

**ANNAMALAI UNIVERSITY**

**MASTER OF SCIENCE**

**M.Sc. ZOOLOGY**

**DEGREE COURSE**

**UNDER CBCS**

**(2021-2022)**

**The Course of Study and the Scheme of Examinations**

S.No	Study Components		Ins. Hrs /Week	Credit	Title of the paper	Maximum Marks		
	Course Title					CIA	Uni. Exam	Marks
<b>SEMESTER I</b>								
1	Core	Paper-1	5	4	Life and Diversity of Invertebrates	25	75	100
2		Paper-2	5	4	Life and Diversity of Chordates	25	75	100
3		Paper-3	5	4	Cell and Molecular biology	25	75	100
4	Practical I	Paper-1	9		Life and diversity of Invertebrates, Life and diversity of Chordates and Cell and molecular Biology	-	-	-
5	ELECTIVE	Paper-1	3	3	(A) Aquaculture and Farm management (B) Biostatistics and Bioinformatics	25	75	100
6	OPEN ELECTIVE (Non-Major)	Paper-1	3	3	(A) Apiculture (B) Public Health and Hygiene	25	75	100
			<b>30</b>	<b>18</b>		<b>125</b>	<b>375</b>	<b>500</b>
<b>SEMESTER II</b>								
7	Core	Paper-4	4	4	Genetics	25	75	100
8		Paper-5	4	4	Environmental Biology	25	75	100
9		Paper-6	4	4	Biotechnology	25	75	100
10	Practical I	Paper-I	-	4	Life and diversity of Invertebrates, Chordates, Cell and molecular Biology.	25	75	100
11		Paper-II	10	4	Genetics, Environmental Biology and Biotechnology	25	75	100

**M.Sc., ZOOLOGY: Syllabus (CBSC)**

12	Compulsory Paper		2	2	Human Rights	25	75	100
13	ELECTIVE	Paper-2	3	3	(A) Endocrinology (B) Bio-Chemistry	25	75	100
14	OPEN ELECTIVE Non-Major	Paper-2	3	3	(A) Vermiculture (B) Wild Life Management and Conservation	25	75	100
15	Field Study*			2		25	75	100
16			<b>30</b>	<b>30</b>		<b>225</b>	<b>675</b>	<b>900</b>

**\* Field Study**

There will be field study which is compulsory in the first semester of all PG courses with 2 credits. This field study should be related to the subject concerned with social impact. Field and Topic should be registered by the students in the first semester of their study along with the name of a mentor before the end of the month of August. The report with problem identification and proposed solution should be written in not less than 25 pages in a standard format and it should be submitted at the end of second semester. The period for undergoing the field study is 30 hours beyond the instructional hours of the respective programme. Students shall consult their mentors within campus and experts outside the campus for selecting the field and topic of the field study. The following members may be nominated for confirming the topic and evaluating the field study report.

- (i). Head of the respective department
- (ii). Mentor
- (iii). One faculty from other department

**ANNAMALAI UNIVERSITY**

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**SYLLABUS  
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**SEMESTER I**

**PAPER-1**

**LIFE AND DIVERSITY OF INVERTEBRATES**

**UNIT-I**

Broad Classification of the Animal Kingdom – Concepts of species, hierarchical taxonomy.

**Protozoa**

Feeding - Locomotion, Reproduction and Parasitic adaptations of Rhizopoda, Mastigopora, Ciliophora, Saprozoans and Mycetozoa with suitable examples.

Economic importance with respect to Health aspect of Soil, Fresh water and Marine Protozoans, Osmoregulation in Protozoa.

Theories on Origin and evolution of Metazoa – Syncytial, Colonial and Polyphyletic theories.

**Porifera**

Functional morphology of freshwater sponges with suitable example. Inter relationship between different classes.

Marine sponges.

Reproduction – Asexual and Sexual, Regeneration in sponges.

Systematic position and Affinities of sponges.

**UNIT-II**

**Coelenterata**

Origin and evolution of Coelenterata, Polymorphism, Reproduction and Metagenesis of Coelenterata.

Corals and Coral reefs, Types of theories.

Systematic position of Ctenophora.

**Helminthes**

Platyhelminthes - Functional morphology and adaptive Biology for parasitic mode of life.

Aschelminthes - Functional morphology and adaptive Biology for parasitic mode of life.

Helminthes in human diseases.

Life cycle of *Wuchereia bancrofti*

### **UNIT-III**

#### **Annelida**

Archiannelida, Interrelationship between different classes of Annelida.

Evolutionary significance of Trochophore Larva.

Origin and evolution of coelom.

Adaptive radiation in Annelida.

Origin of Metamerism in Annelida.

#### **Arthropoda**

Xiphosura-structure and affinities.

Onychophora.

Origin and Evolutionary significance of Crustacean Larvae. Sense organs in Arthropoda,

Tagmatization, Crustacean parasites, Mouth parts in insects. Commercial products of insects.

Economic importance of insects. Arthropod vectors.

### **UNIT-IV**

#### **Mollusca**

Torsion and Detorsion in Gastropoda - Adaptive radiation in Mollusca. Shell in different classes

of Mollusca. Foot in Mollusca. Economic importance of Mollusca. Photoreceptors in Mollusca.

Larval forms in Mollusca. Pearls producing Marine and Fresh Water Molluscs.

#### **Echinodermata**

Origin and evolutionary significance of Echinodermata. Water vascular system in Echinodermata.

Pedicellariae of Echinodermata. Feeding mechanism in Echinodermata. Origin and evolutionary significance of Echinoderm larva.

### **UNIT-V**

#### **Minor Phyla**

Structural peculiarities and affinities of Ctenophores, Acanthocephala, Nematomorpha, Pogonophora.

Invertebrate fossils: Trilobites, Brachiopoda, Cephalopoda and Echinodermata.

## **Course Objectives**

1. The program provides the student with an introduction to the recent advances in zoology
2. Compare and contrast the major groups of marine protozoans and invertebrates
3. Completion of the courses students will be able. CO1- To classify Phylum Porifera with taxonomic Keys.
4. Demonstrated a broad understood of animal diversity, including knowledge of the scientific classification
5. Students gain knowledge and skill in the fundamentals of animal sciences, understands the complex interactions among various living organisms
6. Analyse complex interactions among the various animals of different phyla, their distribution and their relationship with the environment
7. Apply the knowledge and understanding of Zoology to one's own life and work
8. Understands the complex evolutionary processes and behaviour of animals
9. Apply the knowledge of internal structure of cell, its functions in control of various metabolic functions of organisms.
10. Describe Phylum Nematoda and give examples of pathogenic Nematodes
11. Classify Protista up to phylum using examples from parasitic adaptation
12. Pathology associated with various diseases

### **Unit-1: (50 to 100 contents)**

- To understand the broad classification of the Animal Kingdom
- To learn the concepts of species, hierarchical taxonomy.
- By learning the feeding, locomotion and economic importance of health aspects of different protozoa.

### **Unit-2: (50 to 100 contents)**

- To study origin and evolution of Coelenterata.
- To understand the polymorphism and reproduction.
- To acquire the knowledge of Metagenesis of Coelenterata.

### **Unit-3: (50 to 100 contents)**

- To study about the segmented worms.
- To study the Interrelationship between different classes of Annelida and Arthropoda.
- To learn and acquire the knowledge in helminthes.

### **Unit-4: (50 to 100 contents)**

- To learn in human diseases and understand the origin and evolutionary significance of Mollusca and Echinodermata.
- To learn and understand the Fresh water molluscans and water vascular system in Echinodermata.

### **Unit-5: (50 to 100 contents)**

- To learn Structural peculiarities and affinities of Minor Phyla.
- To learn the characteristic feature of fossils.

**Text Books**

1. Barnes. R.D. 1974. Invertebrate Zoology. W.B. Saunders Co., Philadelphia.
2. Hyman L.H. 1951 The Invertebrata, Vol I to VI. Mc Graw – Hill Book Co., New York.
3. Barrington, E.J. W. 1969. Invertebrate Structure and Functions. English Language Book Society.
4. Hyman, L. H. 1940. The Invertebrates (6 volumes) New York: McGraw-Hill. A classic work.
5. Kotpal R.L. (2014) Modern text book of zoology: Invertebrates: animal diversity- I. 11th Edition. Meerut: Rastogi Publications.

**Reference Items: books, Journal**

1. Jordan E. L. and Verma P.S. (2001) Invertebrate Zoology Revised Edition, Published by S. Chand Publications.
2. Kotpal R. L. (2014) Modern Text Book of Zoology: Vertebrates. Rastogi Publications.
3. Kotpal R.L. (2014) Modern text book of zoology: Invertebrates: animal diversity- I. 11th Edition. Meerut: Rastogi Publications.
4. Animal Kingdom D. Bhaskara Rao – 2010
5. Chemical zoology. Vol. II. Porifera, Coelenterata and Platyhelminthes. M Florkin, BT Scheer 1968.
6. Hyman, L. H. 1940. The Invertebrates (6 volumes) New York: McGraw-Hill. A classic work.
7. Anderson, D. T. (Ed.). (2001). Invertebrate zoology (2nd ed.). Oxford: Oxford University Press.
8. Brusca, R. C., & Brusca, G. J. (2003). Invertebrates (2nd ed.). Sunderland, Mass.: Sinauer Associates.
9. Miller, S.A., & Harley, J.P. (1996). Zoology (4th ed.). Boston: WCB/McGraw-Hill.
10. Pechenik, Jan A. (2005). Biology of the invertebrates. Boston: McGraw-Hill, Higher Education. pp. 590 pp. ISBN 978-0-07-234899-6.
11. Ruppert, E. E., Fox, R. S., & Barnes, R. D. (2004). Invertebrate zoology: a functional evolutionary approach. Belmont, CA: Thomas-Brooks/Cole.
12. Adiyodi, K.G. & Adiyodi, R.G. (Eds) 1983- . Reproductive Biology of Invertebrates. Wiley, New York. (Many volumes.)
13. Giese, A.G. & Pearse, J.S. (Eds) 1974- . Reproduction of Marine Invertebrates. Academic Press, New York. (Many volumes.)
14. Advances in Invertebrate Reproduction. Elsevier Science, Amsterdam. (Five volumes.)

**E- Materials**

- [https://books.google.co.in/books?id=k6l9FGcjM\\_EC&pg=PA5&dq=Classification+Bino mial+Nomenclature+animal+kingdom&hl=en&sa=X&ved=0ahUKEwj57P7Qxv7nAhW8I bcAHQ9LB6sQ6AEIMjAB#v=onepage&q=Classification%20Binomial%20Nomenclatur e%20animal%20kingdom&f=false](https://books.google.co.in/books?id=k6l9FGcjM_EC&pg=PA5&dq=Classification+Bino%20mial+Nomenclature+animal+kingdom&hl=en&sa=X&ved=0ahUKEwj57P7Qxv7nAhW8IbcAHQ9LB6sQ6AEIMjAB#v=onepage&q=Classification%20Binomial%20Nomenclature%20animal%20kingdom&f=false)
- [http://tnschools.gov.in/media/textbooks/11\\_Zoo\\_Vol\\_2\\_\\_EM.pdf](http://tnschools.gov.in/media/textbooks/11_Zoo_Vol_2__EM.pdf)
- <https://biologydictionary.net/taxonomy/>
- [https://books.google.co.in/books?id=TAkrDAAAQBAJ&pg=PA94&dq=animal+kingdom +phylum+protozoa+and+porifera+invertebrates&hl=en&sa=X&ved=0ahUKEwjyqybztX\\_7 nAhVJ6XMBHUFVBtQQ6AEIMDAB#v=onepage&q=animal%20kingdom%20phylum% 20protozoa%20and%20porifera%20invertebrates&f=false](https://books.google.co.in/books?id=TAkrDAAAQBAJ&pg=PA94&dq=animal+kingdom +phylum+protozoa+and+porifera+invertebrates&hl=en&sa=X&ved=0ahUKEwjyqybztX_7 nAhVJ6XMBHUFVBtQQ6AEIMDAB#v=onepage&q=animal%20kingdom%20phylum% 20protozoa%20and%20porifera%20invertebrates&f=false)
- <https://www.askiitians.com/revision-notes/biology/animal-kingdom/phylum-protozoa-and-porifera.html>
- <https://www.pmfias.com/classification-animalia-animal-kingdom/>

**Course Out Comes (five outcomes for each units should be mentioned)**

**1) After studied unit-1, the student will be able to understand**

- Basic Concepts of Species
- Hierarchical taxonomy
- Importance of Parasitic Protozoan
- Economic importance of Protozoan and Porifera
- Systematic position and Affinities of sponges

**2. After studied unit-2, the student will be able to understand**

- Origin and evolution of Coelenterata.
- Corals and Coral reefs.
- Systematic position of Ctenophora.
- Helminthes in human diseases.
- Life cycle of *Wuchereria bancrofti*.

**3. After studied unit-3, the student will be able to understand**

- Origin and Evolution of Annelida
- Evolutionary significance of Trochophore Larva
- Adaptive radiation in Annelida
- Origin and Evolutionary significance of Crustacean
- Economic importance of insects

**4. After studied unit-4, the student will be able to understand**

- Torsion and Detorsion in Gastropoda
- Economic importance of Mollusca

- Pearls production.
- Water vascular system
- evolutionary significance of Echinoderm larva

**5. After studied unit-5, the student will be able to understand**

- Structural peculiarities and affinities of Acanthocephala
- Structural peculiarities and affinities of Nematomorpha, Brachiopoda
- Structural peculiarities and affinities of Chaetognatha and Echiuroidea
- Invertebrate fossils: Trilobites, Brachiopoda
- Invertebrate fossils: Mollusca and Echinodermata.

## PAPER - 2

### LIFE AND DIVERSITY OF CHORDATES

#### UNIT - I

**Principles of Taxonomy:** Nomenclature – Binominal and Trinominal nomenclature

Suffix as for super family name (oidea), family name (idae)

Use of suffixes 'i', 'orum', 'ae' 'arum', 'ensis' and 'iensis'.

**Tautonyms, Synonyms and Homonyms.**

**New Trends in Taxonomy:** Ecological approach, Ethological approach, Cytological approach, Biochemical approach and Numerical taxonomy.

**Taxonomic key:** Indented, Simple non-Bracket Grouped type, combination

**Pictorial:** Branching type, Circular and Box-type of keys.

#### UNIT - II

**Prochordata:** Systematic position and Phylogeny of Prochordates.

**Ostracoderms:** Silurian and Devonian Ostracoderms and their evolutionary position.

**Placoderms:** Origin of Jaws- Structural peculiarities of Cyclostomata.

#### UNIT-III

**Chondrichthyes:** Fossil history of Chondrichthyes, tendencies in Elasmobranch evolution.

**Actinopterygii:** Origin and evolution, Adaptive radiation of bony fishes.

**Amphibia:** Origin and evolution of Amphibia.

#### UNIT-IV

**Reptilia:** Evolution of Reptilia. Saurischian and Ornithischian Dinosaurs -Rhynchocephalia - Adaptive radiation of Reptiles.

**Aves:** Birds as glorified reptiles. Fossil history of birds. Palate in Birds. Adaptive radiation in birds.

**Mammal:** Evolution of Mammals, Structural peculiarities of Prototheria, Metatheria and Eutheria.

#### UNIT-V

**Comparative anatomy:** Origin and evolution of the vertebrate integumentary system, Paired fins and limbs, heart and brain of vertebrates.

## **Course Objectives**

1. To understand the taxonomy of vertebrates
2. To inculcate the importance of taxonomy and animal diversity
3. To teach the functional morphology and adaptive radiations
4. To explicit the evolutionary significance and affinities of chordates
5. To understand the phylogeny of chordates

### **Unit-1: (50 to 100 contents)**

Principles of Taxonomy: Nomenclature – Binominal and Trinominal nomenclature

Suffix as for super family name (oidea), family name (idae)

Use of suffixes 'i', 'orum', 'ae' 'arum', 'ensis' and 'iensis'.

Tautonyms, Synonyms and Homonyms

New Trends in Taxonomy: Ecologic approach, Ethological approach, Cytological approach, Biochemical approach and Numerical approach.

Taxonomic key: Indented, Simple non-Bracket Grouped type, combination

Pictorial: Branching type, Circular and Box-type of keys.

### **Unit-2: (50 to 100 contents)**

Prochordata: Systematic position and Phylogeny of Prochordates.

Ostracoderms: Silurian and Devonian Ostracoderms and their evolutionary position.

Placoderms: Origin of Jaws- Structural peculiarities of Cyclostomata.

### **Unit-3: (50 to 100 contents)**

Chondrichthyes: Fossil history of Chondrichthyes, tendencies in Elasmobranch evolution.

Actinopterygii: Origin and evolution, Adaptive radiation of bony fishes.

Amphibia: Origin and evolution of Amphibia.

### **Unit-4: (50 to 100 contents)**

Reptilia: Evolution of Reptilia. Saurischian and Ornithischian Dinosaurs -Rhynchocephalia - Adaptive radiation of Reptiles.

Aves: Birds as glorified reptiles. Fossil history of birds. Palate in Birds. Adaptive radiation in birds.

Mammal: Evolution of Mammals, Structural peculiarities of Prototheria, Metatheria and Eutheria.

**Unit-5: (50 to 100 contents)**

Comparative anatomy: Origin and evolution of the vertebrate integumentary system, Paired fins and limbs, heart and brain of vertebrates.

**Text Books**

- 1 Kapoor, V.C., 1998. Theory and Practice of Animal Taxonomy. Oxford and IBH Publishing Co., Pvt., Ltd., New Delhi.
- 2 Colbert, E.H., 1969. Evolution of Vertebrates. John Wiley and Sons Inc., New York.
- 3 Hobart M. Smith, 1960. Evolution of Chordate Structure. Holt, Rinehart and Winston, Inc., New York.
- 4 Waterman, A.J., 1971. Chordate structure and function. McMillan Co., London
- 5 Jolie, M. 1968. Chordate Morphology. East West Press, Pvt., Ltd.,
- 6 Young, J.Z., 1969. Life of Vertebrates. Clarendon Press, Oxford.
- 7 Holstead, 1969. The pattern of Vertebrate Evolution. Freeman and Co. San Francisco, USA.
- 8 Waterman, A.J., 1971. Chordate structure and function. McMillan Co., London
- 9 P.S. Verma and V. K. Agarwal, Cell Biology, Genetics, Molecular Biology, Evolution and Ecology. S. Chand Publishing Corporation Ltd.,
- 10 Mohan P. Arora, 2010. Organic Evolution. Himalaya Publishing House, Pvt., Ltd., New Delhi.
- 11 Romer, A.S. and T. S. Parson, 1978. Vertebrate Body. W.B. Saunders Co., Philadelphia.
  - a. Subramanian, M.A., 2013. Chordate evolution. MJH Publishers, Chennai.
- 12 Hyman, L.H., 1966. Comparative Vertebrate Anatomy. The University of Chicago Press, Chicago.

**Reference Items: books, Journal**

- 1 The behavior of Animals: Mechanism, Function and Evolution (ed. Johan J. Bolhuis, Luc-Alain Giraldeau), 2004, Wiley Publishers
- 2 The Growth of Biological Thought: Diversity, Evolution, and Inheritance by Ernst Mayr. The Belknap Press of Harvard University Press.

**E- Materials**

- eBook: *Cell Biology, Genetics, Molecular Biology, Evolution and Ecology* (Multicolour Edition) P.S. Verma.

**Course Out Comes (five outcomes for each units should be mentioned)**

**1. After studied unit-1, the student will be able to .....**

- Understand the principles of taxonomy
- Acquire knowledge on nomenclature
- Realize the importance of suffix used in taxonomy
- Know the trends in taxonomy
- Understanding the different taxonomical keys used for identifying the species

**2. After studied unit-2, the student will be able to .....**

- Know the primitive forms of chordates
- Understand the systematic position of the primitive forms
- Acquire knowledge on Silurian and Devonian Chordates
- Realize the importance evolutionary significance
- Understanding the origin of Jaw and structural peculiarities of the species

**3. After studied unit-3, the student will be able to .....**

- Understand the fossil history of Chondrichthyes
- Know the tendencies of elasmobranch evolution
- Acquire knowledge on origin and evolution of Actinopterygii
- Understand the adaptive radiation and evolution of bony fishes
- Know the origin and evolution of Amphibia

**4. After studied unit-4, the student will be able to .....**

- Acquire knowledge of evolution of Reptilia and adaptive radiations and the evolution of Saurischian and Ornithischian Dinosaurs
- Know the fossil history of birds and why it is called as glorified reptiles?.
- Understand the adaptive radiation of birds and palate in birds
- Acquire knowledge on evolution of Mammals
- Grasping the structural peculiarities of Prototheria, Metatheria and Eutheria

**5. After studied unit-5, the student will be able to .....**

- Acquire knowledge on Comparative anatomy of vertebrates
- Understand the origin and evolution of vertebrate integuments
- Know the evolution of paired fins and limbs
- Acquire knowledge on the evolution of heart and aortic arches
- Grasping the development of brain in vertebrates

**PAPER-3**

**CELL AND MOLECULAR BIOLOGY**

**UNIT-I: STRUCTURE AND FUNCTIONS OF CELL ORGANELLES**

Plasmamembrane: Structure, Membrane receptors, Membrane transport - Membrane Potentials. Secondary active transport – ion – selective channels.

Endoplasmic reticulum – structure and functions of Endoplasmic Reticulum.

Mitochondria - Energetics – functions of mitochondria.

**UNIT-II: NUCLEUS**

Structure and function of Nuclear membrane, Structure and function of Nucleolus.

Structure and function of Chromatin - Euchromatin and heterochromatin - Polytene and lampbrush Chromosomes

**UNIT-III: CELL CYCLES AND CANCER CELL**

Cell cycles – Molecular M-Cdk inactivation and creation of G<sub>1</sub> phase, cell growth and cell cycle progression, genetics of cell cycle.

Cancer cell: Characteristics of – possible causes of carcinogenesis (Theories) - Oncogenes - Environmental factors inducing cancer. Hormones in relation to Cancer.

**UNIT-IV: CHEMISTRY OF NUCLEIC ACIDS**

Chemistry of DNA - DNA replication – Experimental proof of semiconservative replication – enzymes in replication.

Chemistry of RNA - Different types of RNA and their functions.

**UNIT-V: INFORMATION TRANSFER**

Information transfer in Prokaryotes and Eukaryotes. Transcription - Promoters - Initiators and terminators – post transcriptional modifications. Trimming of introns and splicing of exons. RNA processing

**Course Objectives**

To understand the structure and molecular basis of cellular interactions, energy transformation, regulation and control of genes, cell cycle and information transfer.

**Unit-1: (50 to 100 contents)**

- Understand the history of cytology, draw the structure of plasma membrane and locate its function.
- Understand and appreciate the diversity of use as it is evolved overtime by the process of mutation, selection and genetic change.
- Acquire the knowledge of energetics.

**Unit-2: (50 to 100 contents)**

- To learn and understand the structure of chromatin and euchromatin.

- Enable the students to describe the structure of polytene chromosomes.
- Explaining the process of Nuclear membrane structure and function etc.

**Unit-3: (50 to 100 contents)**

- Describing the events of each phase of eukaryotic cell cycles.
- Describing and understanding the mitotic phase, nuclear and cell division
- Describing cell cycle progression cell cycle regulation.
- Describing the cell cycle maturation promoting factor MPE and cycle dependent kinase and G1 phase.

**Unit-4: (50 to 100 contents)**

- Analysing the DNA Chemical modification and impact on chromatin remodelling and regulation of gene expression.
- Describing semi conservative replication
- Explaining the process of semi conservative replication.

**Unit-5: (50 to 100 contents)**

- Explaining the nucleic acid transcription, promoters, initiators and terminators.
- Learn the post transcriptional modifications.
- Acquire the knowledge of trimming of introns and splicing.

**Text Books**

1. Verma Agarwal, 2014. Chand & Co Private Limited, New Delhi
2. Avers. C.J., 1976. CellBiology. Van Nostrand Company, New York.
3. Korenberg. A. 1974. DNA Replication. Dorothy- W.H. Freeman and Company,
4. San Francisco.
5. 6. Hawkins, J.D.1996. Gene Structure and Expression, Cambridge University Press, London.
6. 7. Ajoy Paul, 2011. Text book of Molecular Biology, Book and Allied Private limited, Kolkata.

**Reference Items: books, Journal**

1. De Robertis. E.D.F. and De Robertis. E.M.F. 2001. Cells and Molecular Biology, B.I Publications Pvt Ltd, India. 2. Lewin, B.2000 Genes VII. Oxford University Press, New York.
2. Howland J.L. 1973. Cell Physiology, McMillan Publishing Co., New York.
3. De Witt, 1977. Biology of the cell. An evolutionary approach. Saunders Company. 5. Karp, G. 1979. Cell Biology. McGraw Hill Ltd., Japan.
4. Avers. C.J., 1976. CellBiology. Van Nostrand Company, New York.
5. Korenberg. A. 1974. DNA Replication. Dorothy- W.H. Freeman and Company, San Francisco.
6. Hawkins, J.D.1996. Gene Structure and Expression, Cambridge University Press, London.
7. Ajoy Paul, 2011. Text book of Molecular Biology, Book and Allied Private limited, Kolkata.

**E- Materials**

- <http://www.freebookcentre.net/Biology/Cell-Biology-Books.html>
- [https://books.google.co.in/books/about/Cell\\_And\\_Molecular\\_Biology.html?id=iXeQ1Bi9P7cC](https://books.google.co.in/books/about/Cell_And_Molecular_Biology.html?id=iXeQ1Bi9P7cC)

**Course Out Comes (five outcomes for each units should be mentioned)**

**1. After studied unit-1, the student will be able to**

- Explain the structure of membrane and intercellular components and related to the function.
- Summarizing the energy transduction in cells.

**2. After studied unit-2, the student will be**

- Exhibiting knowledge in structure and function of Nuclear membrane.
- Understanding the properties of polytene chromosome.
- To study the structure and function of Nucleolus.

**3. After studied unit-3, the student will be**

- Demonstrate the knowledge of cell cycle and M-Cdk inactivation.
- To understand the creating G1 phase and cell cycle progression.
- To acquire the knowledge in hormonal activity and cancer.

**4. After studied unit-4, the student will be**

- Understand the chemistry of DNA
- They acquire the knowledge of describing the structure, replication of DNA
- To explain the post of transcriptional and transduction of DNA.

**5. After studied unit-5, the student will be**

- To know the information transfer in prokaryotic and eukaryotic.
- The student can able to understand the about the specificity of exon and introns.

**CORE ELECTIVE**

**PAPER-1**

**(to Choose either A (or) of B)**

**A. AQUACULTURE AND FARM MANAGEMENT**

**UNIT-I:**

**Introduction to Aquaculture:**

Importance of Aquaculture, Global Scenario, Present Status in India - Prospects and scope.

**Aquaculture Farms:** Site selection, topography, water availability and supply, Soil conditions and quality. Design and layout, structure and constructions.

**UNIT II:**

**Cultivable species and their culture system:**

Species selection–Culture of Seaweeds (Gracilaria), Crustaceans (Prawns – Litopenausvannamei&Macrobrachiumrosenbergi), Molluscs (Edible Oysters and Pearl Oyster) and Fishes (Seabass&Catla)

**UNIT-III:**

**Survey of seed Resources and Live Feed Production:**

Distributions and abundance seed resources of natural system, collection methods and segregation. Artificial breeding under controlled conditions, induced breeding technique, larval rearing, packing and transportation.

Live feed –Culture of Microalgae, Rotifer and Artemia - Feed formulations.

**UNIT-IV:**

**Type of Culture systems and Employment opportunity**

Traditional, Extensive, Semi-intensive and Intensive systems, composite fish culture, sewage water fish culture, paddy-cum-fish culture, integrated fish culture, raceway culture, cage, pen and rack culture. Employment opportunities in aquaculture industry.

**UNIT-V:**

**Farm Management:**

Water quality management –(temperature, salinity, pH, O<sub>2</sub>, nutrients); Feed management; Control of parasites, predators and weeds.

Disease diagnosis: ELISA, Western Blotting

**Course Objectives**

1. To obtain knowledge on cultivable fin and shell fish resources
2. To understand the culture practices of fin and shell fishes and their management practices

3. To know the commercially important candidate species for culture practices
4. To understand the distribution of seaweeds and their culture methods
5. To know the employment opportunities in aquaculture industry

**Unit-1: (50 to 100 contents)**

- To study and learn the importance of aquaculture, global scenario, present status in India - prospects and scope.
- To understand the aquaculture farms: site selection, topography, water availability and supply, soil conditions and quality. design, layout, structure and constructions.

**Unit-2: (50 to 100 contents)**

- To learn and understand the cultivable species and their culture system: species selection and culture of seaweeds (*Gracilaria*), crustaceans (prawns – *Litopenaeus vannamei* & *Macrobrachium rosenbergi*).
- To learn the molluscs (edible oysters and pearl oyster) and fishes (seabass & catla)

**Unit-3: (50 to 100 contents)**

- To understand the survey of seed resources and live feed production: distributions and abundance of seed resources of natural system, collection methods and segregation.
- To learn the artificial breeding under controlled conditions, induced breeding technique, larval rearing, packing and transportation.
- To acquire the knowledge of live feed - culture of microalgae, rotifer and artemia - feed formulations.

**Unit-4: (50 to 100 contents)**

- To understand the type of culture systems and employment opportunity: traditional, extensive, semi-intensive and intensive systems.
- To understand the composite fish culture, sewage water fish culture, paddy-cum-fish culture. To learn a study, the integrated fish culture, raceway culture, cage, pen and rack culture. employment opportunity in aquaculture industry.

**Unit-5: (50 to 100 contents)**

- To understand the farm management: water quality management – (temperature, salinity, pH, O<sub>2</sub>, nutrients); feed management;
- To study the control of parasites, predators and weeds in the farm.
- To learn the disease diagnosis: elisa, western blotting

**Text Books**

1. Site selection and Farm Design. 1997. CIBA, Chennai.

2. Principles and Practices of Pond Aquaculture (Aennan, J.F., R.O. Smilterman and G. Tehebenoglosus (eds.), Oregon State University, U.S.A., 1983.
3. Biswas, K.P. A text book of Fish, Fisheries and Technology. Narmada Publishing House, New Delhi.
4. The giant freshwater Prawn *Macrobrachium rosenbergii* (De Man).1990. Kerala Agricultural University, College of Fisheries, Kochi.
5. Freshwater fishes. 1992. Hand Book on Aquafarming. MEPDA, Kochi.
6. Bhamrah, H.S. and Juneja, K. An Introduction to Fishes (K. Balvinder, ed.,). Anmol Publications Pvt. Ltd.,
7. Hand Book on Aquafarming. 1992. Oceanic Cage Culture: Sea Fishes, Shrimp, Lobster and Mud Crab. MPEDA, Kochi.
8. Bhamrah, H.S. and Juneja, K. An Introduction to Fishes (K. Balvinder, ed.,). Anmol Publications Pvt. Ltd.,
9. Biswas, K.P. A text book of Fish, Fisheries and Technology. Narmada Publishing House, New Delhi.
10. Artificial Reproduction – FAO
11. Production of live feeds- FAO
12. Live Feeds - an overview | Science Direct Topics
13. Rajan, R. 2018. Training Manual on Live Feed Production for Marine Finfishes
14. Pillai, T.V.R., 1990. Aquaculture. Principles and Practise. Fishing News Books, Blackwell Publishing Ltd., 575pp.
15. Aquaculture and the Environment (ed. T.V.R. Pillay), 2004. Blackwell Publishing Ltd.,
16. Pillai, T.V.R., 1990. Aquaculture. Principles and Practise. Fishing News Books, Blackwell Publishing Ltd., 575pp.
17. Aquaculture and the Environment (ed. T.V.R. Pillay), 2004. Blackwell Publishing Ltd., Aquaculture Development, Health and Wealth - FAO

**Reference Items: books, Journal**

1. Jhingran, V. G., 1982. Fish and Fisheries of India. Hindustan Publishing Corporation, New Delhi.
2. Principles and Practices of Pond Aquaculture (Aennan, J.F., R.O. Smilterman and G. Tehebenoglosus (eds.), Oregon State University, U.S.A., 1983.
3. Hand Book on Aquafarming.1992. Oceanic Cage Culture: Sea Fishes, Shrimp, Lobster and Mud Crab. MPEDA, Kochi.
4. Site selection and Farm Design. 1997. CIBA, Chennai.

5. The giant freshwater Prawn *Macrobrachium rosenbergii* (De Man).1990. Kerala Agricultural University, College of Fisheries, Kochi.
6. Freshwater fishes. 1992. Hand Book on Aquafarming. MEPDA, Kochi.
7. Bhamrah,H.S. and Juneja, K.An Introduction to Fishes (K. Balvinder, ed.,). Anmol Publications Pvt. Ltd.,
8. Biswas, K.P. A text book of Fish, Fisheries and Technology. Narmada Publishing House, New Delhi.
9. Aquaculture and the Environment (ed. T.V.R. Pillay), 2004. Blackwell Publishing Ltd.,
10. Aquaculture Journal
11. Aquaculture Research Journal
12. Aquaculture Disease Diagnosis and Health Management. 10.1007/978-81-322-2271-2\_23

### **E- Materials**

- [www.fao.org](http://www.fao.org)-Production of live feeds - FAO
- <http://eprints.cmfri.org.in/id/eprint/7787> - Live feed production for marine aquaculture status, problems and prospects
- [www.sciencedirect.com](http://www.sciencedirect.com) - Live Feeds - an overview  
[www.researchgate.net](http://www.researchgate.net) › publication › 215799508 - Production and Utilization of Marine Copepods as Live feed for Larval Rearing of Tiger Shrimp *Penaeus monodon* with Special Emphasis on Astaxanthin.

[www.researchgate.net](http://www.researchgate.net) › publication › 261994048 - Induced\_Breeding

### **Course Out Comes (five outcomes for each units should be mentioned)**

#### **1. After studied unit-1, the student will be able to .....**

- Know what are Aquaculture and their importance?
- Gain knowledge on Global scenario and Indian status
- Understand the prospects and scope of aquaculture
  
- Acquire knowledge on farm design, structure and construction
- Realize the importance of farm management

#### **2. After studied unit-2, the student will be able to .....**

- Acquire knowledge on cultivable species
- Understand the culture system of the species
- To gain the knowledge of culture practice of seaweeds, prawns, molluscs and fishes
- Realize the importance of physico-chemical parameters in the culture
- Gain knowledge on management aspects of farm

#### **3. After studied unit-3, the student will be able to .....**

- Understand the seed resource availability in the natural system
- Know the methods of How to collect seeds from wild environment?
- Acquire knowledge on artificial breeding techniques and induced breeding methods

- Gain knowledge on packing and transportation of seeds
- Learn information on the culture of live feed organisms and feed formulations

**4. After studied unit-4, the student will be able to .....**

- Know the traditional culture system followed in our country
- Understand the intensive culture system practices in our country
- Realize the importance of culture system of fishes
- Why the integrated aqua farming of fishes practiced?
- Understand the employment opportunity in the aquaculture industry

**5. After studied unit-5, the student will be able to .....**

- Understand the role of environmental factors in the culture system
- Gain knowledge on feed management in the culture system
- Acquire knowledge on Control of parasites and predators in the culture system
- Know the eradication techniques of weeds in the farm
- Procure knowledge on disease diagnosis and the methods used for diagnosis.

**ELECTIVE**

**PAPER-1**

**B. BIOSTATISTICS AND BIOINFORMATICS**

**UNIT-I: INFERENCE STATISTICS**

**Introduction:** Definition of statistical population and sample in biological studies. Variables: qualitative and quantitative, Discrete and continuous.

Probability; Basic principles - a priori and a posteriori probabilities - addition and multiplication rules of probability. Conditional probability. Theoretical distribution, normal binomial and Poisson - application (computation required).

**UNIT-II**

Hypothesis testing - Null hypothesis - levels of significance - degrees of freedom - type I and type II errors.

Test of significance: Chi-square test for goodness of fit, homogeneity and association between attributes (Problem relating to Genetics, patterns of distribution etc. to be worked out).

Test of significance for large and small samples - comparison of sample mean with population mean comparison of two - sample (computation required)

**UNIT-III: CORRELATION AND REGRESSION**

Correlation: definition and types - simple, multiple -partial, linear, nonlinear, mutual, cause and effect etc. Uses of scatter diagram and correlation graph in the study of correlation between two variables. Computation of Karl Pearson's co-efficient of correlation - testing its significance, Interpretation.

Regression analysis, derivation of regression equation between two variable regression coefficient - construction of regression lines - properties - application. ANOVA

Population Statistics -Vital statistics - natality and mortality rates. Population estimation - population growth.

**UNIT-IV: BASIC BIOINFORMATICS**

Bioinformatics - Biological /Specialized Database - Servers for Bioinformatics (NCBI, EBI, Genom) Virtual Library - Data mining - Data Warehousing - Searching techniques - Genomics - Proteomics.

**UNIT-V: ALGORITHM IN BIOINFORMATICS**

Algorithm and tools sequence analysis - Similarity Search - Genetic algorithm - Gene finding - Protein prediction - Biomolecular visualization - Phylogenetic analysis - Drug designing.

**Course Objectives**

- To understand the basic concepts of biostatistics and bioinformatics.
- To solve biological problems through computational management.

**Unit-1: (50 to 100 contents)**

- To study about the inferential statistics.
- To learn the statistical population and sample in biological studies.

- To understand the Variables, qualitative, quantitative and Discrete and continuous.
- To study the probability and basic principles.
- To study the apriori and aposteriori probabilities and addition and multiplication rules of probability.
- To understand the Conditional probability.
- To learn the Theoretical distribution, normal binomial and Poisson - application (computation required).

**Unit-2: (50 to 100 contents)**

- To acquire the knowledge hypothesis testing and null hypothesis.
- To study the levels of significance, degrees of freedom and type I and type II errors.
- To learn and understand the Test of significance: Chi-square test for goodness of fit, homogeneity and association between attributes (Problem relating to Genetics, patterns of distribution,
- To understand and learn the Test of significance for large and small samples and comparison of sample mean with population mean comparison of two - sample (computation required)

**Unit-3: (50 to 100 contents)**

- To study the correlation and types of simple, multiple -partial, linear, nonlinear, mutual, cause and effect etc.
- To understand the graphs and uses of scatter diagram and correlation graph in the study of correlation between two variables.
- To learn the Computation of Karl Pearson's co-efficient of correlation.
- To study the testing its significance, Interpretation.
- To learn and understand the regression analysis, derivation of regression equation between two variable regression coefficient.
- To learn the construction of regression lines - properties - application.
- To understand and study the ANOVA.
  
- To learn the Population Statistics and Vital statistics.
- To learn the natality and morality rates. Population estimation - population growth.

**Unit-4: (50 to 100 contents)**

- To understand the basic concepts of bioinformatics.
- To learn and study the Biological /Specialized Database.
- To understand and study the Servers for Bioinformatics (NCBI, EBI, Genoment) Virtual Library Data mining - Data Warehousing.
- To learn the Searching techniques.
- To study the Genomics and Proteomics.

**Unit-5: (50 to 100 contents)**

- To understand the algorithm in bioinformatics.
- To learn the Algorithm and tools sequence analysis.
- To study the Similarity Search, Genetic algorithm, Gene finding, Protein prediction and Biomolecular visualization
- To learn the Phylogenetic analysis and Drug designing.

### **Text Books**

1. Gupta, S.P. 1988. An easy approach to statistics. Chand & Co., New Delhi.
2. Pillai, R.S.N. and Bagawathi, V. 2005 Statistics. S. Chand & Co. Ltd, New Delhi.
3. Mahajan, B.K. 1984. Methods in Biostatistics for Medical students and research Workers. Smt. Indu Mahajan, New Delhi.
4. Westhead, D.R., Parish, J.H. and Tugman, R.M. 2003 Bioinformatics. Viva Books Pvt. Ltd., New Delhi
5. Arthur, M.L. 2003. Introduction to Bioinformatics Oxford University Press, New Delhi.
6. Higgings D. and Taylor, W. 2000 Bioinformatics: Sequence, Structure and Databanks. Oxford University Press, New Delhi.

### **Reference Items: books, Journal**

1. Milton, J.S 1992 Statistical Methods in Biological and Health Science. McGraw-Hill Inc, New York.
2. Scheffler, W.C. 1963 Statistics for biological sciences. Addition - Wesley Publication Co., London.
3. Snedecor, G. and Cochran, W. G. 1967 Statistical Methods. Oxford Publication Co., New Delhi.
4. Spiegel, M.R. 1981 Theory and problems of statistics, Schaum's Outline Series McGraw - Hill International Book Co., Singapore.
5. Stansfield, W.O. 1984 Theory and Problems of genetics (including 600 problem) Schaum's outline series. McGraw - Hill Book, Co., New York.
6. Sokal, R.R. and Rohlf, F. J. 1969 Biometry. The Principles and Practice of Statistics in Biological Research. W.H. Freeman and Co., San Francisco.
7. Durbin, R., Eddy, S.R., Krogh, A. and Mitchison, G. 1998. Biological sequence Analysis. Cambridge University Press, Cambridge, U.K.
8. Baxevanis, A. and Ouellette, B.F. 1998. Bioinformatics: A practical guide to the analysis of genes and proteins. Wiley Interscience, Hoboken, New Jersey, USA.
9. Arthur M. Lesk. 2006. Introduction to Protein structure. Oxford University Press, New Delhi.

### **E- Materials**

- <http://www.freebookcentre.net/Biology/BioInformatics-Books.html>
- <http://www.biostat.jhsph.edu/~iruczins/teaching/misc/notes.bio.pdf>

### **Course Out Comes (five outcomes for each units should be mentioned)**

#### **1. After studied unit-1, the student will be able to .....**

- Compute basic probabilities as used in statistical applications by demonstrating the elementary rules of probability
- prove an understanding of discrete probability distributions by assembling a discrete probability distribution
- Solving binomial distribution problems that require the use of a discrete binomial distribution
- Planning and proposing the uses of the Poisson distribution for solving problems

**2. After studied unit-2, the student will be able to .....**

- Show a working knowledge of sampling, sampling distributions, and confidence intervals by constructing a sampling distribution of the sample mean.
- The use and application of hypothesis testing
- Understand the applications of Chi-square

**3. After studied unit-3, the student will be able to .....**

- Understand how to apply linear regression to analyze problems
- Understand how to design an experiment by ANOVA.

**4. After studied unit-4, the student will be able to .....**

- Understand the basic concepts of Bioinformatics and its significance in Biological data analysis.
- Understand various techniques used in genomics and proteomics

**5. After studied unit-5, the student will be able to .....**

- Understand the various techniques, algorithms and tools used for Phylogenetic Analysis

**OPEN ELECTIVE (NON-MAJOR)**

**PAPER-1**

**(to Choose either A or B)**

**A. Apiculture (Bee keeping)**

**Unit I**

**Introduction of Modern bee keeping-** Importance of beekeeping - Scope of beekeeping - Bee species- Cast differentiation, Colony organization - Division of labor in honeybee - Life cycle of honeybee and nuptial flight

**Unit II**

**Scientific bee keeping- Beekeeping equipments-** Equipments for improving efficiency of honeybees - Equipments for improving efficiency of bee's keepers - Equipments for improving hygienic conditions - Methods of Swarm Capturing- Capturing a Swarm from a tree branch - Capturing a Swarm from Ground - Inspection and Handling the Colony - Hiving by dividing an established colony - Establishment, Seasonal Management of apiary and inspection of bee colonies.

**Unit III**

**Apiculture in Agriculture** -Bee plants and floral calendar- Importance and qualities of good bee flora - Pollination, Need of bee pollination - Management of honeybees for pollination - Migratory beekeeping –

**Unit IV**

**Honeybee products** -- Honey- Its constituents, methods of collection and uses - Importance of other bee products to mankind - Pollen –Method of collection, constituents, uses - Royal jelly- Method of collection, constituents, uses - Propolis - Method of collection, constituents, uses - Bee wax- Method of collection, constituents, uses - Bee venom- Method of collection, constituents, uses.

**Unit V**

**Problems of beekeeping industries,** Natural Climate Condition, natural enemies, pest and diseases, human activities and Apiary and Hive Hygiene.

**Course Objectives**

1. To provide direction of higher education towards social utility (benefit).
2. To equip the students with latest technologies in emerging area.
3. To extend the knowledge from laboratory to field.
4. To provide skills and job oriented techniques to the students.
5. To understand the basic life cycle of the honeybee.
6. Learn to manage the beehives for honey production and pollination.

**Unit-1: (50 to 100 contents)**

- Understand the general discipline of bees.
- Identify different species of bees.
- Understand the different cast of bees and their role in colony.
- Get acquainted in the communication skill methods used to buy bees.

**Unit-2: (50 to 100 contents)**

- Understand the factors to be considered for site selection.
- Selective sites for hive installation.
- Perform inspection of colonies.
- Manage the colonies of beehive

**Unit-3: (50 to 100 contents)**

- Identifying different types of floral calendar.
- Understand the methods of bee pollination.
- Acquiring knowledge about migratory.

**Unit-4: (50 to 100 contents)**

- Extract honey using appropriate procedure.
- Understanding of harvesting royal jelly, propolis, pollen and bee venom.
- Understand the methods of harvesting honey.

**Unit-5: (50 to 100 contents)**

- To Acquire the knowledge of beekeeping industries.
- To learn the natural climate condition, natural enemies, pest and diseases, human activities.
- To study the apiary and hive hygiene.

**Text Books**

- 1) Introduction to disease of bee –Bailey, L
- 2) World of honeybee –Butter C. G.
- 3) Beekeeping in India –Sardar Sing (ICAR)

**Reference Items: books, Journal**

- 1) Introduction to disease of bee –Bailey, L
- 2) World of honeybee –Butter C. G.
- 3) Beekeeping in India –Sardar Sing (ICAR)
- 4) The Principle of Insect Physiology-Wigglesworth, V.S.
- 5) Applied Zoology- B. B. Waykar, A. Y. Mahajan, B. C. More. (Prashant Publication Jalgaon)

**E- Materials**

- [http://www.digitalbookindex.org/\\_search/search010agriculturebeekeepinga.asp](http://www.digitalbookindex.org/_search/search010agriculturebeekeepinga.asp)
- [http://library.uniteddiversity.coop/Beekeeping/A\\_Practical\\_Manual\\_of\\_Beekeeping.pdf](http://library.uniteddiversity.coop/Beekeeping/A_Practical_Manual_of_Beekeeping.pdf)
- <https://thebeeyard.org/ebooks/>

**Course Out Comes (five outcomes for each units should be mentioned)**

**1. After studied unit-1, the student will be able to**

- Identify different types of species.
- Ascertain different roles played in different species of bees.

- Ascertain importance of economic aspects of honeybees.

**2. After studied unit-2, the student will be able to**

- Identify the need of improving efficiency of bee keepers.
- Understanding the biology and the behavior.
- Manage insect's diseases and nuisances in beehive.

**3. After studied unit-3, the student will be able to**

- Identify common Indian tests stored in combs built by bees.
- Enable to learn the management techniques.

**4. After studied unit-4, the student will be able to**

- Learn and understand the local skills, knowledge and traditions.
- Acquire knowledge of integration into forming system.
- To learn different types of products and its uses.

**5. After studied unit-5, the student will be able to**

- To Acquire the knowledge of beekeeping industries.
- To learn and understand the natural climate condition, natural enemies, pest and diseases, human activities.
- To study and learn the apiary and hive hygiene.

**OPEN ELECTIVE (NON-MAJOR)**

**PAPER-1**

**B. PUBLIC HEALTH AND HYGIENE**

**UNIT – I**

Scope of Public Health and Hygiene – Nutrition and health – classification of foods – Balanced Diet – malnutrition - Nutritional deficiencies – Vitamin deficiencies. Nutritional requirements of special groups.

**UNIT – II**

Environment and Health Hazards – Environmental degradation – pollution and associated health Hazards – Health problems due to industrializations – Hospital waste management.

**UNIT – III**

Communicable diseases and their control measures such as Measles, Polio, Chikungunya, Rabies, Plague, Leprosy and AIDS.

**UNIT – IV**

Non – communicable diseases and their preventive measures such as Hypertension, Coronary Heart Diseases, Stroke, Diabetes, Obesity and Mental ill – Health. Alcoholism and drug dependence.

**UNIT – V**

Health Education and Health programmes in India – WHO programmes – government and voluntary Organizations and their health service – Precautions first Aid and awareness on sporadic diseases.

**Course Objectives**

- To impart awareness on public health, Hygiene and diseases. To educate and emphasize on preventive measures of diseases. To create knowledge on Health Education.

**Unit-1: (50 to 100 contents)**

- To give a better understanding about yourself.
- Understand the nutrition, health, nourishment of children.
- To acquire the knowledge about nutritional requirements, vitamins deficiencies, and balanced diet.

**Unit-2: (50 to 100 contents)**

- To understand the pollution and health hazards.

- By learning the health problems and due to industrialization.
- To understand the Hospital waste management.

**Unit-3: (50 to 100 contents)**

- By learning the communicable diseases and control measures.
- To know about the disease of the Measles, Polio, Chikungunya, Rabies, etc.
- To know completely about, HIV and Leprosy.

**Unit-4: (50 to 100 contents)**

- By learning the Non-communicable diseases and preventive measures.
- Learning about obesity and mental ill health problem.
- Understand about, alcoholism and drug dependence.

**Unit-5: (50 to 100 contents)**

- To thoroughly know the WHO programmes.
- To study the government service helpline to create awareness on alcoholism and drug dependence.

**Text Books**

- Park and Park, 1995: Text book of preventive and social medicine – Banarsidas Bhanot Publ. jodhpur- India.
- Verma, S. 1998: Medical zoology, Rastogi Publ.- Meerut- India Singh, H.s. and Rastogi, P. 2009: Parasitology, Rastogi Publ. India.
- Dubey, R.C and Maheswari, D.K. 2007: Text Book of Microbiology – S. Chand & co. Publ. New Delhi– India.

**Reference Items: books, Journal**

- Park and Park, 1995: Text book of preventive and social medicine – Banarsidas Bhanot Publ. jodhpur- India.
- Verma, S. 1998: Medical zoology, Rastogi Publ.- Meerut- India Singh, H.s. and Rastogi, P. 2009: Parasitology, Rastogi Publ. India.
- Dubey, R.C and Maheswari, D.K. 2007: Text Book of Microbiology – S. Chand & co. Publ. New Delhi– India.

**E-Materials**

- [http://www.digitalbookindex.org/\\_search/search010homeecohygienesanitationa.asp](http://www.digitalbookindex.org/_search/search010homeecohygienesanitationa.asp)

**Course Out Comes (five outcomes for each units should be mentioned)**

**1. After studied unit-1, the student will be able to**

- Describe under connected relationships among physical social and environmental health and diseases.
- Students comes to know the about the role of multiple determination of health across diverse population.

**2. After studied unit-2, the student will be able to**

- Describe the environmental pollution and health hazards.
- To study and able to understand hospital applications, health problems due to industrialization.

**3. After studied unit-3, the student will be able to understand**

- The major themes for life skill based hygiene education.
- Student acquire knowledge about communicable diseases.

**4. After studied unit-4, the student will be able to understand**

- How to take precautionary steps for communicable diseases and sporadic diseases.
- Student can able to learn the demerit's and alcoholism and drug dependence.
- To learn the remedy for obesity mental illness and health problems.

**5. After studied unit-5, the student will be able to understand**

- To know the government and voluntary organizations and their health service of India.
- Understand the health programme in India.

**SEMESTER II**

**PAPER-4**

**GENETICS**

**UNIT-I: MOLECULAR STRUCTURE OF GENETIC MATERIAL**

Molecular structure of DNA and RNA - Replication, theories, Gene concept - One gene one polypeptide concept.

Identification of DNA and RNA as the genetic material.

Microbial Genetics - Conjugation, transformation and transduction and Sexduction.  
Chromosome mapping in prokaryotes (Virus, Bacteria), Gene mapping by human pedigree analysis, synteny.

**UNIT-II: REGULATION OF GENE ACTION**

Enzyme regulation of gene action. Gene regulation of gene action - Operon concept - GAL and LAC Operon system. Evidence of regulation of gene action.

Genes and metabolism. Inborn errors of metabolism in Man (With reference to protein, carbohydrates, Lipid and nucleic acid).

**UNIT-III: CHROMOSOME AND GENETICS DISORDERS**

Applied Genetics - Application of genetics in animal breeding. Application of genetics in Crime and Law - DNA fingerprinting, Genetic basis of intelligence. Studies on Twins.  
Sex chromosomes. Dosage compensation- X inactivation. Genomic imprinting.  
Human Genetics: Variations in karyotypes (autosomal and sex chromosomal) with special reference to Klinefelters, Turners and Down's syndromes in man. Genetic counselling - Objectives, ethics and principles.

**UNIT-IV: GENES IN DEVELOPMENT, RADIATION GENETICS AND POPULATION GENETICS**

Genes in development and differentiation Mechanism of chromosomal breakage - physical chemical and biological factors or agents. Mutagens and mutagenesis and carcinogenesis – genetics effects of radiation.

**Population genetics:**

Population and gene pool. Hardy Weinberg Law-Genetic equilibrium.  
Calculation of gene frequencies for Autosomal (Complete dominance, codominance and multiple alleles) and sex linked genes. Factors affecting Hardy Weinberg equilibrium.

**UNIT-V: GENETIC ENGINEERING AND APPLIED GENETICS**

**Genetic Engineering** – Techniques of genomic sequencing - Recombinant DNA techniques. Applications of Recombinant DNA technology.

**Applied Genetics** - Application of genetics in animal breeding. Application of genetics in Crime and Law - DNA fingerprinting, Genetic basis of intelligence. Studies on Twins.

## **Course Objectives**

1. To understand the fine structure of genetic materials.
2. To acquire the knowledge of Regulation of gene action.
3. To know the chromosomal basis of genetic disorders.
4. To understand the development and differentiation of genes.
5. To know the importance of population genetics.
6. To understand the nuances of genetic engineering and applied genetics.

### **Unit-1: (50 to 100 contents)**

- To understand molecular structure of genetic material.
- To acquire the knowledge of replication theories identification.
- To Understand the principles of gene mapping mechanisms.

### **Unit-2: (50 to 100 contents)**

- To Study the enzyme regulation of gene action.
- To enable the students to understand the operon concepts, metabolic disorders.

### **Unit-3: (50 to 100 contents)**

- To understand how the mutation can affect gene dosage, X inactivation chromosomal aberrations.
- To discuss the human genome structure in the context of physiological function and disease.
- To analyse epigenetic modification and imprinting in the role of disease.

### **Unit-4: (50 to 100 contents)**

- To understand the development of genes and breakage, to understand the knowledge of radiation procedure and effects of radiations.
- Describing population structure in terms of genetic variation.
- Evaluating the principles to describe the genetics profile of populations as specified by Hardy Weinberg Law.

### **Unit-5: (50 to 100 contents)**

- Analyzing the function of applied genetic research in technology, nature, and society.
- Assessing the impact of genomics, proteomics and bioinformatics on society.
- Identifying ethical issues related to gene manipulation and analysis.

## **Text Books**

1. Verma, P.S. and V.K. Agarwal, 1995 Genectis, 8th edition, S. Chand & Co, New Delhi – 110 055.580pp.
2. Verma, P.S. and V.K. Agarwal, 2009.9th edition, S. Chand & Co, New Delhi.

3. S.C. Rastogi Biotechnology, Principles and Applications 2007 Narosa Publishing house, Pvt.Ltd.
4. Verma.P.S and Agarwal.V.K (2004) Genetics, S.Chand & Co., New Delhi .
5. Dalela.R.C and Verma.S.R (1970) A Textbook of Genetics,Jaiprakash Nath and Company., Meerut.

**Reference Items: books, Journal**

1. Watson. J.D. Hopkins, N.H., Roberts, J.W., Steitz, J.A. and Weiner, A.M. 1987 Molecular Biology of the Gene. W.A. Benjamin/Cummings Co., New York.
2. Sinnot. E.W., Dunn. L.C., Dobzhansky, T.H. 1973. Principles of Genetics. McGraw Hill Co., New Delhi.
3. Daniel L. Hartl. 1994. Genetics. Jones and Barflaff Publishing, Boston.
4. Lewin, B. 2000. Genes VII. Oxford University Press, New York.
5. Ayala, F. I. and Kieger, J.A. Jr., 1980, Modern Genetics. The Benjamin Publishing Co. London,
6. Goodenough, U. 1984. Genetics. Saundes College Publishing Co., London.
7. Curs Sten 1973 Principles of Human Genetics. W.H. Freeman and Co., New York.
8. Jenking, J.B. 1983. Human Genetics. The Benjamin Cummings Publishing& Co., Lndan.
9. Market, C.L. & Ursprung, 1973. Development Genetics, Prentice Hall.
10. Gardner E.J. Simmons, M.J. and Snustad, D.P.1991 John Wiley & Sons, New York.

**E- Materials**

- <http://www.agrimoon.com/principles-of-genetic-pdf-book/>
- [http://www.bionet.nsc.ru/ICIG/CHM/books/Hartl\\_Jones\\_Genetics.pdf](http://www.bionet.nsc.ru/ICIG/CHM/books/Hartl_Jones_Genetics.pdf)
- [http://gsi.semmelweis.hu/files/ebook/Genetics%20genomics\\_en.pdf](http://gsi.semmelweis.hu/files/ebook/Genetics%20genomics_en.pdf)
- [http://www.freebookcentre.net/medical\\_text\\_books\\_journals/genetics\\_ebooks\\_online\\_texts\\_download.html](http://www.freebookcentre.net/medical_text_books_journals/genetics_ebooks_online_texts_download.html)
- [http://web.iitd.ac.in/~amittal/SBL101\\_Essentials\\_of\\_Genetics.pdf](http://web.iitd.ac.in/~amittal/SBL101_Essentials_of_Genetics.pdf)
- <https://epdf.pub/principles-of-genetics.html>

**Course Out Comes (five outcomes for each units should be mentioned)**

**1. After studied unit-1, the student will be able to**

- Describe the structure of nucleic acid and polypeptide concept.
- They can able to understand the bacterial genetics and family history.

**2. After studied unit-2, the student will be able to**

- Discuss the mechanisms of genetic regulation .
- To understand the knowledge of operon systems and metabolic errors.

**3.After studied unit-3, the student will be able to**

- Describe the mutation of dosage compensation and imprinting.
- To study the syndromes of sex & autosomal chromosomes in human.

**4. After studied unit-4, the student will be able to**

- To understand the genes and development, chromosomal breakage, mutagenesis and carcinogenesis
- Understand the insight into the mathematical, statistical and computational basis of genetic analysis.

**5. After studied unit-5, the student will be able to**

- To analyse the function of applied genetic research in technology, nature, and society.
- They assess the impact of genomics, proteomics and bioinformatics on society.

**PAPER-5  
ENVIRONMENTAL BIOLOGY**

**UNIT-I:**

**PRINCIPAL AND SCOPE OF ENVIRONMENTAL BIOLOGY**

Ecology and Environment: an introduction - Earth, Man and Environment Relationship - Importance of biological cycles in the environment. Principal and Scope of environmental biology – Environmental health, education and Public understanding. Natural and Man-made ecosystem, Marine environment an analysis. Food chain and food web, Energy flow - Trophic structure and levels – Pyramids, ecological efficiencies. Classification of ecosystem: Fresh water, marine, estuarine and terrestrial ecosystems. Primary and secondary production – definition, measurement of productivity in terrestrial and aquatic pathways in ecosystem; Basic laws of energy flow; energy flow models, nature and flux of energy through communities. Influence of competition, predation and disturbances - Community succession - homeostasis.

**UNIT-II:**

**COMMUNITY, POPULATION AND BIOLOGICAL CYCLES**

**Community ecology:** types of community, succession process, competition and coexistence, types of interactions: predation, parasitism, antibiosis, commensalism, cooperation and mutualism, population growth. Social and Economic impact of environmental policies. Classification of biomass, major biotic elements of each biome and their characteristics, Community succession and climax stage.

**Population ecology:** Structure and distribution of population - Growth curves - Groups, Natality, Mortality - Density indices, Life study tables - factors affecting population growth - Carrying capacity. Fluctuation and regulation Population regulation and human population control. Complete and incomplete biogeochemical cycles - Sedimentary cycle - Recycle pathway of elements - Cycling of non - essential and organic nutrients.

**UNIT-III:**

**HABITAT AND RESOURCES ECOLOGY**

Biomass, Adaptations with reference to physico - chemical features of environment of terrestrial, freshwater, estuarine, marine habitats. Unique features of Coral Reefs, Seaweeds, Sea grasses and Mangroves. Renewable and non - renewable resources - animal resources. Conventional and non - conventional energy sources. Natural resources and their conservation.

**UNIT-IV:**

**ENVIRONMENTAL CONSERVATION, DISASTER AND MANAGEMENT**

Principles of conservation - Rain water harvesting - Soil health and fauna inputs in agriculture Biosphere reserves - wildlife conservation, forest conservation and management. Biodiversity - Germplasm conservation and cryopreservation. Social forestry - tribal welfare. Fossil fuel and the environments. Environmental Disaster and Management: Effect of climate change, global warming and its effect on living organisms – Tsunami, Cyclone Earth Quake, Flood: Causes, consequences, control and management. War and its impact on environment. Remediation and reclamation of the Environment-Role of microbes in bioremediation.

**UNIT-V:**

**POLLUTION AND MANAGEMENT**

Environmental Pollution: Types of environmental pollution and their biological effects. Air, soil, noise, Radioactive and water pollution - causes, effects and control. Hazardous solid waste. Industrial disaster and pollution - Case studies-chemical Industries - Pesticide Industries - Bhopal Disaster, Chernobyl accident, Love canal Disaster, Exxon Oil Disaster, Impact and Remedial Measures - Labeling - Laws and Regulations - Pollution Control Board. Thermal Pollution, Marine Pollution – Biological indicators and their role in environmental monitoring.

Environmental education and awareness - Organizations involved in environmental protection - Principles of conservation: Application of ecological principles - germplasm conservation. Global Environmental Issues and Human Health Environmental Impact Assessment, Policy and Laws.

### **Course Objectives**

- To generate up-to-date knowledge on environmental conservation and management through a comprehensive understanding of the components of ecosystem, biological cycles, habitat ecology, resource ecology, pollution and its management.

### **Unit-1: (50 to 100 contents)**

- Environmental studies will be able to recognize the physical, chemical, and biological components of earth system.
- Understanding the classification of Ecosystem.

### **Unit-2: (50 to 100 contents)**

- Understand the social and economic impact of the environment.
- Understand the detailed explanation of population and distribution.

### **Unit-3: (50 to 100 contents)**

- Study the various habitats of environments.
- Acquire knowledge in renewable and non-renewable sources.

### **Unit-4: (50 to 100 contents)**

- Studying the disaster management.
- Understand the definition of Tsunami, Cyclone, earth quake and how it occurs.

### **Unit-5: (50 to 100 contents)**

- Understand the types of pollution causative factors, and control.
- Understand the importance of the non-polluting sources of energy to the energy.

### **Text Books**

1. Odum F.P. 1983 Basic Ecology, Saunders College Publication 613 papers.
2. Odum, Eugene D. 2004 Fundamental of ecology. Brooks college 5<sup>th</sup> edition 624 pages.
3. Rastogi V.B and Jayaraj.M.S Animal Ecology and distribution of animals.

### **Reference Items: books, Journal**

1. Alpha Soli, I. Arceivala.1998. Wastewater treatment for pollution control - Second Ed. Tata McGraw Hill Publication Company Ltd., New Delhi.
2. Asthana, D.K. and Asthana, M.2001. Environmental Problems and Solutions. S. Chand and Co., New Delhi.
3. Bandopadhyay, J.1985. India's Environment Crisis and response. Nataraj Publishers, Dehra Dun.
4. Berwer. A.1988. The Science of ecology. Saunder's college publishing.
5. Cain ML, Bowman WD and Hacker SD (2011) Ecology, Sinauer Associates Publishers.
6. Clark RS (2001) Marine Pollution, Clarendon Press Oxford, New York
7. Henry M and Stevens H (2009) A Primer of Ecology with R, Springer.

8. Ismail, S.A.1997. Vermicology, Biology of Earthworms. Orient Longman, Chennai.
9. Krebs CJ (2008) Ecology: The Experimental Analysis of Distribution and Abundance (6th Edition), Benjamin Cummings.
10. Kudesia, V.P and Ritu Kudesia (1992) Water Pollution, Pragati Prakashan Publication, Meerut.14
11. Kurnarasawmy, K., A. Alagappa Moses and M. Vasanthy (2004) Environmental Studies (A Text Book for All Under Graduate Students) Bharathidasan University Publications.
12. Molles MC (2013) Ecology: Concepts and Applications, McGraw-Hill Publishers, UK
13. Odum. E.P. 1996 Fundamentals of Ecology. Nataraj Publishers, Dehra Dun.
14. Odum EP (2008) Fundamentals of Ecology, Cengage Learning (Thompson), USA.
15. Rao, M. N and H.V.N. Rao (1993) Air Pollution, Tata McGraw -Hill Publishing Company Limited. New Delhi.
16. Sawyer, C. N., P.L McCarty and G.F. Perkin (1994) Chemistry for Environmental Engineers, "Edition. McGraw-Hill.
17. Sharma, B.K and H.Kaur (1994) Soil and Noise Pollution. God Publishing House, Meerut.
18. Smith TM and Smith RL (2008) Elements of Ecology (7th Edition), Benjamin Cummings.
19. Smith, R.L.1986. Elements of Ecology. Harpet and Row Publishers, New York.
20. Stiling P (2014) Ecology, McGraw-Hill Publishers, UK
21. Trivedi, P.R.and Gurdeepraj, K. 1992. Environmental Biology. Akashdeep Publishing House New Delhi
22. Swarup, R.,Mishra, S.N. and Jauhari,V.P. 1992. Encyclopodia of Ecology. Mittal Publications, New Delhi.

### **E-Materials**

- <https://open.umn.edu/opentextbooks/textbooks/environmental-biology>.

### **Course Out Comes (five outcomes for each units should be mentioned)**

#### **1.After studied unit-1, the student will be able to understand**

- Asses necessary scientific concepts and data.
- They establish integral cultural context.

#### **2. After studied unit-2, the student will be able to understand**

- Acquire the knowledge and still to view the self and social situation in the ecological and cultural and social context.
- Acquire the knowledge skill necessary to achieve and understanding environmental problems.

#### **3. After studied unit-3, the student will be able to understand**

- Appreciate attributes of natural resources and management.
- Appreciate the ideas of unsustainable development.

**4. After studied unit-4, the student will be able to understand**

- Competent in basic forest management principles and evaluation of forest stands for health, wild life habitat.
- Identifying soli type how they are formed and ways to modify soil structure and improved soil fertility.

**5. After studied unit-5, the student will be able to understand list out major places and**

- Describing the effects of air pollution and their management.
- Know about the global environmental issues.

**PAPER-6**

**BIOTECHNOLOGY**

**UNIT-I:**

**GENETIC ENGINEERING AND RECOMBINANT DNA TECHNOLOGY**

Gene cloning - the basic steps - various types of restriction enzymes - ligase linkers and adaptors - c DNA - transformation - Selection of recombinants.

Gene probe - Molecular finger printing (DNA finger printing) - RFLP - the PCR techniques - Genomic library - Blotting techniques - Southern blotting - Northern blotting - Western blotting

**UNIT-II:**

**CLONING VECTORS**

Bacterial plasmid vectors PBR 322 and PUL 19 – Bacteriophage vectors – phage  $\lambda$  – phage M13 - cosmids – phagemids – yeast plasmid vectors – Y1p, yEp – Transposons – shuttle vectors.

**UNIT-III:**

**ANIMAL BIOTECHNOLOGY**

In vitro fertilization (IVF) technology - Dolly - embryo transfer in human.

Human gene therapy – stem cell therapy – genes for vaccines – legal and ethical issues in biotechnology.

**UNIT-IV:**

**MICROBIAL BIOTECHNOLOGY**

Fermentation - bioreactor - Microbials products - Primary & Secondary Metabolites - Biopolymers, Biopesticides and Biofertilizers. Biological control – microbial inoculants.

**UNIT-V:**

**ENVIRONMENTAL BIOTECHNOLOGY AND APPLICATIONS OF BIOTECHNOLOGY**

Bioremediation - bioremediation of hydrocarbons - Industrial wastes - Heavy metals - Xenobiotics - bioleaching - biomining - biofuels. Applications of biotechnology in agriculture, medicine and food science. Genetically modified organism (GMO'S) - GM foods. Biotechnology & biosafety – IPR – Patent.

**Course Objectives**

- To familiarize the use of the data and techniques in Biotechnology in living organisms. To find solution of problems concerning human activities including agriculture, medical treatment, industry and environment.

**Unit-1: (50 to 100 contents)**

- To study about the gene cloning techniques
- To learn the various type of restriction enzyme technology.
- To study the ligase linker and adaptors.
- To study the c DNA - transformation - Selection of recombinants.

- To understand the Gene probe - molecular finger printing (DNA finger printing), RFLP Techniques.
- To learn the genomic library.
- To learn the PCR blotting techniques.

**Unit-2: (50 to 100 contents)**

- To acquire the knowledge of Cloning Vectors such as bacterial plasmid vectors PBR 322 and PUL 19.
- To study the bacteriophage vectors – phage  $\lambda$  – phage m13 - cosmids – phagemids .
- To study Yeast plasmid vectors – y1p, yep – transposons – shuttle vectors.

**Unit-3: (50 to 100 contents)**

- To understanding thoroughly the Animal biotechnology like In vitro fertilization (IVF) technology - Dolly - embryo transfer in human.
- To understand the human gene therapy, stem cell therapy and gene vaccines.
- To learn the legal and ethical issues in biotechnology.

**Unit-4: (50 to 100 contents)**

- To study the fermentation and bioreactor techniques.
- To understand the microbial product of Primary and Secondary Metabolites.
- To learn the Bio-polymers, Bio-pesticides and Bio-fertilizers.
- Attaining knowledge in Biological control – microbial inoculants.

**Unit-5: (50 to 100 contents)**

- To understand the environmental and applications of biotechnology.
- To study the Bioremediation of hydrocarbons.
- To learn the Industrial wastes and Heavy metals.
- To study the Xenobiotics, bioleaching, biomining, biofuels.
- To learn the applications of biotechnology in agriculture, medicine and food science.
- To study the Genetically modified organism (GMO'S) - GM foods.
- To understand the Biotechnology & biosafety – IPR – Patent.

**Text Books**

1. Gupta, P.K. 2004. Biotechnology and Genomics. Rastogi Publications, Meerut.
2. R.C. Dubey 2001 A text book of biotechnology. Rajendra Ravindra Printer. New Delhi.
3. Chopra, V.L. and Nanin, A. 1992. Genetic Engineering and Biotechnology.
4. Oxford and I BH Publishing Co., New Delhi.

**Reference Items: books, Journal**

1. Purohit, S.S. and S.K. Mathur. 1999. Biotechnology Fundamentals and Application. Agro Botanica, New Delhi.
2. Alan Scragg. 1999. Environmental Biotechnology, Longman Publication.
3. T.A. Brown 2004 Gene cloning and DNA analysis. Blackwell Science, Osney Mead, Oxford.
4. Dawson, M.T., Powell, R., and Gannon, F. 1996. Gene Technology. Bios Scientific Publishers.
5. Marx, J.L. 1989 A Revolution in Biotechnology. Cambridge University, Press, Oxford.

6. Old, R.W. and Primrose, S.B. 1985 Principles of Gene Manipulations. An introduction to Genetic Engineering. Oxford Blackwell Publishers, London.
7. Winnacker, E.L. 2003. From Genes to Clones. Panima Publishing Corporation, New Delhi.
8. Das, H.K. 2004. Text Book of Biotechnology. Wiley Dreamtech India Pvt. Ltd., New Delhi.

### **E. Materials**

- <https://www.ebooks.com/en-us/subjects/science-biotechnology-ebooks/114/>
- <https://library.umac.mo/ebooks/b2805507x.pdf>

### **Course Out Comes (five outcomes for each units should be mentioned)**

#### **1. After studied unit-1, the student will be able to understand**

- The tools and strategies used in genetic engineering.
- The applications of recombinant DNA technology and genetic engineering.

#### **2. After studied unit-2, the student will be able to understand**

- The Bacterial plasmid vectors PBR 322 and PUL 19.
- Bacteriophage vectors

#### **3. After studied unit-3, the student will be able to understand**

- Biotechnological techniques like embryo transfer and in vitro fertilization

#### **4. After studied unit-4, the student will be able to understand**

- Critically evaluate the role of micro-organisms in specific biotechnological processes

#### **5. After studied unit-5, the student will be able to understand**

- The applications of biotechnology in agriculture, medicine and food science.

**CORE PRACTICAL**

**PAPER-1**

**LIFE AND DIVERSITY OF INVERTEBRATES AND CHORDATES AND CELL  
AND MOLECULAR BIOLOGY**

**INVERTEBRATA (Slides / Specimens / Xerox)**

1. Identification and study of selected Protozoans and Helminthes of medical importance. (Any Two)
2. Identification and study of sections of available animals from Cnidaria, Aschelminthes and Annelida to understand the evolution of /different types of coelom.
3. Identification and study of larval forms from all major phyla of Invertebrates. (Any Four)
4. Identification and study of types minor phyla.
5. Identification and study of Invertebrate fossils
6. Dissection of digestive system of any insect, pila/sepia
7. Dissection of nervous system of Prawn, any insect, Pila/Sepia
8. Dissection of reproductive system of any insect.
9. Mounting of:
  - a. Appendages or Prawn
  - b. Radula of Pila
  - c. Sting of Honeybee
  - d. Pedicellaria of Sea urchin - Demonstration
  - e. Aristotle's lantern of sea urchin - Demonstration
10. Study of prepared slides of mouth part of Honey bee, Housefly, Mosquito, Bed bug and Butterfly to relate structure and function.

**CHORDATA (Slides / Specimens / Xerox)**

1. Study of the following specimen to bring out their affinities:
  - a. Amphioxus
  - b. Balanogossus
  - c. Ascidian
  - d. Peteromyzon
2. Study of the following specimens with reference to their adaptive features for their respective modes of life
  - a. Echeneis
  - b. Ichthyophis / Uraeotyphlus

- c. Hyla
  - d. Draco
  - e. Pigeon
  - f. Bat
3. Study of the following skull types with reference to jaw suspensions
- a. Fish
  - b. Frog
  - c. Calotes
  - d. Snake
  - e. Rat/Rabbit
4. Dissection of aortic arches in Teleost
5. Dissection and display of IX<sup>th</sup> and X<sup>th</sup> Cranial nerves of cat fish
6. Demonstration of portal system of Rat

## **CELL AND MOLECULAR BIOLOGY**

### **CYTOLOGICAL TECHNIQUES**

Micrometry – measurements using ocular and stage micrometers – measurements of cell from any prepared slide. Vital staining – Buccal smear stained with Methylene blue. CHROMOSOME Chromosome preparation – procedure. Preparation of meiotic chromosomes from any fish – (demonstration) MOLECULAR BIOLOGY TECHNIQUES (Demonstration only) Centrifuge, Isolation of DNA from Liver – Isolation of RNA – Denaturation of DNA – measurement of spectrophotometry – Isolation and analysis of proteins – electrophoresis.

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**CORE PRACTICAL**

**PAPER-2**

**GENETICS, ENVIRONMENTAL BIOLOGY AND BIOTECHNOLOGY**

**GENETICS**

1. Preparation of culture medium Culture of *Drosophila*. Methods of maintenance. Sex identification. Identification of four mutants.
2. Identification of blood groups A, B, ABO and Rh
3. Mounting of salivary glands of *Chironomus* larva. Analysis of banding pattern
4. Preparation of Buccal smear to show squamous epithelial cells.
5. Karyotyping using human metaphase chromosome plates (Giemsa stained). Identification of syndromes (Down, Klinefelter and Turner) from Karyotype Photographs showing clinical features of each syndrome case.
6. Problems relating to the application of binominal theorem in population genetics with reference to P.T.C. and Earlobe attachment.

**ENVIRONMENTAL BIOLOGY**

1. Estimation of Aquatic - Primary productivity - Dark and Light bottle.
2. Estimation of Dissolved oxygen, Salinity, Nitrites, Phosphates, Calcium, Silicates and Alkalinity in water samples.
3. Analysis of Industrial effluent - TDS, TSS, BOD, (COD - Demonstration).
4. Collection, isolation and identification of Plankton.
5. Study of sandy, muddy and rocky shore fauna with special reference to the adaptation to the environment.
6. Animal Association - parasitism, mutualism and commensalisms.
8. An educational tour to:-
  - a). Drinking water treatment plant.
  - b). Effluent treatment plant
  - c). Sewage treatment plant.
  - d). Sandy, Muddy and Rocky Shores.

**BIOTECHNOLOGY**

Visit to Biotechnology Laboratory to observe the demonstration of,

1. Tissue culture.

2. Titration and preparation of virulent phage.
3. Isolation of DNA from the plasmids.
4. Restriction enzymes digestion of DNA.
5. DNA electrophoresis in Agarose gel.

Necessary books may be referred to learn the techniques and to be recorded in the record Note books. Observation of photographs of different instruments used in Biotechnology, their principles and applications.

**CORE ELECTIVE**

**PAPER-2**

**(to Choose either A or B)**

**(A) ENDOCRINOLOGY**

**UNIT-I: Hormones and Hormone Action**

Principles of Endocrinology - The endocrine patient - Principles of Hormone Action - Health Care Reform, Population Health, and the Endocrinologist - Laboratory Techniques for Recognition of Endocrine Disorders.

**UNIT-II: Hypothalamus and Pituitary**

Neuro-endocrinology and Disorders of the Neuro-hypophysis - Pituitary Physiology and Diagnostic Evaluation - Pituitary Masses and Tumors - Posterior Pituitary Gland.

**UNIT-III: Thyroid**

Thyroid Physiology and Diagnostic Evaluation of Patients with Thyroid Disorders - Hyperthyroid Disorders - Hypothyroidism and Thyroiditis - Nontoxic Diffuse Goiter, Nodular Thyroid Disorders, and Thyroid Malignancies - Sick euthyroid syndrome.

**UNIT-IV: Reproduction**

Endocrine changes in pregnancy - Endocrinology of fetal development - Normal and aberrant growth. Puberty, ontogeny, physiology disorders - Hormonal Contraception and fertility control - Testicular Disorders and male reproductive tract - Sexual Dysfunction in Men and Women - Menstrual Disorders and Pelvic Pain - The Menopause Transition and Postmenopausal Hormone Therapy - Hirsutism and Virilization - Gynecologic Malignancies.

**UNIT-V: Polyendocrine and Neoplastic Disorders**

Pediatric Disorders of Sex Development - Normal and Aberrant Growth in Children - Physiology and Disorders of Puberty - Hormones and Athletic Performance - Endocrinology and Aging - Multiple Endocrine Neoplasia. The Immunoendocrinopathy Syndromes - Endocrinology of HIV/AIDS - The Long - Term Endocrine Sequelae of Multimodality Cancer Therapy.

**Course Objectives**

- To understand the objectives of endocrinology. To study the comparative account and functions of endocrine glands of vertebrates Hormone receptors / receptor biology, Molecular biology, Hormonal assays

**Unit-1: (50 to 100 contents)**

- Learning the principles of Endocrinology.
- Studying the function of endocrine glands and vertebrate's hormones.
- Learning and acquiring knowledge of hormonal assay.

**Unit-2: (50 to 100 contents)**

- Acquire knowledge of neuro endocrines.
- Function of hormone action and healthcare.
- Studying the recognition disorders.

**Unit-3: (50 to 100 contents)**

- Understanding thoroughly the physiological function of thyroid gland.
- Deficiencies of thyroid disorders.
- Learning the cancer tissues of thyroid.

**Unit-4: (50 to 100 contents)**

- Study the reproductive biology of embryo.
- Attaining knowledge in fertility control and male and female disorder.

**Unit-5: (50 to 100 contents)**

- Study the Pediatric disorders.
- Learning natural and absent growth in children.
- Understanding the knowledge of immune endocrinopathy syndromes.

**Text Books**

1. Barington (1979) Hormones and evolution Vol I&II Academic press, New York.
2. John F- Laycock and Peter H. Wise, Essential of Endocrinology
3. Wiliaimas R.H.(1974). Textbook of Endocrinology V.Ed. Saunders Press, London.
4. Endocrinology- Hadley
5. General endocrinology Bagrara and Tumer, W.B. Saunders.
6. The Physiology of Reproduction, Vol I& II E.K.Nobil and JU. D.Neil, Raven Press, New York, 1988.
7. Benjamin Levin-Gene VII, Oxford University Press.
8. Lodish et al Molecular Cell Biology

**Reference Items: books, Journal**

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

**E-Materials**

- <https://www.ebooks.com/en-us/subjects/medicine-endocrinology-metabolism-ebooks/1069/>

**Course Out Comes (five outcomes for each units should be mentioned)**

**1. After studied unit-1, the student will be able to understand**

- Understanding the function of endocrine organs, metabolisms and their effects on their body.
- Knowledge the pharmacology and use of insulin.
- Understand the endocrine problems.

**2. After studied unit-2, the student will be able to understand**

- Ability to analyse the related to hormone
- Ability to analyse pituitary disorders.
- Learning the deficiency hypothalamus.

**3. After studied unit-3, the student will be able to understand**

- Learning and acquiring the
- Studying hypo and hyper thyroidsism.
- Understanding the diagnosis of thyroid gland function.

**4. After studied unit-4, the student will be able to understand**

- Acquiring knowledge about reproduction system.
- Learning the reproduction anatomy of physiology.
- Acquire the knowledge of gonadal hormones of physiology.

**5. After studied unit-5, the student will be able to understand list out major places.**

- Enable them to understand child disorders.
- Learning the athletic performance by hormone test.
- Learning about different types of neoplasma and learn about multimodality cancer therapy.

**CORE ELECTIVE**

**PAPER-2**

**(B) BIOCHEMISTRY**

**UNIT-I:**

**WATER AND ANALYTICAL BIOCHEMISTRY**

Water - Biological importance, pH and Acid - Base balance. Henderson Hasselbach equation. Buffers - Biological importance. Acidosis, Alkalosis. Electrolyte and water balance - Regulation of electrolyte content of body fluids and maintenance of pH, reabsorption of electrolytes. Collection and processing of blood and urine samples, Anticoagulants, Preservative for blood and urine, Transport of biological samples.

**UNIT-II:**

**BIOMOLECULES**

Digestion of dietary proteins; Absorption of amino acids; General reactions in the degradation of amino acids; Deamination and transamination reactions; Urea cycle; Glucogenic and ketogenic amino acids; Fate of the carbon skeleton of individual amino acids; Carbohydrate metabolism-Introduction - Normal, fasting and post prandial level, maintenance of blood glucose concentration-hypo and hyperglycemia, renal threshold value. Diabetes Mellitus: types, clinical features, metabolic defects, complications, GTT, galactosemia, fructosuria, glycogen storage diseases. Protein - structure, classification, Properties of protein and biological significance. variation of plasma and serum protein; Clinical features of phenylketonuria, alkaptonuria, albinism and tyrosinosis; Disorders in urea cycle. Lipids - hyper triacylglyceridemia, hypo and hyperlipoproteinemia; Atherosclerosis - clinical features and complications; Lipid storage disease, fatty liver.

**UNIT-III:**

**BIOENERGETICS**

Bioenergetics: Laws of thermodynamics; Concept of free energy, and standard free energy change; Determination of free energy change for a reaction; Equilibrium constant and standard free energy change; Biological oxidation-reduction reactions; Standard reduction potential and its relationship with free energy change. Metabolic pathways: Characteristics of metabolic pathways; Strategies used to study metabolic pathways. High energy compounds: ATP as universal energy currency in biological systems; Processes that generate and utilize ATP in the cell; other high-energy compounds; Role of NADH and NADPH in metabolism. Carbohydrate - structure, classification and biological significance. Lipid - Structure classification and biological significance. METABOLISM 1. Glycogenesis, 2. Glycogenolysis, 3. Glyconeogenesis, 4. Glycolysis, 5. Hexose mono phosphate shunt. Biosynthesis and Oxidation of Fatty Acids. Energetics.

**UNIT-IV:**

**HORMONES/ SIGNALING MOLECULES**

General characteristics of hormones and other signaling molecules; Classification - Steroid Hormones, Protein Hormones, Tissue Hormones, functions, Vasoactive Peptide Synthetic Hormones, mechanism of action and abnormalities of the hormones of thyroid, pancreas, hypothalamus, pituitary and gonads; Hormone replacement therapy; Plant hormones with specific reference to Auxins; Pheromones: types and functions.

**UNIT-V:**

**VITAMINS AND CLINICAL BIOCHEMISTRY**

Water and Lipid Soluble Vitamins - structure, classification, sources and deficiencies. Biochemical functions, requirements and deficiency diseases associated with vitamin B complex,

C and A, D, E & K vitamins in man. Disorders of Carbohydrate Metabolism, Lipids – Digestive diseases – Maldigestion, malabsorption, creatorrhoea, diarrhoea and steatorrhoea. Disorders of liver and kidney – Jaundice, fatty liver, normal and abnormal functions of liver and kidney. Inulin

and urea clearance. Abnormalities in Nitrogen Metabolism - Blood Clotting: Disturbances in blood clotting mechanisms – haemorrhagic disorders – haemophilia, Von Willebrand's disease, purpura, Rendu-Osler-Werber disease, thrombotic thrombocytopenic purpura, disseminated intravascular coagulation, acquired prothrombin complex disorders, circulating anticoagulants. Cancer – Cellular differentiation, carcinogens and cancer therapy.

**Unit-1: (50 to 100 contents)**

- Understand the chemistry of water.
- Describe the chemistry of enzymes.
- Describe the classification of organization of proteins.

**Unit-2: (50 to 100 contents)**

- Understanding of fundamental biochemical principles, functions of biomolecules, metabolic pathways.
- Learning the regulation of biological and biochemical process.

**Unit-3: (50 to 100 contents)**

- To understand the properties of carbohydrates, proteins, lipids, cholesterol, DNA, RNA, and their Biological importance.
- To learn understand concept and mechanisms of ATP Synthesis.

**Unit-4: (50 to 100 contents)**

- Learning different types of Hormones.
- Studying the structure of endocrine glands.
- Acquire knowledge of plant hormones and pheromons.

**Unit-5: (50 to 100 contents)**

- Learn the biochemical changes, deficiency disorders.
- Study the blood clotting mechanisms.
- Learn and study the digestive disease of liver and Kidney.

**Text Books**

1. Practical Clinical Biochemistry- Harold Varley, Fifth edition, CBS Publication  
and Distributors, New Delhi.
2. Medical Biochemistry- Dr. M.N. Chattejee III Edition, 1998 JAYPEE  
BROTHERS, Medica publishers (p) LTD, New Delhi.
3. Essentials of Medical Physiology 7th Edition 2016 by K Sembulingam Prema  
Sembulingam.

4. Biophysical chemistry- Principles and techniques- Upadhyay, Upadyay and Nath

Himalaya publication house Mumbai.

**Reference Items: books, Journal**

1. Textbook of Biochemistry for Medical Students by Vasudevan DM.
2. Murray, R. K, Granner, D.K. Maynes, P.A and Rodweli, V. W. 1998. Harper's Biochemistry. 25th Edition. McGraw Hill, New York.
3. Hames, B. D., Hoopa, N.M and Houghton, J.D. 1998. Instant notes in Biochemistry. Viva Books Pvt. Ltd. New Delhi.
4. Jain, J. L. Jain, S. and Jain N. 2005. Fundamental of Biochemistry, S. Chandra & Co. Ltd. New Delhi.
5. Vasudevan, D.M. and Sreekumar. S. 2000. Text of Biochemistry for Medical students. Jaypee Brothers, Medical Publishers (P) Ltd. New Delhi.
6. Rama Rao, A.V.S.S. 1986. Text Book of Biochemistry. L.K. & S Publishers. A.P.
7. Ambika, S. 1990. Fundamentals of Biochemistry for Medical Students, Published by the author. Lehninger, A.L. 2004. Principles of Biochemistry. CBS Publishers, New Delhi.
8. Zubay, G.1989. Biochemistry. McMillan Publishing Co., New York.
9. Voct, D and Voct, J.G. 2004. Biochemistry. John Wiley and Sons, Inc.
10. Physical chemistry- Puri and Sharma, Pathania Vishal Publication and Co., Jalandhar.

**E-Materials**

- <https://www.ebooks.com/en-us/subjects/science-biochemistry-ebooks/645/>
- <https://www.e-booksdirectory.com/listing.php?category=8>

**Course Out Comes (five outcomes for each units should be mentioned)**

**1.After studied unit-1, the student will be able to**

- Analyse buffer, electrolytes, and water balance.
- Student acquire knowledge to the experiments on blood and urine samples.
- Describe the transport of biological samples.

**2.After studied unit-2, the student will be able to**

- Describe the digestion of protein, absorption, degradation of aminoacids.
- Students can understand the deamination and transmination reactions.
- Student will use current biochemical techniques to plan and molecular techniques.

**3. After studied unit-3, the student will be**

- Exposed to wide range carries that combine biology and medicine.
- Student learn the biological significance of how macro molecules broken down into micro molecules.

**4. After studied unit-4, the student will be able to understand**

- Students were aware of tissues hormones and Synthetic hormones.

**5. After studied unit-5, the student will be able to soluble vitamins.**

- Student can be able to understand the disorders of carbohydrates metabolisms.

**OPEN ELECTIVE (NON-MAJOR ELECTIVE)**

**(to Choose either A or B)**

**PAPER -2**

**(A)VERMICULTURE**

**UNIT I**

Earthworm taxonomy – Morphological and anatomical – Classification of earthworms – Food habits – Digestive system – Excretion – Reproduction and Life cycle – Earthworm as farmer's friend.

**UNIT II**

Types of earthworm – Exotic and native species – South Indian and North Indian species used in Vermicomposting – Collection and Preservation of earthworms for vermicomposting – Culture techniques of earthworms – monoculture and polyculture techniques, factors affecting vermicomposting – pH, moisture, temperature etc.

**UNIT III**

Vermicompost production – Requirements – Different methods of Vermicomposting – Heap method – Pot method and Tray method – types of vermicomposting materials – general procedures in home – maintenance of vermicomposting beds – harvesting the worms – earthworm predators, parasites and pathogens.

**UNIT IV**

Role of Earthworms in soil fertility – Use of Vermicompost for crop production – Use of earthworms in land improvement and land reclamation – Economics of Vermicompost and vermiwash production. Earthworms as animal feed – Medicinal value of earthworm meal – Role of Earthworms in Solid Waste, Sewage waste management and Vermifilters. Earthworms as bioreactors.

**UNIT V**

Interaction of earthworms with other organisms – Influence of chemical inputs on earthworm activities – Large scale manufacture of Vermicompost, packaging of vermicompost and its marketing – Financial supporting – Government and NGOs for vermiculture work

**Course Objectives**

- 1.To acquire knowledge of vermiculture
- 2.To get the thorough knowledge of making vermicompost and vermiculture
3. To create self-employment opportunity.

**Unit-1: (50 to 100 contents)**

- To understand the Earthworm taxonomy.
- To learn the classification of Earthworms.

**Unit-2: (50 to 100 contents)**

- To study the types of Earthworm species.
- Acquire knowledge in collection and preservation and cultural techniques.
- To learn the factors affecting the vermicomposting.

**Unit-3: (50 to 100 contents)**

- Study the methods of vermicomposting.
- Study the equipments of materials for compost materials.
- To study the earth worm predators, parasites and pathogens.

**Unit-4: (50 to 100 contents)**

- To study the role of earthworms in soils.
- To learn the land improvement techniques.
- To know the medicinal value of earthworms.
- Study the role of earthworm in sewage waste management and vermifilters.

**Unit-5: (50 to 100 contents)**

- Understanding the role of worms in modern farming.
- To understand the potential of vermicompost as an alternative to chemical fertilizer.
- To understanding the Economical value of vermicompost techniques and Financial support by governments.

**Text Books**

1. Edwards CA & Bateer JE. 1977. Biology of Earthworms. Chapman & Hall.
2. Edwards CA. 1998. Earthworm Ecology. CRC Press.
3. Sultan A Ismail. 1997. Vermicology-the Biology of Earthworms. Orient Longman.
4. Earthworm in Agriculture – S.C. Talashikar and Dosani, Agrobios Publications, Near Nasarani Cinema, Jodhpur, 342 002.
5. Vermicompost for sustainable Agriculture – P.K. Gupta Agrobios 2nd Edition.

**Reference Items: books, Journal**

1. Edwards CA & Bateer JE. 1977. Biology of Earthworms. Chapman & Hall.
2. Edwards CA. 1998. Earthworm Ecology. CRC Press.
3. Sultan A Ismail. 1997. Vermicology-the Biology of Earthworms. Orient Longman.
4. Earthworm in Agriculture – S.C. Talashikar and Dosani, Agrobios Publications, Near Nasarani Cinema, Jodhpur, 342 002.
5. Vermicompost for sustainable Agriculture – P.K. Gupta Agrobios 2nd Edition.
6. Earthworm ecology – Clive A. Edwards St. Lucie press – CRC Press Washington DC.
7. Biology of Earthworm - Edward and Lofti – Chapman and Hall Publication.

**E-Materials**

- <http://www.vermico.com/ebooks/>
- [https://www.eawag.ch/fileadmin/Domain1/Abteilungen/sandec/E-Learning/Moocs/Solid\\_Waste/W4/Manual\\_On\\_Farm\\_Vermicomposting\\_Vermiculture.pdf](https://www.eawag.ch/fileadmin/Domain1/Abteilungen/sandec/E-Learning/Moocs/Solid_Waste/W4/Manual_On_Farm_Vermicomposting_Vermiculture.pdf)
- <https://www.kobo.com/us/en/ebook/compost-vermicompost-and-compost-tea>

**Course Out Comes (five outcomes for each units should be mentioned)**

**1. After studied unit-1, the student will be able to**

- Understand the worm forming in modern forming.
- Understand potential vermin compost as an alternative to chemical fertilizer.
- Acquire knowledge about the maintaining health of soil and humans.

**2. After studied unit-2, the student will be able to**

- Understand a important role in Economics.
- Understand the role of vermiculture in protecting the environment.
- Student can learn and get the knowledge of composting.

**3. After studied unit-3, the student will be**

- By using vermicompost in their field can increase the crop yield.
- Student residing near by the cities using vermicompost used in small scale for garden.
- By propagating vermicompostion.

**4. After studied unit-4, the student will be**

- The student enables to generate income by supplying worms, vermivash and vermicompost.
- By developing propagating vermicomposting technology to present environmental pollution.
- Learn towards organic forming and healthy food.

**5. After studied unit-5, the student will be**

- To study the interaction of earthworm in the organisms.
- To learn the production of vermicompost for Agriculture.
- To understand the financial support of the Governments.

**OPEN ELECTIVE (NON-MAJOR ELECTIVE)**

**PAPER -2**

**(B) WILDLIFE MANAGEMENT & CONSERVATION**

**Unit I**

**Introduction to Wildlife**

Scope and opportunities of Wildlife Sciences – Major types of forest types of India -Protected areas – Sanctuaries - National Parks – Tiger reserves – Biosphere Reserves and their role.

**Unit II**

**Wildlife Conservation**

IUCN Red Data list – CITES – Endangered Mammals of India & Conservation – Project Tiger & Project Elephant. Conservation of Indian rhino, lion & Thar. Importance of Zoo in Conservation

**Unit III**

**Ornithology**

Terms used in description of Birds Plumage & parts – Types of Bills – Types of feet – Identification of birds in the field based on tail, bill, crest, leg & colour.

**Unit IV**

**Indian Butterflies**

Butterflies & Moths – Identification of types of Swallowtails: Club tails – Roses – Bird wings – Mime – Mormon – Raven - Helen - peacock – Jay – Blue bottles – Sword tails – Zebra. Whites, sulfurs and orange-tips.

**Unit V**

**Important Reserves**

History, Location, Habitats, Fauna and importance of Mudumalai Tiger Reserve – Sathyamangalam Tiger Reserve – KalakkadMundanthurai Tiger Reserve – Anamalai Tiger Reserve – Gulf of Mannar.

**Course Objectives**

- The Course is framed to train the student about various wildlife techniques.
- To train the students to find job opportunities as biologists in reserves.

**Unit-1: (50 to 100 contents)**

- Develop the knowledge of Ecology.
- Develop skill basis, Geological analysis and basic surviving.
- Understanding of forestry.

**Unit-2: (50 to 100 contents)**

- Understand the IUCN data list.
- Understand the conservation of endangered mammal.
- Learn the importance of zoo in conservation.

**Unit-3: (50 to 100 contents)**

- Description of bird plumage and parts.
- Learning of types of bills and types of feet.
- Identify the birds based on tail, bill and crest.

**Unit-4: (50 to 100 contents)**

- Studying the type and characteristics of butterflies.
- Learning the structure and varieties of Indian butterflies

**Unit-5: (50 to 100 contents)**

- To learn the habitats and importance of tiger reserve.
- Learn the forest management related to economy and environment.

**Text Books**

1. Ali S, Ripley SD. Handbook of the birds of India and Pakistan. Compact edition. Oxford University Press and BNHS, Mumbai. Ali, S. and SD Ripley.
2. Caughley G, Sinclair AR. Wildlife ecology and management. Blackwell Science.
3. Divan S, Rosencranz A. Environmental law and policy in India: Cases, materials and statutes. New Delhi: Oxford University Press.
4. Kehimkar ID. Book of Indian butterflies. Oxford University Press; 2008.
5. Prater SH, Barruel P. The book of Indian animals. Bombay: Bombay Natural History Society.

**Reference Items: books, Journal**

1. Ali S, Ripley SD. Handbook of the birds of India and Pakistan. Compact edition. Oxford University Press and BNHS, Mumbai. Ali, S. and SD Ripley.
2. Caughley G, Sinclair AR. Wildlife ecology and management. Blackwell Science.
3. Divan S, Rosencranz A. Environmental law and policy in India: Cases, materials and statutes. New Delhi: Oxford University Press.
4. Kehimkar ID. Book of Indian butterflies. Oxford University Press; 2008.
5. Prater SH, Barruel P. The book of Indian animals. Bombay: Bombay Natural History Society.
6. Sale JB, Berkmüller K. Manual of wildlife techniques for India.

**E- Materials**

- [https://moodle.ufsc.br/pluginfile.php/822773/mod\\_resource/content/1/Wildlife%20Ecology%2C%20Conservation%20and%20Management%20-%20A.%20R.E.%20Sinclair%20J.%20M.%20Fryxell%20G.%20Caughley%20-%20Blackwell%20Publishing.pdf](https://moodle.ufsc.br/pluginfile.php/822773/mod_resource/content/1/Wildlife%20Ecology%2C%20Conservation%20and%20Management%20-%20A.%20R.E.%20Sinclair%20J.%20M.%20Fryxell%20G.%20Caughley%20-%20Blackwell%20Publishing.pdf)
- [https://nndfw.org/Summit%20Presentations%202015/Intro%20to%20wildlife%20management\\_CSmith.pdf](https://nndfw.org/Summit%20Presentations%202015/Intro%20to%20wildlife%20management_CSmith.pdf)
- <http://ifs.nic.in/Dynamic/book/page7.pdf>

**Course Out Comes (five outcomes for each units should be mentioned)**

**1. After studied unit-1, the student will be able to**

- Understand the factors affecting the need to find sustainable practices for producing food.
- How the environment influences plant growth and crop field?
- Learn to modify soil structure and drainage to reduce erosion to reduce the soil erosion.

**2. After studied unit-2, the student will be able to**

- Students can evaluate the current status of endangered mammals.
- Students learn the information of project tiger and project elephant.
- Apply knowledge to solve problems related to wildlife conservation.

**3. After studied unit-3, the student will be able to**

- Identify species, characteristics, habited requirement and life cycle of bird.
- Learn how wildlife conservation and management relates to economy both currently and in future.
- Understand the structure and types of plumage.

**4. After studied unit-4, the student will be able to**

- Identify the types of butterflies.
- Identify the types of moths.

**5. After studied unit-5, the student will be able to**

- Gain awareness and understanding of international forestry.
- Develop skills geographical analysis, basic surviving, mapping.

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