiratory gases – anaerobiosis - Respiratory Quotient.

Circulation: Composition of blood – blood coagulation – structure of human heart – heart beat – origin and conduction – cardiac cycle – blood pressure.

Unit III **Excretion and Homeostasis**

Excretion: Structure and function of nephron – mechanism of urine formation in man – nitrogenous waste products – ammonotelism, ureotelism, uricotelism – ornithine cycle – dialysis. Osmoregulation: in crustaceans and fishes – thermoregulation – mechanisms – ectotherms – endotherms – heterotherms

Unit IV **Muscular, Nervous and Chemical Coordination**

Structure of skeletal muscle and myofibril – molecular organization, mechanism and chemistry of muscle contraction.

Structure of neuron – conduction of nerve impulse - synaptic transmission – neuromuscular junction – reflex action - receptors – photo and phonoreceptors.

Endocrine glands: structure and functions of pituitary and pancreas.

Unit V **Reproduction and Behavioural Physiology**

Anatomy of reproductive organs in human – ovary – testis – reproductive cycles – hormonal control of reproduction. Animal behaviour – types – learning and learned behaviour – Biological clock – circadian rhythm – circannual and lunar periodicity.

Text Book

1. Maria Kuttikan, A. and N. Arumugam. 2004. *Animal Physiology.* Saras Publication Kottar, Nagercoil.

Books for Reference

1. Sembulingam, K., Prema Sembulingam. 2008. *Essentials of Medical Physiology*. JaypeeBrothers. New Delhi

2.Rastogi, S.C. 1979. *Essentials of Animal Physiology* – Wiley Eastern Ltd. New Delhi.

3.William S. Hoar. 1987. *General and Comparative Physiology* 3rd Edition. Prentice Hallof India (P) Ltd.

4.Verma, P, Tyagi, S. and V.K. Agarwal. 2002. *Animal Physiology*. S.Chand & CompanyLtd. New Delhi.

5.Prosser, C.L. and F.A Brown. 1984. *Comparative Animal Physiology*. SaundersPhiladelphia.

6.Sambasivah Kamalakara Rao and Agustin Chellappa. 1983. *Animal Physiology* S. Chand and Company.

7.aNagabhrushanam, R., Kodarkar, M.S. and R. Sarojini. 2002. *Text book of Animal – Physiology*, Second Edition, Oxford and IBH Publishing Co, Pvt. Ltd.

SEMESTER -V			
Core IX Cell Biology and Genetics			
Code: 18UZOC53	**Hrs/week : 5**	**Hrs/Sem: 75**	**Credits: 4**

Vision :

To give an insight on basic organization and functions of the cellular components and the principles of inheritance at the cellular level in organisms.

Mission :

To provide unique integrated approach of Cell Biology and Genetics, covering cellular organization, inheritance and hereditary disorders, to gain an enhanced knowledge and understanding of biology and inheritance.

Course Outcome

CO.No	Upon completion of this course, students will be able to	PSO addressed	CL
CO-1	understand the organization of the cell and to differentiate between prokaryotic and eukaryotic cell.	2	Un
CO-2	describe the structure and functioning of cell organelles as a system to carry out cellular processes	2	Un
CO-3	analyse the complexity and harmony of the cell from the acquired knowledge	2	An
CO-4	explain the types of chromosome; composition, structure, and replication of DNA	4	Ev
CO-5	demonstrate the genetic basis of Mendelian and non-Mendelian inheritance	5	Un
CO-6	develop the ability to think critically, analyse and use the information gained to solve problems related to genetics	6	Cr
CO-7	evaluate hereditary patterns for genetic disorders by applying genetic information to innovate solutions for health related issues	6	Ev
CO-8	apply the practical and conceptual knowledge of Cell biology and Genetics to understand other fields of biology	8	Ap

SEMESTER -V			
Core IX Cell Biology and Genetics			
Code: 18UZOC53	**Hrs/week : 5**	**Hrs/sem: 75**	**Credit: 4**

Unit I Cell and Plasma membrane

Protoplasm theory - Cell theory. Prokaryotic and Eukaryotic cells. Plasma membrane-structure, chemical composition, specialized structures and functions.

Unit II Cell Organelles

Cytoplasm- ultrastructure and functions of mitochondria, golgi apparatus, endoplasmic reticulum, lysosome, ribosome.

Unit III Nucleus

Ultrastructure and functions - nucleus, nuclear membrane, nucleolus. chromosome – structure – types, giant chromosomes - polytene chromosome, lampbrush chromosome. DNA- chemistry, structure and replication.

Unit IV Mendelian Genetics

Mendelian laws – monohybrid and dihybrid cross – back cross – test cross – incomplete dominance – inheritance of combs in fowls – multiple alleles – multiple genes – skin colour in man.

Unit V Sex linked Inheritance and Genetic Disorders

Sex determination in man – sex linked inheritance in man – haemophilia – colour blindness. Inborn errors of metabolism – phenylketonuria – albinism. Mutant haemoglobins – sickle cell anaemia. Syndromes – autosomal – Down's syndrome – sex chromosomal – Turner's and Klinefelter's syndrome.

Text books

1. Arumugam, N. 2017. *Cell Biology*. Saras Publications, 114/ 35G ARP. Camp Road, Periavilai, Kottar P.O, Nagercoil.
2. Meyyan, R.P. 2007. *Genetics*. Saras Publications, 114/ 35G ARP. Camp Road, Periavilai, Kottar P.O, Nagercoil.

Books for Reference

1. Power, C.B. 2004. *Cell Biology*. Himalaya Publishing House, Ramdoot Dr. Bhalenaomang Gingaon Mumbai.
2. Verma, P.S. and V.K. Agarwal. 2008. *Cytology* (8^{th} edition). S.Chand and Co Ltd 7361 Ram Nagar, New Delhi .

3. De Robertis, E.D.P. and E.M.F De. Robertis, 1988. *Cell and Molecular Biology* 9th International Edition, K.M. Varghese Company, Mumbai.
4. Verma, P.S. and V.K. Agarwal. 2008. *Genetics*. 9th Edition, S. Chand and Co Ltd., New Delhi.
5. Gardner, Simmons and Snustad. 1991. *Principles of Genetics*, 8th Edition. John Wiley and Sons. Inc. New York.

PRACTICALS

Hrs / Week : 2 **Credit - 1**

1. Preparation of squamous epithelium.
2. Onion root tip squash: Observation of different stages of mitosis.
3. Chironomous larva: Mounting of polytene chromosomes.
4. Observation of cells through ultramicroscope.
5. Micrometry.
6. DNA – Watson & Crick model, Golgi complex, endoplasmic reticulum, mitochondria, ribosome (models/ charts)
7. Verification of Mendel's monohybrid cross using beads.
8. Verification of Mendel's dihybrid cross using beads.
9. Sex linked inheritance of colour blindness and haemophilia (chart).
10. Genetic basis and clinical manifestations of Down's, Klinefelters and Turner's syndrome (chart).

Books for Reference:

1. Verma P.S. 1992. *A Manual of Practical Zoology - Chordates*. S. Chand & Company Ltd. Ram Nagar, New Delhi -.
2. Jayasurya, Dulsy Fatima, Meyyan, R.P., Arumugam, N. and V. Kumaresan 2013. *Practical Zoology*. *(Cell Biology-Embryolgy- Animal Physiology- Immunology Ecol Genetics- Evolution - Microbiology - Biochemistry - Biophysics*) Saras Publication, Kottar P.O., Nagercoil.
3. Emmanuel C., Rev. Fr. S. Ignacimuthu, S.J. and S. Vincent. 2006. *Applied Genetics - Recent Trends and Techniques*. MJP Publishers, 47, Nallathambi Street, Triplicane, Chennai
4. Eldon John Gardner, Michael J. Simmons and D. Peter Snustad. 1991. *Principles of Genetics.* Eighth Edition. John Wiley & Sons, INC. New York.

SEMESTER - VI			
Core XI : Biostatistics and Bioinformatics			
Code : 18UZOC62	**Hrs/Week : 5**	**Hrs/Sem : 75**	**Credits : 4**

Vision

- To explore the integration and application of statistics and bioinformatics in biology

Mission

- To acquire the skills and perspectives on statistics and bioinformatic tools in analysis and interpretation of data

Course Outcome

CO No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO 1	attain an insight on statistical methods for analysis of biological data	1	Kn
CO 2	acquire knowledge on the bio informatics concepts for analyzing molecular data	1	Kn
CO 3	identify the problems in data analysis and match the appropriate statistical method and corresponding software	4	Un
CO 4	analyse and use the bioinformatics tools for advanced sequence alignment, database searches, genome analysis and protein structure studies	8	Ap
CO 5	undertake statistical operations in biology	7	Ap
CO 6	operate commonly used bioinformatic tools and statistical methods and understand their limitations	8	Ap
CO 7	apply bioinformatics in life science research	8	Ap
CO 8	understand and critically evaluate the data analysis procedures in publications of molecular biology research	2,3	Un

SEMESTER - VI			
Core XI : Biostatistics and Bioinformatics			
Code : 18UZOC62	**Hrs/Week : 5**	**Hrs/Sem : 75**	**Credits : 4**

Unit I **Biostatistics – Collection and Display of Data**

Introduction – populations and samples – types of variables – collection of primary data – survey – census - sampling methods – sources of secondary data – classification of data – frequency distribution – presentation of data – tables - parts -types – diagrams – line diagram – bar diagram – pie diagram – graphs – histogram.

Unit II **Measures of Location and Dispersion**

Concept – computation for grouped and ungrouped data – relative merits and limitations of measures of central tendency mean, median and mode – measures of dispersion – range, variance, standard deviation, standard error and coefficient of variation.

Unit III **Statistical Inference and Correlation Analysis**

Probability theory – terminology – types - theorems of probability - chi- square test and goodness of fit – correlation – definition – types – scatter diagram – Karl Pearson's correlation coefficient – calculation of r value and interpretation – testing the significance of relationship using student's t-test.

Unit IV **Bioinformatics – An Overview**

Definition – scope – applications of bioinformatics – properties of biological databases –databases retrieval tools – PubMed – Medline – Locuslink – Entrez - SRS

Unit V **Protein and Nucleotide Sequence Databases.**

Protein sequence databases – NCBI – SWISS PROT - nucleotide sequence databases – EMBL – GENBANK - sequence alignment softwares – BLAST – FASTA – applications of bioinformatics tools in research on bioinformatics.

Text Book

1. Arumugam, N. 2010. *Biostatistics, Computer Applications, Bioinformatics and Instrumentation,* Saras Publication, Nagercoil

Books for Reference

1. Palanisamy. S. and M. Manoharan. 1990. *Statistical Methods for Biologists.* Palani Paramount Publications, Palani

2. Gurumani, N. 2005. *An Introduction to Biostatistics.* 2nd edition, MJP Publishers, Chennai
3. Agarwal, S.K. 2008. *Biostatistics,* APH Publishing Corporation. New Delhi
4. Arunima Mukherjee, 2008. *Bioinformatics,* Oxford Book Company, Jaipur, India
5. Thiagarajan, B. and Pa.Rajalakshmi. 2009. *Computational Biology.* MJP Publishers, Chennai

PRACTICALS

Hours / Week : 2 **Credit - 1**

1. Preparation of a questionnaire and collection of data by survey method.
2. Demonstration of simple random sampling by simulation using students (lottery and table of random number method)
3. Construction of continuous frequency table for the weight / height of students.
4. Diagrammatic presentation of data - simple bar diagram and pie diagram
5. Graphical presentation of data – histogram, frequency polygon and frequency curve
6. Calculation of mean, median, mode, standard deviation, standard error and coefficient of variation using neem leaves
7. Study of probability and chi - square test with two coins tossing experiment
8. Calculation of correlation coefficient and testing its significance
9. BLAST
10. FASTA

Books for Reference

1. Rajadurai, M. 2010. *Bioinformatics – A Practical Manual*, PSB Book Enterprises, Chennai.
2. Gurumani, N. 2005. *An Introduction to Biostatistics.* 2nd edition, MJP Publishers, Chennai.

SEMESTER VI			
Core XII Ecology and Biodiversity			
Code: 18UZOC63	**Hrs/Week: 4**	**Hrs/Sem: 60**	**Credits:4**

Vision

To support advanced knowledge building in ecological principles and conservation ecology

Mission

To develop knowledge and critical understanding of ecology, conservation and biodiversity science and practice and sustainable use and management of its ecosystem services.

Course Outcome

CO.No	Upon completion of this course, students will be able to	PSO addressed	CL
CO – 1	understand and relate the interactions and the interdependence among environmental factors and living organisms.	1,2	Un
CO – 2	compare the adaptations of the organisms in different habitats	2	Un
CO – 3	analyse the mechanisms regulating the dynamics composition and organization of communities	2	Un,An
CO – 4	explore the interactions between organisms, the dynamics of populations and environment	1,3	Un,An
CO –5	explain different levels of biodiversity	1	Un,
CO – 6	discuss the direct and indirect values of biodiversity	1,3	Cr
CO-7	identify key threats to biodiversity evaluate management options for conserving biodiversity	1,3	Ap,Ev
CO-8	develop skills and competencies for career in eco-conservation and Eco- tourism	7	Ap

SEMESTER VI			
Core XII Ecology and Biodiversity			
Code: 18UZOC63	**Hrs/Week: 4**	**Hrs/Sem: 60**	**Credits:4**

Unit I **Ecological Factors**

Abiotic factors : Basic concepts and biological effects of temperature and light
Biotic factors : Intra and interspecific relationships -mutualism, commensalism and antagonism (antibiosis, parasitism, predation and competition) – Biogeochemical cycles: carbon - nitrogen and phosphorous cycles

Unit II **Population& Community Ecology**

Population - Definition – density and estimation, natality – mortality – age distribution – age pyramids – population growth patterns –population fluctuations- population equilibrium — biotic potential – regulation of population density – dispersal – dispersion – population interaction
Community : concepts and characteristics – diversity – structure – community dominance – community stratification – periodicity – community interdependence
Ecotone– Edge effect – ecological niche – Ecological succession

Unit III **Habitat Ecology**

Aquatic - Freshwater – pond
Marine – classification of pelagic and benthic zones ,
Deep sea characteristics , fauna and adaptations .
Terrestrial habitat – desert and cave , characteristics , fauna and adaptations .

Unit IV **Biodiversity**

Definition and levels of Biodiversity (Genetical, Ecological, and Species diversity), values of biodiversity , Threats and loss of biodiversity – causes (natural, and manmade). Hot spots of biodiversity (with special reference to India) IUCN threat categories . Common threatened animal Taxa of India – Red Data Book

Unit V **Biodiversity Conservation and Management**

Conservation of Biodiversity : *In- situ* conservation (Sanctuaries,National parks , Biosphere Reserves, World Heritage sites) Project Tiger – *Ex- situ* conservation (Botanical gardens, gene banks , cryopreservation)
Role of Organizations in conservation: International Union for Conservation of Nature and Natural Resources (IUCN) , Zoological Survey of India (ZSI) , World Wildlife Fund (WWF), National Bureau of Plant Genetic Resources (NBPGR) and Convention on Rio Summit Agenda 21, Biodiversity Act, 2002 .

Text Books

1. Arumugam, N. 2010. *Concepts of Ecology*. Saras Publication, Kottar, Nagercoil.
2. Saha,T.K. 2008. *Ecology and Environmental Biology*. Books and Allied (P) Ltd,Kolkata.

Books for Reference

1. Kumaraswamy, K, AlagappaMoses, A. and Vasanthy, M. 2004. *Environmental Studies* Publication Division.
2. Prabhakar, V.K. 2004. *Environmental Education*. Anmol publications(P) Ltd, New Delhi.
3. Agarwal, K.C. 1999. *Environmental Biology*. AgroBotanica.
4. Verma, P.S. and V.K.Agarwal. 2013. *Cell Biology, Genetics, Molecular Biology, Evolution and Ecology.* S.Chand& Company.
5. Arumugam, N and V.Kumaresan. 2014. *Environmental Studies*, Saras Publication, Nagercoil.
6. Verma and Agarwal. 1985. *Principles of Ecology*. S.Chand& Company Ltd, New Delhi.
7. Veer BalaRastogi and M.S.Jayaraj. 1988. *Animal Ecology and Distribution of Animals*. Kedar Nath& Ram Nath, Delhi
8. Krisnamoorthy, K.V. 2004. *An Advanced Text Book of Biodiversity.* Oxford and IBH, New Delhi

PRACTICALS

Credit - 1

1. Estimation of dissolved O_2 in water sample (pond / sea water)
2. Estimation of alkalinity in water sample (pond / sea water)
3. Estimation of BOD of water samples collected from various sources
4. Detection of transparency of water by Secchi disc
5. Analysis of plankton – fresh water / marine
6. Museum specimens / slides / models and charts
   - Mutualism (Hermit crab & Sea anemone)
   - Commensalism (Echeneis & Shark)
   - Parasitism (Sacculina on crab)
   - Map showing Biosphere Reserves of India
   - Hotspots of India
   - Endangered animals : Greater one horned Rhinoceros , Asiatic lion
   - Endemic animals :Lion tailed Macaque , NilgrisTahr
7. Report on visit to any place of ecological interest – (compulsary).

Books for Reference

1. Jeyasuriya, Arumugam, N. and Dulcy Fatima. 2013. Narayanan L.M *Practical Zoology Vol.3* Saras Publications, Kottar, Nagercoil.
2. Methods in Hydrobiology Manual, *Centre for Advanced Studies in Marine Biology*, Annamalai University.
3. Krisnamoorthy, K.V. 2004. A*n Advanced Text Book of Biodiversity*, Oxford and IBH, New Delhi.

SEMESTER V			
Core Integral I : Marine Biology			
Code: 18UZOI51	**Hrs/Week: 4**	**Hrs/Sem: 60**	**Credits: 4**

Vision

To provide quality education and training in the field of marine biology and environment

Mission

Provides an excellent education in marine biology, emphasizing the flora and fauna of marine environment

To raise awareness about marine environments for the community and the society

Course Outcome

CO.No	Upon completion of this course, students will be able to	PSO addressed	CL
CO - 1	classify the different ecological zones of marine environment, diversity of marine organisms and their adaptations	1,2	Un
CO - 2	explain the physical and chemical properties of sea water and their significance to marine life	1,4	Un, Ev
CO - 3	appraise the ocean production, characteristics and types of coral reefs, mangroves and estuaries	3	Ev
CO - 4	outline the formation, types and properties of the dynamics of ocean	1,2	Un
CO - 5	analyse various types of marine resources and assess the various environmental concerns related to the use and abuse of marine resources	5,6	An, Cr
CO - 6	gain specialized skills in a range of theoretical and practical applications	8,	Cr
CO - 7	develop awareness of scientific issues in marine biology within the larger social context	6	Ap, Cr
CO - 8	design and implement effective solutions to problems in marine environment	7,8	Cr

SEMESTER V			
Core Integral I : Marine Biology			
Code: 18UZOI51	**Hrs/Week: 4**	**Hrs/Sem: 60**	**Credits: 4**

Unit I Marine Habitat

Classification of marine habitat. Characteristics of pelagic and benthic divisions – intertidal, rocky, sandy and muddy shores – the features of flora, fauna and adaptations.

Unit II Physical and Chemical Properties of Sea Water

Physical properties – temperature, temperature distribution, dissolved gases, T/S diagram. Chemical properties - Nutrients (major, minor and trace elements) illumination, salinity - distribution.

Unit III Biological Characteristics of the sea

Plankton – classification, adaptations and methods of collection. Ocean production - Energy flow in the marine environment. Coral reef, mangroves, estuaries - characteristics and types.

Unit IV Dynamics of the Ocean

Tides - generating forces, types, effects of tides in coastal areas; Waves - formation, properties, types - tsunami.

Unit V Resources of the Sea

Chemical resources - manganese nodules, beach placers, Oil resource (Petroleum) Fishery products - fish meal and fish oil. Formation, ornamental and medicinal importance of natural pearls.

Text Book

1. Olivia J. Fernando. 1999. *Sea water - Properties and dynamics.* Dhanesh Publications, Ponnagam, Thanjavur.

Books for Reference

1. Gross, G., 1993. *Oceanography: A view of the Earth*. Sixth edition. Prentice Hall Inc., New Jersey.
2. McCormick, J.M. and J.V. Thiruvathaakal. 1976. *Elements of Oceanography*. W.B. Saunders Company, Philadelphia.
3. Nybakken, J.W. 1997. *Marine Biology – An Ecological Approach*. Addison Weslay Longman, Inc. California, 477pp.
4. Girish Chopra, 2006. *Coastal and Marine Geography*, Common Wealth Publisher, Delhi.
5. Veena. 2012. *Understanding Marine Biology*- Discovery Publishing House PVT.LTD New Delhi
6. Russel. 1970. *Marine Ecology*. Academic Press- London and New York.
7. Nelson and Smith. 1973. *Oil Pollution and Marine Ecology*-Plenum press, New York.

SEMESTER – V			
Core Integral II: Commercial Aquaculture			
Code:18UZOI52	**Hrs/ Week: 4**	**Hrs/ Sem:60**	**Credits: 4**

Vision

To highlight the importance of aquaculture to augment food production

Mission

To impart knowledge on fish culture techniques, health management measures and fish preservation

Course Outcome

CO.No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO-1	understand the biology of a variety of commercially important food fishes.	1	Un
CO-2	analyse the different methods of integrated fish farming	7	An
CO-3	understand the conditioning factors and how they can be manipulated	1, 2	Un
CO-4	interpret the basic culture methodologies of commercially important species	8	Ev
CO-5	acquire knowledge on feed organisms and feed formulation	1	Un
CO-6	identify the common aquaculture diseases and apply appropriate measures for fish health management	8	Ap
CO-7	explain the different techniques of fish processing and preservation	4	Un, Ev
CO-8	apply principles and concepts to solve problems that may be encountered in commercial production	7	Ap

SEMESTER – V			
Core Integral II: Commercial Aquaculture			
Code:18UZOI52	**Hrs/ Week: 4**	**Hrs/ Sem:60**	**Credits: 4**

Unit I **Cultivable Species**

Importance of aquaculture – Current status of aquaculture in India – Cultivable organisms and their qualities. Fin fishes – carps and live fishes. Shell fishes- shrimp, lobster – edible oyster, mussel, pearl oyster. Cultivable sea weeds.

Unit II **Culture Methods and Farm Management**

Polyculture, integrated fish farming – paddy - cum fish culture, animal husbandry - cum fish culture, Management of culture ponds - control of water quality parameters - fertilization - control of predators and weeds.

Unit III **Culture Techniques**

Fin fish - culture of Indian major carp (Catla) - seed collection, breeding and culture techniques

Shell fish - culture of marine prawn, pearl oyster

Unit IV **Fish feed and Disease management**

Fish feed – artificial feed - feed formulation and composition of formulated feed, live feed organisms. Common diseases – white spot disease, dropsy, fin rot, gill rot, saprolegniasis. Parasites - argulus, lernea - prevention and management. Principles of fish health management

Unit V **Fish Processing and Preservation**

Fish preservation – freezing, canning, dry curing, salt curing, smoke curing, Irradiation, special cured products. Preservation and export techniques.

Text Book

1. Santhana Kumar and A.M. Selvaraj. 2006. *Concepts of Aquaculture*. Mac ram Publications, Nagercoil.

Books for Reference

1. Santhanam, R., Sukumaran, M. and P. Natarajan. 1990. *A Manual of Freshwater Aquaculture.* Oxford & IBH publishing Co Pvt. Ltd, Janpath, New Delhi.
2. Dinabandhu Sahoo, S.Z. Qasim. 2009. *Sustainable Aquaculture*. A.P.H Publishing Co, NewDelhi.
3. Agarwal, S.C. 1994. *A Hand book of Fish Farming*. Naranda Publishing House, Delhi.
4. Chaudhuri, A.B. 2009. *Aquaculture Resurgence Birth of Blue Revolution*. Daya Publishing House, Delhi.
5. Sailendra Ghosh. 2009. *Fisheries and Aquaculture Management*. Adhyayan Publisher & Distributors, New Delhi.
6. Santhanam,R., N. Ramanathan and G. Jegathesan 1990. *Coastal Aquaculture in India.* First Edition, CBS Publishers, New Delhi.

SEMESTER – VI			
Core Integral III – Sericulture			
Code : 18UZOI61	**Hrs/Week : 4**	**Hrs/Sem : 60**	**Credits : 4**

Vision

Towards exploring the scope of various techniques involved in sericulture and moriculture for self employment.

Mission

To impart knowledge and technical skills in various aspects of sericulture and moriculture.

Course Outcome

CO.No	Upon completion of this course, students will be able to	PSO addressed	CL
CO - 1	acknowledge various organizations involved in the welfare of sericulture.	7	Un
CO - 2	interpret the practices of Moriculture.	3	Un
CO -3	attain information on the various diseases and pests affecting mulberry and its control measures.	1	Ev
CO - 4	develop skills on various silkworm rearing processes and operations.	8	Ap
CO - 5	use the knowledge of cocoon mounting and harvesting.	7	Ap
CO - 6	enumerate silkworm diseases and its control measures.	7	Un
CO - 7	involve in cocoon stifling, deflossing and reeling.	8	Ap
CO - 8	understand the uses of the products and byproducts of sericulture.	7	Un

SEMESTER – VI			
Core Integral III – Sericulture			
Code : 18UZOI61	**Hrs/Week : 4**	**Hrs/Sem : 60**	**Credits : 4**

Unit I **Introduction**

Introduction to sericulture – sericulture in India and world – role of Central Silk Board(CSB), Central Sericultural Research and Training Institute(CSRTI) –

Unit II **Moriculture**

Commercial varieties of mulberry – mulberry cultivation – cultivation practices – biofertilizers – foliar spray for mulberry – bacterial – viral – fungal –nematode and deficiency diseases – pests of mulberry – symptoms and control measures.

Unit III **Silkworm Rearing**

Mulberry silkworm –Popular silkworm breeds and hybrids in India- morphology– silk gland. Silk worm rearing – rearing house – rearing appliances – rearing operations – chawki rearing – rearing of late age worms – application of sampoorna.

Unit IV **Cocoon Mounting and Marketing**

Mountages – mounting methods – harvesting of cocoons – transport of cocoons – defective cocoons – cocoon markets. Silkworm diseases – bacterial, fungal and viral diseases – pest (Uzifly) symptoms and control measures.

Unit V **Silk Reeling.**

Cocoon stifling – methods of stifling – storage of cocoons – deflossing cocoon cooking – reeling operations. reeling appliances – cottage basin – filature units – uses of silk.

Text Book

1. Ganga, G. and J. Sulochana Chetty. 1991. *An Introduction to sericulture*. Oxford & Publishing Co Pvt. Ltd. New Delhi

Books for Reference

1. Krishnaswamy S. 1990. *New Technology of Silkworm Rearing.* Published by Central Silk Board, Bangalore.
2. Hisao Aruga. 1990. *Principles of Sericulture*. Published by Oxford & IBH Publishing Co. Pvt.Ltd., New Delhi.
3. Tammanna N. Sonwalker. 1993. *Hand Book of Silk Technology*. Published by Wiley Eastern Ltd, Madras.
4. Manjeet S. Jolly. 1987. *Appropriate Sericulture Techniques*. Published by Director, International Centre for Training and Research in Tropical Sericulture, Mysore.
5. Kamal Jaiswal, Sunil, P., Trivedi, B., Pandey, V. and P.N. Pandey 2009. *Indian Sericulture*. ALFA Publication, New Delhi.

SEMESTER V			
Core V	**Biotechnology (Common Core)**		
Course Code: 21UBCC51	**Hrs/ Week: 4**	**Hrs/ Sem: 60**	**Credit: 2**

Objectives:

- To provide broad scope of biotechnology in various fields including agriculture, medicine, environment and forensic studies through effective teaching modules.
- To attain competence in handling biotechnological experiments that enable them to carryout research projects and lifelong profession accomplishment.
- Create awareness in applying modern tools for biotechnological innovation and priorities the ethical implementation of potential biotechnology.

CO. No	Upon completion of this course, students will be able to	PSO addressed	CL
CO-1	discuss different types of animal and plant cloning vectors	1,2	Kn, Un
CO-2	scan the role of restriction enzyme in genetic modification	4	Un
CO-3	clarify the human genome sequences and its application in human welfare	4,7	Un, An
CO-4	apply various gene transfer techniques to generate genetically modified organisms	2,7	Cr
CO-5	perform cell culture, organ culture and stem cell culture to realize the positive impact in health care	6	Un, Ap
CO-6	encapsulate the characteristic features of microbes and their role in production of industrial products and environmental reclamation	5,6	An
CO-7	relate biotechnological achievement and its benefits to mankind	6,7	Ap, Ev
CO-8	get hands on experience to conduct experiments, analyze and interpret data for investigating problems in biotechnology and allied fields	7,8	Ap

Unit I **Cloning Vectors**

Introduction – Scope and importance of biotechnology – Gene cloning techniques - cloning vehicles – bacterial plasmid vectors – pBR322 and Ti plasmid – bacteriophage vectors – lambda – M13 – Plant viral vector – CaMV- Gemini virus and tobamo virus – animal viral vector – SV40- Role of restriction and modification enzymes.

Unit II **Gene Cloning and Screening**

Gene cloning – methods of introduction of cloned genes into host cells – transformation – liposome mediated transfer – electroporation – particle bombardment gun – viral vector method – DNA library – PCR – hybridization technique – Southern, Northern and Western.

Unit III **Animal Cell Culture and Genome Project**

Culture media – cell culture techniques – monolayer culture and immobilized culture of cell lines – techniques and applications of human embryonic stem cell culture – tissue engineering of artificial skin and cartilage. Human Genome Project – types – DNA sequencing methods - Maxam and Gilbert method, Sanger method – potential benefits to mankind.

Unit IV **Environmental and Bioprocess Technology**

Biotechnological methods for sewage and waste water treatment – bioremediation – degradation of xenobiotic (hydrocarbons and pesticides) – role of genetically engineered microbes – biomining – bioleaching – industrial production of penicillin and ethanol – Biodiesel – Biofertilizer – mass cultivation and application of Azolla.

Unit V **Plant Tissue Culture and Health Care Biotechnology**

Plant tissue culture – media - callus culture – plant embryo culture- in vitro pollination – organ culture – suspension culture and anther culture. Edible vaccines- Bt cotton – Golden rice- DNA probes and diagnosis of genetic disorders – DNA fingerprinting technique – gene therapy and treatment of genetic diseases.

Text Books

1. Dubey R.C. S. *A text book of Biotechnology*. New Delhi, Chand and Comp. Ltd, 2004.
2. Kumaresan, V. *Biotechnology* Nagercoil, Saras Publication, 2010.

Books for Reference

1. Clark and J. Pazdernik. *Biotechnology*, California, USA. 2009.
2. Elsevier Academic Press, Dubey, R.C. *Text Book of Biotechnlogy*, New Delhi. 4th edition, S. Chand and Co Ltd, 2006.
3. Ramadass, P. *Animal Biotechnology – Recent Concepts and Development*. Chennai. MJP Publishers. 2009.

4. Rema, L.P. *Applied Biotechnology*, Chennai. MJP Publishers, 2009.
5. Shailendra Singh, *Applied Biotechnology*, 1st edition, New Delhi. Campus Books International, 2007.
6. Singh, B.D. *Biotechnology,* Chennai. *Revised edition*, Kalyani Publishers. 2005.

Practical

Course Code: 21UBCCR1 **Hours/ Week : 2**

1. Isolation of Blue Green Algae
2. Isolation of protoplast
3. Plant tissue culture – anther culture, embryo culture and nodal culture
4. Preparation of synthetic seed
5. Estimation of dissolved oxygen and BOD
6. Separation of protein by column chromatography
7. Isolation of Plasmid
8. DNA Estimation by UV-Visible Spectrophotometric method
9. Preparation of animal tissue culture media
10. Preparation of SDS – PAGE (Gel mould only)

Book for Reference:

1. Aneja, K.R., *Experiments in Microbiology, Plant Pathology and Tissue Culture*, New Delhi. Wishwa Prakashan, (A Division of Wiley Eastern Ltd).
2. Asish Verma, Surajit Das, Anchal Singh. Laboratory Manual for Biotechnology. New Delhi: S. Chand and Company Ltd., 2008.
3. Joseph Sam Brook and David S. Russel. Molecular Cloning – A Laboratory Manual, New York, Cold Spring Harbor: Cold Spring Harbor Laboratory Press. 2001.

SEMESTER I			
Core I	**Invertebrata**		
Course Code: 21UZOC11	**Hrs/Week : 6**	**Hrs/Sem : 90**	**Credits : 6**

Objectives:

- To impart knowledge on invertebrate animals.
- To elaborate the organization, functional morphology, anatomy and taxonomic position of representative invertebrates.

Course Outcomes:

CO. No	Upon completion of this course, students will be able to	PSO addressed	CL
CO- 1	know the distinctive features of taxonomic classes within the phyla covered	1	Kn
CO -2	recognize the common members of each phylum and of selected classes	1	Kn
CO – 3	analyze the important concepts in invertebrate body structure and organization, including body symmetry, body cavity, gut formation, segmentation	2	An
CO – 4	examine the important biological processes in invertebrates, including locomotion, body support, reproduction, development, feeding, digestion, excretion, osmoregulation etc.	2	An
CO – 5	impart information on the ecological and economic importance of invertebrates.	2	Un
CO – 6	aware of the importance and diversity of invertebrates	2	Un
CO – 7	develop basic laboratory skills including microscopy, dissection and careful observation.	8	Cr
CO – 8	use knowledge in invertebrates as basic course for further subjects on higher level study.	8	Ap

Unit I Protozoa and Porifera

Salient features of invertebrates.
Protozoa- General characters and outline classification up to classes with Indian or local examples.
Type study: *Paramecium caudatum*: Morphology, nutrition, osmoregulation, excretion. Reproduction (Binary fission and conjugation).
General topic: Life cycle, pathogenicity and control measures of *Entamoeba histolytica.*

Porifera - General characters and outline classification up to classes with Indian or local examples.
Type study: *Leucosolenia*- External morphology – body wall – Reproduction.
General topics – Canal system in sponges

Unit II **Coelenterata and Platyhelminthes**

Coelenterata - General characters and outline classification up to classes with Indian or local examples.
Type study: *Obelia* – External characters and reproduction
General topic: Polymorphism in coelenterates.
Platyhelminthes - General characters and outline classification up to classes with Indian or local examples.
Type study: *Taenia solium*- Morphology and reproduction
General topic: Parasitic adaptations in Platyhelminthes

Unit III **Aschelminthes and Annelida**

Aschelminthes - General characters and classification up to classes with Indian or local examples.
Type study: *Ascaris* – External morphology and life cycle
General topic: Nematode parasites – *Wuchereria bancrofti, Ancylostoma duodinale*

Annelida- General characters and classification up to classes with Indian or local examples.
Type study: Earthworm – Morphology and reproduction
General topic: Biological significance of earthworm

Unit IV **Arthropoda**

General characters and classification up to classes with Indian or local examples.
Type of study: *Penaeus* – external morphology – reproduction and life history.
General topic: Beneficial insects (Honey bee).

Unit V **Mollusca and Echinodermata**

Mollusca -General characters and classification up to classes with Indian or local examples.

Type of study: *Pila globosa*– morphology, reproduction and nervous system
General topic: Pearl formation in bivalves
Echinodermata - General characters and classification up to classes with Indian or local examples.
Type study: *Asterias* – External morphology – water vascular system
General topic: Larval forms of echinoderms and their phylogenetic significance.

Text Books:

1.Kotpal R.L. *Modern Text Book of Zoology: Invertebrates.* Meerut: Rastogi Publications 2009.
2.EkambaranathaIyer M. and T.N. Ananthakrishnan. *A Manual ofZoology*. Vol. 1. India: S. Viswanathan Pvt Ltd 1977.

Books for Reference

1.Nair N.C. Leelavathi. S and N.A. Soundara Pandian. *Text book ofInvertebrates*. Nagercoil: Saras Publication 2006.

2.Murugan. T and N. Arumugam. *Invertebrates*. Nagercoil: Saras Publication,2006.

3.Jordan. E.L and P.S. Verma. *Invertebrate Zoology*. New Delhi: S. Chand andCompany Ltd, 2007.

4. Mary. S. Gardiner. *The Biologyof Invertebrates*. New York : Mc Graw-Hill BookCompany 1972.

5. Robert. D Barnes. *Invertebrate Zoology*. Japan Holt Saunders, InternationalEditions 1982.

Websites for Reference

http://www.enchantedlearning.com/subjects/invertebrates/index.s
html http://animalkingdom.net/category/invertebrates/
http://animaldiversity.org/

SEMESTER II			
Core II	**Chordata**		
Course Code: 21UZOC21	**Hrs/ Week : 6**	**Hrs/ Sem : 90**	**Credits : 6**

Objective:

- To impart information on the morphology and comparative anatomy of chordates.
- To provide knowledge on the organization and diversity of chordates.

Course Outcomes:

CO. No	Upon completion of this course, students will be able to	PSO addressed	CL
CO-1	explain the fundamental organization of chordates.	1	Un
CO-2	classify the phylum Chordata	1	Un
CO-3	appreciate the basic concepts of chordate diversity	1	Un
CO-4	analyse the characters of different classes of the chordates	2	An
CO-5	identify the major groups within the phylum Chordata	1	Un
CO-6	reason out the inclusion of different representative animals in particular class	8	An
CO-7	recognize the different structural organizations from evolutionary point of view	8	Ev
CO-8	compare the anatomy of different functional systems in chordates.	2	Ev

Unit I Chordata- Prochordata

Chordata introduction - General characters of chordates and classification up to classes with examples. General characters of prochordates, Type study: *Amphioxus*- external morphology - digestive and excretory system. External morphology and biological significance of the following – *Ascidian, Balanoglossus*. General characters of vertebrates, Agnatha - General characters - Type study: Petromyzon - External morphology, breeding and migration.

Unit II Pisces and Amphibia

Pisces: General characters and classification up to sub-classes with examples. Typestudy: *Scoliodon sorrakowah* - Fins and scales, digestive system, respiratory system, circulatory system, sense organs, reproductive system - General topic: Migration of fishes

Amphibia: General characteristics and classification up to orders with examples. Type study: *Rana hexadactyla* – External morphology, skin, digestive, respiratory, circulatory and nervous system, reproductive system, General topic: Parental care in Amphibia

Unit III Reptilia and Aves

Reptilia: General characters and classification up to order. Type study: *Calotes* - External morphology, digestive system and circulatory system only. General Topic: Identification of poisonous and non poisonous snakes.

Aves: General characteristics and classification up to subclasses. Type study: *Columba livia* - external morphology, flight muscle, digestive system, respiratory system, urinogenital system. General topic: Migration in birds and flight adaptations of birds.

Unit IV Mammalia

Mammalia: General characteristics and classification up to subclasses with examples. Type study: *Oryctolagus cuniculus* – dentition, digestive system, respiratory system,

circulatory system, urinogenital system. General topics: Egg laying mammals and adaptations of aquatic mammals.

Unit V Comparative Anatomy

Comparative anatomy: Respiratory system- skin, gills, lungs, air sacs, air bladder and accessory respiratory organs in fishes. Circulatory system – Evolution of heart and aortic arches, venous system and lymphatic system.

Text Books

1. Kotpal R.L. *Modern Text Book of Zoology - Vertebrates.* Meerut: Rastogi Publications.2019.
2. Jordan E.L and Verma P.S. *Chordate Zoology.* New Delhi: S. Chand & Co Ltd. 2006.
3. Thangamani. A, Prasanna Kumar. S. Narayanan. L.M, N. Arumugam. *Chordata.* Nagercoil: Saras Publication. 2006.

Books for Reference

1.Ekambaranatha Iyer M., Anantha Krishnan T.N. *Manual of Zoology Vol II* Chennai: S.Viswanathan Pvt Ltd. 1995.

2.Jordan E.L and Verma P.S. *Chordate Zoology.* New Delhi: S. Chand & Co. Ltd. 2006.

3.Newman. H.H. *The Phylum Chordata.* Motikala: Satish Book Enterprise.1987.

4.Prasad S.N. *Vertebrate Zoology.* Allahabad: Kitab Mahal Private Ltd. 2005.

SEMESTER III			
Part III Core III: Developmental Zoology			
Code: 21UZOC31	**Hrs/Week: 4**	**Hrs / Sem: 60**	**Credits: 4**

Objectives

To acquire a greater appreciation of life and its development

To understand the complexity of developmental processes and the underlying mechanism

To attain knowledge on reproductive technology and stem cells

Course Outcome:

CO.No.	Upon completion of this course, students will be able to	PSO's addressed	CL
CO-1	expose to concepts and process in developmental biology	1,2	Un
CO-2	Illustrate the events occur during fertilization	8	Un
CO-3	Acquire knowledge about the developmental process andembryogenesis	6	Un
CO-4	explain the sequential changes from cellular grade of organization to organ grade of organization	7	Un
CO-5	describe the development of extra embryonic membrane and the nature and physiology of placenta	3	Un,An
CO-6	Create awareness on new technology in embryology and its relevance to Man	1,7	Cr
CO-7	Create awareness on advanced reproductive technologies	1,3	Un, Cr
CO-8	Analyse the causes of infertility in human and can take preventive measures.	2,3	An

SEMESTER III			
Core III: Developmental Zoology			
Code:21UZOC31	**Hrs/Week:4**	**Hrs/Sem:60**	**Credits:4**

Unit I **Gametogenesis**

Basic concepts of developmental biology -Gametogenesis – spermatogenesis, oogenesis- sperm and egg of chick and man

Unit II **Development of Chick**

Fertilization : Pre and post fertilization events - cleavage, gastrulation and fate Map of Chick

Unit III **Development of Human**

Cleavage – Fate map of human - gastrulation in human Organogenesis- Development of heart and brain in mammal

Unit IV **Organizer & Foetal membrane**

Organizer- primary and secondary organizers, morphogenetic fields and gradient hypothesis, embryonic stem cells- culture & applications, placenta in mammals – types and physiology

Unit V **Assisted Reproductive Technology**

Manipulation of reproduction in human - Infertility (Male & Female) - Poly Cystic Ovarian Disease (PCOD) - artificial insemination,test-tube babies - amniocentesis - Birth control- contraceptive devices–surgical, hormonal methods, physical barriers – IUCD, termination of gestation

Text Books

1. Arumugam. N. 2006 *Developmental Zoology*, Saras Publication
2. Mohan P. Arora 1991 *Organic Evolution*, Himalaya Publishing House.

Books for Reference

1. Berril. M.J. 1982. *Developmental Biology*, Tata McGraw- Hill Publishing Company Ltd.New Delhi.
2. Verma.P.S. and U.K. Agarwal, *Chordate Embryology* (10th Edition) S.Chand&

Company Ltd, New Delhi.

3. Balinsky, B. I. 1981. *Introduction to Embryology*. Saunders College, Philadelphia.
4. Jay M Savage, 1998, *Evolution*, Amerind Publishing House Co, New Delhi.
5. Paul Amos Moody ,1997, *An Introduction to Evolution*, Kalyani Publishers, Ludhiyana
6. Arumugam.N 2001 *Evolution* , Saras publication, Kottar, Nagercoil.

SEMESTER VI			
Core IX	**Immunology and Microbiology**		
Course Code: 21UZOC61	**Hrs/ Week: 4**	**Hrs/ Sem: 60**	**Credits: 4**

Objectives

- To highlight the importance of immunity, immune system, and lymphoid organs
- To elucidate the nature of microorganisms and the culture techniques of bacteria
- To learn the role of microbes in agriculture, food and in medical field.

Course outcome

CO. No	Upon completion of this course, students will be able to	PSO addressed	CL
CO-1	understand the importance of immunity and immune response	2	Un
CO-2	explain the structure and functions of different types of lymphoid organs	2	Ev
CO-3	demonstrate the types and basic structure of immunoglobulins	4	Un
CO-4	classify bacteria and outline the general structure of microbes	1	An
CO-5	analyse the causes and prevention of food poisoning, food spoilage and to discuss preservation methods	7	An, Cr
CO-6	explain the causative agents, symptoms of microbial diseases and to propose preventive measures	7	Un, Cr
CO-7	to perform experiments in Immunology and interpret the results	8	Ev
CO-8	to develop skills in fundamental techniques in microbiology including sterilization, isolation and culture of bacteria	6, 8	Cr

Unit I **Immunity Types and Lymphoid Organs**

Immunity – types – innate immunity – factors controlling innate immunity – acquired immunity –types – active and passive immunity, Lymphoid organs – thymus, bone marrow, spleen and lymph nodes.

Unit II **Immune Response**

Cells of the immune system – development and fate of stem cells - Lymphocytes, B Lymphocytes, T Lymphocytes - types of T cells and macrophages –Immune response – humoral - primary and secondary – B cell activation - cell mediated immune response – Tcell activation – biological functions of cell mediated immunity.

Unit III **Antigens and Antibodies**

Antigens – definition – epitopes – cross reactive antigen - heterophile antigen – Frossman antigen – haptens. Antibodies (Immunoglobulins) - definition – structure and functions of immunoglobulin – Ig classes - IgG, IgA, IgM, IgD and IgE.

Unit IV **Structure, Shape and Culture of Microbes**

Importance and scope of Microbiology – classification of bacteria - general structure of bacteria, fungus and virus. Culture media, continuous and batch culture techniques – bacterial growth curve.

Unit V **Food, Agricultural and Medical Microbiology**

Food Microbiology: Food poisoning - botulism, salmonellosis; food spoilage and preservation methods. Agricultural Microbiology: Rhizosphere - microorganisms - symbiotic and asymbiotic nitrogen fixation. Medical Microbiology: Causative agent, symptoms, prevention and control of tuberculosis, gonorrhea, candidiasis, dermatophytosis, dengue and COVID-19.

Textbook

1. Kannan, I. *Immunology*. Chennai: MJP Publishers 2007
2. Chakraborty, P.A. *Text Book of Microbiology*. Kolkata: New Central Book Agency (P) Limited. 1995.

Books for Reference

1. Arumugam, N., Mani, A., Narayanan, L.M., Dulsy Fatima and A.M.Selvaraj. *Immunology and Microbiology*. Nagercoil : Saras Publication. 2015.
2. Rao, C.V. *An Introduction to Immunology*. New Delhi: Narosa Publishing House. 2005.
3. Joshi K.R and Osamo N.O. *Immunology.* India: Agro Botanical Publishers, 4th Edition, 1994.
4. Surendra Naha. *Fundamentals of Immunology*. New Delhi: Dominant Publishers & Distributors Pvt. Ltd. 2012.
5. Pelczar, M.J, Chan, E.C.S. and N.R. Krieg. *Microbiology* New Delhi: Mc Graw– Hill Book Company. 1986.
6. Arti Kapil. *Text Book of Microbiology.* India: Universities Press (India) Pvt. Ltd. 9th Edition, 2013.

PRACTICALS

Course Code: 21UZOCR6

Hours/ Week: 2 **Credit: 1**

1. Lymphoid organs– chart/ slides of histology
2. Single Radial Immuno diffusion (Demonstration)
3. Double Immuno diffusion (Demonstration)
4. Microscopic observation of different types of lymphocytes
5. Sterilization techniques
6. Preparation of culture media
7. Serial dilution technique
8. Simple staining of bacteria

9. Gram staining of bacteria
10. Hanging drop technique.
11. Study of distribution of microorganisms in nature – soil, water and air.
12. Culture and counting of bacterial colonies using colony counter.
13. Spotters – autoclave, hot air oven, laminar flow hood, inoculation needle, agar plate.

Books for Reference

1. Jayasurya, Dulsy Fatima, Meyyan, R.P., Arumugam, N. and V. Kumaresan. *Practical Zoology.* (*Cell Biology- Embryology - Animal Physiology - Immunology- Ecology-Genetics-Evolution - Microbiology - Biochemistry - Biophysics*). Nagercoil: Saras Publication, Kottar P.O.2013.
2. James Cappuccino and Natalie Sherman. *Microbiology A Laboratory Manual*. Tokyo: Addison - Wesly- Hyman Inc.1990.

SEMESTER III			
NME I	**Basic Biotechnology**		
Course Code: 21UZON31	**Hrs/ Week : 2**	**Hrs/ Sem: 30**	**Credit: 2**

Objectives

- To impart basic knowledge on biotechnology
- To develop skills in biology using various biotechniques
- To motivate the students to take up career in biotechnology related fields in their future

Course Outcome

CO. No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO-1	understand the basic principles of Biotechnology	1	Un
CO-2	distinguish between prokaryotic and eukaryotic cells from their structural studies	2	An
CO-3	understand the restriction enzymes and cloning vectors and assess their use in genetic engineering.	4	Un, Ev
CO-4	analyse the structure of DNA, and use various techniques to visualize, manipulate and separate the DNA molecules	4, 5	Un, An
CO-5	apply the various gene manipulation techniques to generate genetically modified organisms	6	An
CO-6	evaluate techniques of gene delivery and cloning to adapt in manipulation of genes	5	Ev
CO-7	discuss the preparation and characterization of appropriate nano materials in the field of nanotechnology	7	Cr
CO-8	to perform biotechnology experiments to isolate separate and amplify DNA molecules	8	Cr

Unit I **Introduction to Basic Biotechnology**

Definition, history of Biotechnology - scope of Biotechnology; structure of cell - eukaryotic and prokaryotic cells.

Unit II **Basics of Gene Manipulation**

Structure of DNA - gene concept - central dogma of life - concept of genetic engineering - Type II Restriction enzymes and DNA ligases in genetic engineering - cloning vectors – definition - general characters - plasmid cloning vector – pBR322 - construction of recombinant DNA - basic steps in cloning.

Unit III **Techniques in Biotechnology**

Agarose gel electrophoresis, SDS PAGE, PCR - Gene delivery methods – transformation, transfection, methods, biolistic method (gene gun).

Unit IV **Genetic Modification of Organisms**

Transgenic animals and plants - methods of production of transgenic organisms - outline of microinjection mediated gene transfer to animals - outline of Agrobacterium mediated gene transfer to plants – GMOs – Super mouse, Gold fish, Golden rice, Bt Cotton.

Unit V **Demonstrations/ Model/ Chart**

DNA isolation, restriction digestion, agarose gel electrophoresis, SDS PAGE, PCR, Structure - DNA, tRNA (Model/ Chart).

Text Book:

Kumaresan, V. *Biotechnology*. Nagercoil: Saras Publication, 6th edition, 2012.

Books for Reference:

1. Dubey, R.C. *A Textbook of Biotechnology*. New Delhi: S. Chand and Company Ltd., 2009.
2. Rastogi, S.C. *Biotechnology Principles and Applications*. Chennai: Reprint, Narosa. Publishing House, 2020.
3. Singh, B.D. *Biotechnology*. New Delhi: Kalyani Publishers. 2015.
4. Sathyanarayana, V. *Biotechnology*. Kolkatta:. Books and Allied (P) Ltd. 15th Edition. 2020.
5. Harisha S. *Biotechnology Procedures and Experiments Hand Book*. New Delhi: Lakshmi Publications. First Edition. 2008.
6. Asish Verma, Surajit Das, Anchal Singh. *Laboratory Manual for Biotechnology*. New Delhi: S. Chand and Company, Ltd., 2008.

SEMESTER IV			
NME II	**Applied Biotechnology**		
Course Coe: 21UZON41	**Hrs/ Week: 2**	**Hrs/ Sem: 30**	**Credit: 2**

Objectives

- To impart comprehensive knowledge on various aspects of modern biotechnology.
- To understand the applications of biotechnological innovations for environmental protection and human welfare.

Course Outcomes

CO. No.	Upon completion of this course, students will be able to	PSO Addressed	CL
CO-1	understand the production of different bio-products	4	Un
CO-2	examine the nature and feature of SCP and aerobic and anaerobic digestion	4,5	An
CO-3	apply the techniques to clean up the environment through various treatment methods	3,7	Ap
CO-4	create awareness to cure cancer	4	Cr
CO-5	understand the importance of biosafety and IPR	8	Un
CO-6	evaluate the synthesis and applications of bio-products	7	Ev
CO-7	adopt appropriate tools and techniques in biotechnological manipulation	7	Cr
CO-8	apply the experimental procedures to the spectrum of fields making use of Biotechnology	8	Ap

Unit I **Food and Beverage Biotechnology**

Fermented food – yoghurt, bread – microbial biomass – nutritive value of Single Cell Protein and mushroom cultivation (White button mushroom) - wine and beer. (Demo – Mushroom cultivation & Microbial production of wine).

Unit II **Fuel Biotechnology**

Biogas – substrates- process of production – applications; biodiesel – manufacture - advantages.

Unit III **Environmental Biotechnology**

Sewage treatment – primary, secondary and tertiary treatments. Bioremediation – types, bio remediation of ground water - In-situ and Ex-situ bioremediation.

Unit IV **Health Care Biotechnology**

Gene therapy methods – germ line and somatic cell line – gene therapy for cancer.

Unit V **Regulations in Biotechnology**

Biosafety – guidelines, Intellectual Property Right – copy right and trade mark – patent.

Text Book

1. Kumaresan, V. *Biotechnology.* Kottar, Nagercoil: Saras Publication: - 6th edition. 2012.

Books for Reference

1. Dubey, R.C. *A textbook of Biotechnology*. New Delhi: S. Chand and Company Ltd. 2009
2. Rastogi, S.C. *Biotechnology, Principles and Applications*. Chennai: Narosa Publishing House. 2012.
3. Singh, B.D. *Biotechnology*. New Delhi: Revised edition. Kalyani Publishers. 2015
4. Sathyanarayana, V. *Biotechnology*. Kolkatta: Books and Allied(P) Ltd.15th edition 2020
5. Harisha S. *Biotechnology Procedures and Experiments Hand Book*. New Delhi, India: Infinity Science Press, LIC, Hinghum, Massachusett. 2007.
6. Asish Verma, Surajit Das, Anchal Singh. *Laboratory Manual for Biotechnology*. New Delhi: S. Chand and Company. 2008.

SEMESTER IV			
Skill Based Elective	**A. Clinical Laboratory Technology**		
Course Code: 21UZOS41	**Hrs/ Week: 2**	**Hrs/ Sem: 30**	**Credits: 2**

Objectives

- To become skilled persons for employment.
- To learn the utility and the applications of the instruments.
- To study the etiology of various diseases affecting human beings.

Course Outcome

CO. No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO-1	understand the laboratory practices and know how to maintain the laboratory instruments	1	Un
CO-2	analyze and distinguish various types of blood cells	2	An
CO-3	understand the pathological diseases and explain the test for hepatitis, AIDS and intestinal parasite	3	An
CO-4	evaluate critical thinking of biochemical test	5	Un
CO-5	demonstrate the proficiency in basic methods of instrumentation and quantitative analytical skills used to conduct biological research	6	Un
CO-6	develop skills in various lab techniques	7	Cr
CO-7	acquire knowledge to handle clinical equipments	4	Un
CO-8	design, carryout and interpret scientific experiments	8	Ap

Unit I **Best Laboratory Practices and Instrumentation**

Best laboratory practices - norms to be followed in a clinical lab - sterilization - dry heat (hot air oven), moist heat (autoclave) and UV radiation (laminar flow chamber) – X- Ray - CT scan and MRI scan.

Unit II **Haematology**

Collection and storage of blood, preparation and use of blood components - blood groupings (A,B,O & Rh factor). Estimation of haemoglobin.

Unit III **Clinical Pathology**

Dialysis - hepatitis test – hemolytic jaundice - analysis of sputum - AIDS (ELISA Western blot test) Diagnosis of dengue and COVID-19.

Unit IV **Clinical Biochemistry**

Estimation of cholesterol, urea, uric acid, creatinine of blood - assay of enzyme alkaline phosphatase.

Unit V **Demonstration/ Charts/ Models/ Hands-on Training/ Hospital Visit**

Stethoscope, sphygmomanometer, electrocardiogram, EEG and echo cardiogram - analysis of urine - routine physical examination.

Text Book:

1. Ramnik Sood. *Medical Laboratory Technology*, Methods and Interpretations New Delhi: Jaypee Brothers Medical Publishers (P) Ltd.2005.
2. Jyoti Saxena, Mamta Banuthiyal and Indu Ravi Laboratory. *Manual of Microbiology, Biochemistry, and Molecular Biology*. New Delhi: Scientific Publishers (India). 2015.

Books for Reference:

1. Biswajit Mohanty and Sharbari Basu. *Fundamentals of Practical Clinical Biochemistry.* New Delhi: B.I Publications Pvt. Ltd. 2006.
2. Estridge, B.H., Reynolds, A.P. and N.J. Walters. *Basic Medical Laboratory Techniques.* Banglore: Thomson Delmar Learing Fastern press (Bangalore) Pvt. Ltd. 4th edition 2000.
3. Kannai, L. Mukherjee. *Medical Laboratory Technology.* Chennai: Tata Mc Graw Hill Publishing Company Limited, Vol-I, Vol-II and Vol-III. 1997.

SEMESTER III	
Self Study (Compulsory) **Wildlife Conservation**	
Course Code : 21UZOSS1	**Credits: 2**

Objectives:

- To recognize the importance of wildlife conservation.
- To study the techniques of wildlife census.
- To learn the role of Sanctuaries and National Parks in wildlife conservation.

Course outcome

CO. No	upon completion of this course, students will be able to	PSO addressed	CL
CO-1	acquire knowledge on the need for conservation of wildlife	1	Un
CO-2	explain about the status and conservation of endangered species.	1	Un
CO-3	be aware of wildlife wealth of India and the threatened species	1	Un
CO-4	apply principles of wildlife management in protecting the threatened species	3	Ap
CO-5	analyse the values, benefits of wildlife and cause for wildlife depletion	3	An
CO-6	understand the Wildlife Conservation Policies and to improve the conservation strategies.	8	Un, Cr
CO-7	assess wildlife population by learning the various census techniques	6	Ev
CO-8	discuss the role of Wildlife Sanctuaries and National Parks in wildlife conservation	3	Cr

Unit I **Wildlife Census Techniques**

Wildlife census techniques - direct method - line transect method – block count method- indirect method - pellet analysis method - pugmark techniques.

Unit II **Need for Conservation**

Wildlife values and benefits - causes of wildlife depletion – need for conservation - endangered species of reptiles, birds and mammals in India.

Unit III **Wildlife and their Management**

Principles of wildlife management - wildlife wealth of India - threatened wildlife, threats to survival and management of Red Panda, Musk deer, Great Indian Bustard, Olive Ridley turtle, Nilgiritahr, Nilgiri langur.

Unit IV **Sanctuaries and National Parks**

Definition – importance – Vedanthangal, Koonthankulam Bird Sanctuary – Mudumalai Sanctuary- Anamalai Sanctuary - National Parks - Guindy Deer Park – Gulf of Mannar Biosphere Reserve.

Unit V **Wildlife Conservation Policies**

The World Conservation Union (IUCN), Red Data Book.
World Wildlife Fund (WWF), Indian Board of Wildlife (IBWL) – National Board for Wildlife (NBWL), Man and Biosphere Programme (MAB), Project Tiger. Wildlife Protection Act 1972, Significance of NGO's in wildlife conservation.

Books for Reference

1. Anubha Kaushik and Kaushik C.P. *Environmental Science & Engineering*. New Delhi: New Age International (p) Publishers. 2020.
2. Hosetti B.B. *Concepts in Wildlife Management*. New Delhi: Daya Publishing house, A division of Astral International Pvt. Ltd. 2017.
3. Dr. Reena Mathur. *Wildlife Conservation and Management*. Meerut: Rastogi Publications; 1st Edition. 2018
4. Seshadri, B. *India's Wildlife Reserves*. New Delhi: Sterling Publishers 1990.
5. Saharia, V.B. *Wildlife in India*. Dehradun: Nataraj Publication.1998.
6. Verma, P.S. and Agarwal V.K. *Cell Biology, Genetics, Molecular Biology, Evolution and Ecology*. New Delhi: S. Chand & Company Pvt. Ltd, Ram Nagar. 2009.
7. Brain Groombridge. *Global Biodiversity*. London SE1 8 HN: Chapman & Hall, 2-6 Boundary Row. 1992.