UG ROGRAM (4 Y ears Honors)
CBCS - 2020-21

SUBJECT
ZOOLOGY

Syllabus and Model Question Papers

ETAILS OF PAPER TITLES & CREDITS

Sem	Course no.	Course Name	Course type (T/L/P)	Hrs./Week (Arts/Commerce:5 &Science:4+2)	Credits (Arts/Commerce:4 &Science:4+1)	Max. Marks Cont/ Internal/Mid Assessment	Max. Marks Sem - end Exam
I	1	Animal Diversity – IBiology of Non- Chordates	T	4	4	25	75
		Animal Diversity – IBiology of Non- Chordates Lab	L	2	1	-	50
II	2	Animal Diversity –IIBiology of Chordates	T	4	4	25	75
		Animal Diversity –II Biology of ChordatesLab	L	2	1	-	50
III	3	Cell biology,Genetics, Molecular Biology &Evolution	T	4	4	25	75
		Cell biology,Genetics, Molecular Biology & Evolution Lab	L	2	1	-	50
IV	4	Physiology, CellularMetabolism & Embryology	T	4	4	25	75
		Physiology, Cellular Metabolism & Embryology Lab	L	2	1	-	50
	5	Immunology & Animal Biotechnology	T	4	4	25	75
		Immunology & Animal BiotechnologyLab	L	2	1	-	50
V	6A	Sustainable Aquaculture Management	T	4	4	25	75
		Sustainable Aquaculture Management Lab	L	2	1	-	50
	7A	Post Harvest Technologyof Fish And Fisheries	T	4	4	25	75
		Postharvest Technology of Fish And Fisheries Lab	L	2	1	-	50
	OR						
	6B	Live Stock Management-I (Biology of Dairy Animals)	T	4	4	25	75
		Live Stock Management-I Lab (Biology of Dairy Animals)	L	2	1	-	50
	7B	Live Stock Management -II (Dairy Production and Management)	T	4	4	25	75
		Live Stock Management -II Lab (Dairy Production and Management)	L	2	1	-	50
	OR						
	6C	Poultry Management- I (Poultry Farming)	T	4	4	25	75
		Poultry Management- I Lab (Poultry Farming)	L	2	1	-	50

	7C	Poultry Management- II (Poultry Production and Management	T	4	4	25	75
		Poultry Management- II Lab (Poultry Production and Management	L	2	1	-	50
	OR						
	6D	Seri Culture -I***	T	4	4	25	75
		Seri Culture -I Lab	L	2	1	-	50
	7D	Seri Culture -II	T	4	4	25	75
		Seri Culture -II Lab	L	2	1	-	50

Note: *Course type code: T: Theory, L: Lab, P: Problem solving

Note 1: For Semester–V, for the domain subject **ZOOLOGY**, any one of the three pairs of SECs shall be chosen as courses 6 and 7, i.e., 6A & 7A or 6B & 7B or 6C & 7C or 6D&7D. The pair shall not be broken (ABC allotment is random, not on any priority basis).

Note 2: One of the main objectives of Skill Enhancement Courses (SEC) is to inculcate field skills related to the domain subject in students. The syllabus of SEC will be partially skill oriented. Hence, teachers shall also impart practical training to students on the field skills embedded in the syllabus citing related real field situations.

Note 3: To insert assessment methodology for Internship/ on the Job Training/Apprenticeship under the revised CBCS as per APSCHE Guidelines.

- **First internship (After 1st Year Examinations):** Community Service Project. To inculcate social responsibility and compassionate commitment among the students, the summer vacation in the intervening 1st and 2nd years of study shall be for Community Service Project (the detailed guidelines are enclosed).
- **Credit For Course: 04**

- **Second Internship (After 2nd Year Examinations):** Apprenticeship / Internship / on the job training / In-house Project / Off-site Project. To make the students employable, this shall be undertaken by the students in the intervening summer vacation between the 2nd and 3rd years (the detailed guidelines are enclosed).
- **Credit For Course: 04**

- **Third internship/Project work (6th Semester Period):**
  During the entire 6th Semester, the student shall undergo Apprenticeship / Internship / On the Job Training. This is to ensure that the students develop hands on technical skills which will be of great help in facing the world of work (the detailed guidelines are enclosed).
- **Credit For Course:12**

B. Sc	Semester: I	Credits:4
Paper: 1	Animal Diversity – Biology of Nonchordates	Hrs/Wk:4

Course Outcomes: By the completion of the course the graduate should able to –

- Describe general taxonomic rules on animal classification
- Classify Protozoa to Coelenterata with taxonomic keys
- Classify Phylum Platyhemninthes to Annelida phylum usingexamples from parasitic adaptation and vermin composting
- Describe Phylum Arthropoda to Mollusca using examples andimportance of insects and Molluscans
- Describe Echinodermata to Hemichordate with suitable examples andlarval stages in relation to the phylogeny

Learning objectives

- To understand the taxonomic position of protozoa to helminthes.
- To understand the general characteristics of animalsbelonging to protozoa to hemichordate.
- To understand the structural organization of animal'sphylum from protozoa to hemichordate.
- To understand the origin and evolutionary relationship of different phyla from protozoa to hemichordate.
- To understand the origin and evolutionary relationship of different phylum from annelids to hemichordates.

UNIT I:

Principles of Taxonomy – Binomial nomenclature – Rules of nomenclature Whittaker's five kingdom concept and classification of Animal Kingdom.

Phylum Protozoa: General Characters and classification of protozoa up to species level with suitable examples Locomotion, nutrition and reproduction in Protozoan's *Elphidium (typestudy)*

UNIT II:

Phylum Porifera: General characters and classification up to species level with suitable examples Skelton in Sponges Canal system in sponges

Phylum Coelenterate: General characters and classification up to species level with suitable examples Mutagenesis in *Obelia,* Polymorphism in coelenterates, Corals and coral reefs formation

Phylum Ctenophore: General Characters and Evolutionary significance (affinities)

UNIT III:

Phylum Platy helminthes: General characters and classification up to species level with suitable examples Life cycle and pathogen city of *Fasciolahepatica* Parasitic Adaptations in helminthes

Phylum Nemathelminthes: General characters and classification up to species level with suitable examples Life cycle and pathogen city of *Ascaris lumbricoides*

UNIT IV:

Phylum Annelida: General characters and classification up to species level with suitable examples *Hirudinaria granulosa*- External characters, digestive system, excretory system and reproductive system, Evolution of Coelom and Coelomoducts, Vermiculture - Scope, significance, earthworm species, processing, Vermicompost, economic importance of vermin compost

Phylum Arthropoda : General characters and classification up to species level with suitable examples Prawn-External characters, appendages, respiratory system and circulatory system Vision and respiration in Arthropoda, Metamorphosis in Insects *Peripatus*- Structure and affinitiesSocial Life in Bees and Termites

UNIT V:

Phylum Mollusca: General characters and classification up to species level with suitable examples ,Pearl formation in Pelecypoda, Sense organs in Mollusca,Torsion in gastropods

Phylum Echinodermata: General characters and classification up to species level with suitable examples, Water vascular system in starfish, Larval forms of Echinodermata

Phylum Hemichordate: General characters and classification up to species level with suitable examples, *Balanoglossus* - Structure and affinities

Co-curricular activities (suggested)

- Preparation of chart/model of phylogenic tree of life, 5-kingdom classification, *Elphidium* life cycle etc.
- Visit to Zoology museum or Coral island as part of Zoological tour
- Charts on life cycle of *Obelia*, polymorphism, spongespicules
- Clay models of canal system in sponges
- Preparation of charts on life cycles of *Fasciola* and *Ascaris*
- Visit to adopted village and conducting awareness campaign on diseases, to people as part of Social Responsibility.
- Plaster-of-Paris or Thermocol model of *Periapt's*
- Construction of a vermicompost in each college, manufacture of manure by students and donating to local farmers
- Models of compound eye, bee hive and terminarium (termitaria) by students
- Visit to apiculture centre and short-term training as part of apprenticeship programme of the govt. of Andhra Pradesh
- Chart on pearl forming layers using clay orThermocol
- Visit to a pearl culture rearing industry/institute
- Live model of water vascular system
- Phylogeny chart on echinoderm larvae and their evolutionary significance
- Preparation of charts depicting the feeding mechanism, 3coeloms, tornarialarvaetc., of *Balanoglossus.*

REFERENCE BOOKS:

1. L.H. Hyman '*The Invertebrates' Vol I, II and V.* – M.C. Graw Hill Company Ltd.
2. Kotpal, R.L. 1988 - 1992 Protozoa, Porifera, Coelenterata, Helminthes,Arthropoda, Mollusca, Echinodermata. Rastogi Publications, Meerut.
3. E.L. Jordan and P.S. Verma '*Invertebrate Zoology'* S. Chand and Company.
4. R.D. Barnes '*Invertebrate Zoology'* by: W.B. Saunders CO.,1986.
5. Barrington. E.J.W., '*Invertebrate structure and Function'* by ELBS.
6. P.S. Dhami and J.K. Dhami. Invertebrate Zoology. S. Chand and Co. New Delhi.
7. Parker, T.J. and Haswell'*A text book of Zoology'* by, W.A., Mac Millan Co.London.
8. Barnes, R.D. (1982). *Invertebrate Zoology*, VEdition"

B. Sc	Semester: I	Credits:1
Paper: 1(L)	Animal Diversity – Biology of Nonchordates Lab	Hrs/Wk:2

Learning Outcomes:

- To understand the importance of preservation of museum specimens
- To identify animals based on special identifying characters
- To understand different organ systems through demo or virtual dissections
- To maintain a neat, labeled record of identified museum specimens

Syllabus:

1. **Study of museum slides / specimens / models (Classification of animals up to orders)**

   Protozoa: Amoeba, *Paramecium, Paramecium Binary fission and Conjugation, Vorticella, Entamoebahistolytica, Plasmodium vivax*
   Porifera: *Sycon, Spongilla, Euspongia, Sycon*- T.S & L.S, Spicules, Gem mule
   Coelenterata: *Obelia – Colony & Medusa, Aurelia, Physalia, Velella, Corallium, Gorgonia, Pennatula*v.
   Platyhelminthes: *Planaria, Fasciola hepatica, Fasciola*larval forms – Miracidium, Redia, Cercaria, *Echinococcusgranulosus, Taeniasolium, Schistosomahaematobium*vii.
   Nemathelminthes: *Ascaris (Male & Female), Drancunculus, Ancylostoma,Wuchereria*
   Annelida: *Nereis, Aphrodite, Chaetopteurs, Hirudinaria,* Trochophore larva
   Arthropoda: Cancer, Palaemon**,** Scorpion, *Scolopendra, Sacculina, Limulus, Periapt's,* Larvae - Nauplius, Mysis, Zoea, Mouth parts of male &female *Anopheles* and *Culex,* Mouthparts of Housefly and Butterfly. xiii.
   Mollusca: *Chiton, Pila, Unio, Pteredo, Murex, Sepia, Loligo, Octopus, Nautilus,* Glochidium larva
   Echinodermata: *Asterias, Ophiothrix, Echinus, Clypeaster, Cucumaria, Ante don,* Bipinnaria larva
   Hemichordata: *Balanoglossus,* Tornaria larva.
2. **Dissections:**
   Prawn: Appendages, Digestive system, Nervous system, Mounting of Statocyst
   Insect Mouth Parts
   Laboratory Record work shall be submitted at the time of practicalamination

   An **"Animal album**" containing photographs, cut outs, with appropriate write up about the above mentioned taxa. Different taxa/ topics may be given to differentsets of students for thispurpose
   Computer - aided techniques should be adopted or show virtual dissections

RFERENCE MANUALS:

1. Practical Zoology- Invertebrates S.S.Lal
2. Practical Zoology - Invertebrates P.S.Verma
3. Practical Zoology - Invertebrates K.P.Kurl
4. Ruppert and Barnes (2006) Invertebrate Zoology,8th Edition, Holt SaundersInternational Edition

B. Sc	Semester: II	Credits:4
Paper: 2	Animal Diversity – Biology of Chordates	Hrs/Wk:4

Course Outcomes: By the completion of the course the graduate should able to -

- Describe general taxonomic rules on animal classification of chordates
- Classify Protochordata to Mammalian with taxonomic keys
- Understand Mammals with specific structural adaptations
- Understand the significance of dentition and evolutionary significance
- Understand the origin and evolutionary relationship of different phyla from Prochordata to mammalian.

Learning objectives

- To understand the animal kingdom.
- To understand the taxonomic position of Protochordata to Mammalian.
- To understand the general characteristics of animals belonging to Fishes to Reptilians.
- To understand the body organization of Chordata.
- To understand the taxonomic position of Protherian mammals.

UNIT I:

General characters and classification of Chordata upto species level Protochordata- Salient features of Cephalochordate, Structure of *Branchiostoma* Affinities of Cephalochordate. Salient features of Urochordata Structure and life history of *Herdmania* Retrogressive metamorphosis –Process and Significance.

UNIT II:

Cyclostomata, General characters, Comparison of *Petromyzon* and *Myxine* Pisces: General characters and classification of Fishes upto species level ***Scoliodon*****:** External features, Digestive system, Respiratory system, Structure and function of Heart, Structure and functions of the Brain. Migration in Fishes Types of Scales Dipnoi.

UNIT III:

General characters of Amphibian Classification of Amphibian upto species level with examples. ***Ranahexadactyla*****:** External features, Digestive system, Respiratory system, Structure and function of Heart, structure and functions of the Brain

Reptilia: General characters of Reptilia, Classification of Reptilia upto species level with examples

Calotes: External features, Digestive system, Respiratory system, Structure and function of Heart, structure and function of Brain Identification of Poisonous and non-poisonous snakes and Skull in reptiles.

UNIT IV:

Aves: General characters and classification of Aves upto species level *Columba livia*: External features, Digestive system, Respiratory system, Structure and function of Heart, structure and function of Brain Migration in Birds Flight adaptation in birds.

UNIT V:

General characters of Mammalian Classification of Mammalian upto species level with examples Comparison of Prototherians, Metatherians and Eutherians Dentition in mammals

Co-curricular activities (suggested)

- Preparation of charts on Chordate classification (with representative animal photos) and retrogressive metamorphosis
- Thermocol or Clay models of Herdmania and Amphioxus
- Visit to local fish market and identification of local cartilaginous and bony fishes
- Maintaining of aquarium by students
- Thermocol model of fish heart and brain
- Preparation of slides of scales of fishes
- Visit to local/nearby river to identify migratory fishes and prepare study notes
- Preparation of Charts on above topics by students (Eg: comparative account of vertebrate heart/brain/lungs, identification of snakes etc.)
- Collecting and preparation of Museum specimens with dead frogs/snakes/lizards etc., and/or their skeletons
- Additional input on types of snake poisons and their antidotes (student activity).
- Collection of bird feathers and submission of report on Plumology
- Taxidermic preparation of dead birds for Zoology museum
- Map pointing of prototherian and metatherianmammals
- Chart preparation for dentition in mammals.

REFERENCE BOOKS:

1. J.Z. Young, 2006. The life of vertebrates. (The Oxford University Press, New Delhi). 646 pages. Reprinted
2. Arumugam, N. Chordate Zoology, Vol. 2. Saras Publication. 278 pages. 200 figs.
3. A.J. Marshall, 1995. Textbook of zoology, Vertebrates. (The McMillan PressLtd., UK). 852 pages. (Revised edition of Parker &Haswell,1961).
4. M. Ekambaranatha Ayyar, 1973. A manual of zoology. Part II. (S. ViswanathanPvt. Ltd.,Madras).
5. P.S. Dhami& J.K. Dhami, 1981. Chordate zoology. (R. Chand & Co.). 550pages.
6. Gurdarshan Singh & H. Bhaskar, 2002. Advanced Chordate Zoology. Campus Books, 6 Vols., 1573 pp., tables, figs.
7. A.K. Sinha, S. Adhikari& B.B. Ganguly, 1978. Biology of animals. Vol. II. Chordates. (New Central Book Agency, Calcutta). 560 pages.
8. R.L.Kotpal, 2000. Modern textbook of zoology, Vertebrates. (Rastogi Publ., Meerut).632pages.
9. E.L. Jordan & P.S. Verma, 1998. Chordate zoology. (S. Chand & Co.). 1092pages.
10. G.S. Sandhu, 2005. Objective Chordate Zoology. Campus Books, vii, 169pp.
11. Sandhu, G.S. & H. Bhaskar, H. 2004. Textbook of Chordate Zoology. Campus Books, 2 vols., xx, 964 p.,figs.
12. Veena, 2008. Lower Chordata. (Sonali Publ.), 374 p., tables, 117 figs.

B. Sc	Semester: II	Credits:1
Paper: 2(L)	Animal Diversity – Biology of Chordates Lab	Hrs/Wk:2

Learning Outcomes:

- To understand the Taxidermic and other methods of preservation of chordates
- To identify chordates based on special identifying characters
- To understand internal anatomy of animals through demo or virtual dissections, thus directing the student for "empathy towards the fellow living beings"
- To maintain a neat, labelled record of identified museum specimens

Observation of the Following Slides / Spotters / Models

- Protochordata: *Herdmania, Amphioxus, Amphioxus* T.S through pharynx.
- Cyclostomata: *Petromyzon and Myxine.*
- Pisces: *Pristis, Torpedo, Hippocampus, Exocoetus, Echeneis, Labeo, Catla, Claries, Channa,Anguilla.*
- Amphibian: *Ichthyophis, Amblystoma, Axolotl larva,Hyla,*
- Reptilia: *Draco, Chameleon, Uromastix, Testudo, Trionyx, Russels viper,Naja*
- Krait, *Hydrophis, Crocodile.*
- Aves: *Psittacula, Eudynamis, Bubo, Alcedo.*
- Mammalian: *Ornithorhynchus, Pteropus, Funambulus.*

Dissections-

1. *Scoliodon* IX and X, Cranial nerves
2. *Scoliodon* Brain
3. Mounting of fish scales

Note: 1. Dissections are to be demonstrated only by the faculty or virtual.

2. Laboratory Record work shall be submitted at the time of practical examination.

REFERENCE BOOKS:

1. S.S.Lal, Practical Zoology –Vertebrate
2. P.S.Verma, A manual of Practical Zoology – Chordata

B. Sc	Semester: III	Credits:4
Paper: 3	Cell Biology, Genetics, Molecular Biology and Evolution	Hrs/Wk:4

Course Outcomes:

The overall course outcome is that the student shall develop deeper understanding of what life is and how it functions at cellular level. This course will provide students with a deep knowledge in Cell Biology, Animal Biotechnology and Evolution and by the completionof the course the graduate shall able to–

- To understand the basic unit of the living organisms and to differentiate the organisms by their cell structure.
- Describe fine structure and function of plasma membrane and different cell organelles of eukaryotic cell.
- To understand the history of origin of branch of genetics, gain knowledge on heredity, interaction of genes, various types of inheritance patterns existing in animals
- Acquiring in-depth knowledge on various of aspects of genetics involved in sex determination, human karyo typing and mutations of chromosomes resulting in various disorder.
- Understand the central dogma of molecular biology and flow of genetic information from DNA to proteins.
- Understand the principles and forces of evolution of life on earth, the process of evolution of new species and apply the same to develop new and advanced varieties of animals for the benefit of the society.

Learning Objectives

- To understand the origin of cell and distinguish between prokaryotic and eukaryotic cell.
- To understand the role of different cell organelles in maintenance of life activities.
- To provide the history and basic concepts of heredity, variations and gene interaction.
- To enable the students distinguish between polygenic, sex-linked, and multiple allelic modes of inheritance.
- To acquaint student with basic concepts of molecular biology as to how characters are expressed with a coordinated functioning of replication, transcription and translation in all living beings.
- To provide knowledge on origin of life, theories and forces of evolution.
- To understand the role of variations and mutations in evolution of organisms.

UNIT I:

Cell Biology: Definition, history, prokaryotic and eukaryotic cells, virus, viroids, mycoplasma Electron microscopic structure of animal cell. Plasma membrane –Models and transport functions of plasma membrane. Structure and functions of Golgi complex, Endoplasmic Reticulum and Lysosomes Structure and functions of Ribosomes, Mitochondria, Nucleus, Chromosomes

(Note: 1. General pattern of study of each cell organelle – Discovery, Occurrence,Number, Origin, Structure and Functions with suitable diagrams**)**

2. Need not study cellular respiration under mitochondrial functions)

UNIT II:

Genetics-I: Mendel's work on transmission of traits Gene Interaction – Incomplete Dominance, Codominance, Lethal Genes Polygene's (General Characteristics & examples); Multiple Alleles (General Characteristics and Blood group inheritance Sex determination (Chromosomal, Genic Balance, Hormonal, Environmental and Haplo- diploidy types of sex determination) Sex linked inheritance (X-linked, Y-linked & XY-linked inheritance)

UNIT III:

Genetics - II: Mutations &Mutagenesis, Chromosomal Disorders (Autosomal and Allosomal) Human Genetics – Karyo typing, Pedigree Analysis(basics)Basics on Genomics and Proteomics

UNIT IV:

Molecular Biology: Central Dogma of Molecular BiologyBasic concepts of-

1. DNA replication – Overview (Semi-conservative mechanism, Semi- discontinuous mode, Origin & Propagation of replication fork)
2. Transcription in prokaryotes – Initiation, Elongation and Termination, Post-transcriptional modifications(basics)
3. Translation – Initiation, Elongation and Termination Gene Expression in prokaryotes (Lac Operon); Gene Expression in eukaryotes

UNIT V:

Origin of life Theories of Evolution: Lamarckism, Darwinism, Germ Plasm Theory, Mutation Theory Neo-Darwinism: Modern Synthetic, Theory of Evolution, Hardy-Weinberg Equilibrium Forces of Evolution: Isolating mechanisms, Genetic Drift, Natural Selection, Speciation

Co-curricular activities (Suggested)

- Model of animal cell
- Working model of mitochondria to encourage creativity among students
- Photo album of scientists of cell biology
- Charts on plasma membrane models/cell organelles
- Observation of Mendelian / Non-Mendelian inheritance in the plants of college botanical garden or local village as a student study project activity
- Observation of blood group inheritance in students, from their parents and grandparents
- Karyo typing and preparation of pedigree charts for identifying diseases in family history
- Charts on chromosomal disorders
- Charts on central dogma/lac Operon/geneticcode
- Model of semi-conservative model of DNA replication
- Model of tRNA and translationechanism
- Power point presentation of transcription or any other topic by students
- Draw geological time scale and highlight important events along the timeline
- Chart on industrial melanism to teach directed selection, Darwin's finches to teach genetic drift, collection of data on weight of children born in primary health centres to teach stabilizing selection etc.

REFERENCE BOOKS:

1. Lodish, Berk, Zipursky, Matsudaria, Baltimore, Darnell 'Molecular Cell Biology' W.H.Freeman and company New York.
2. Cell Biology by DeRobertis
3. Bruce Alberts, Molecular Biology of the Cell
4. Rastogi, Cytology
5. Varma & Aggarwal, Cell Biology
6. C.B. Pawar, Cell Biology
7. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008).Principles of Genetics. VIII Edition. Wiley India.
8. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wileyand SonsInc.
9. Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). Concepts of Genetics. X Edition. Benjamin Cummings.
10. Russell, P. J. (2009). Genetics- A Molecular Approach. III Edition. BenjaminCummings.
11. Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. Introductionto Genetic Analysis. IX Edition. W. H. Freeman andCo.
12. Ridley, M. (2004). Evolution. III Edition. Blackwell Publishing

13. Molecular Biology by freifielder
14. Instant Notes in Molecular Biology by Bios scientific publishers and Viva BooksPrivate Limited
15. Hall, B. K. and Hallgrimsson, B. (2008). Evolution. IV Edition. Jones and BartlettPublishers
16. Campbell, N. A. and Reece J. B. (2011). Biology. IX Edition, Pearson, Benjamin,Cummings.
17. Douglas, J. Futuyma (1997). Evolutionary Biology. Sinauer Associates.
18. Minkoff, E. (1983). Evolutionary Biology. Addison-Wesley.
19. James D. Watson, Nancy H. Hopkins 'Molecular Biology of the Gene'
20. Jan M. Savage. Evolution, 2nd ed, Oxford and IBH Publishing Co., New Delhi.
21. Gupta P.K..'Genetics

B. Sc	Semester: III	Credits:1
Paper: 3(L)	Cell Biology, Genetics, Molecular Biology and Evolution Lab	Hrs/Wk:2

Learning Objectives:

Acquainting and skill enhancement in the usage of laboratory microscope Hands-on experience of different phases of cell division by experimentation Develop skills on human Karyo typing and identification of chromosomal disorders
To apply the basic concept of inheritance for applied research
To get familiar with phylogeny ad geological history of origin & evolution of animals

I. Cell Biology

1. Preparation of temporary slides of Mitotic divisions with onion root tips
2. Observation of various stages of Mitosis and Meiosis with prepared slides
3. Mounting of salivary gland chromosomes of *Chiranomous*

II. Genetics

1. Study of Mendelian inheritance using suitable examples and problems.
2. Problems on blood group inheritance and sex linked inheritance.
3. Study of human Karyo types (Down's syndrome, Edwards, syndrome, Patausyndrome, Turner's syndrome and Klinefelter syndrome).

III. Evolution

1. Study of fossil evidences.
2. Study of homology and analogy from suitable specimens and pictures.
3. Phylogeny of horse with pictures.
4. Study of Genetic Drift by using examples of Darwin's finches(pictures).
5. Visit to Natural History Museum and submission of report.

REFERENCE BOOKS:

1. Burns GW. 1972. *The Science of Genetics. An Introduction to Heredity.* Mac MillanPubl.Co.Inc.
2. Gardner EF. 1975. *Principles of Genetics.* John Wiley & Sons, Inc. NewYork.
3. Harth and Jones EW. 1998. *Genetics – Principles and Analysis.* Jones and BarHett Publ.Boston.
4. Levine L. 1969. *Biology of the Gene.*Toppan.
5. Pedder IJ. 1972. *Genetics as a Basic Guide*. W. Norton & Company,Inc.
6. Rastogi VB. 1991. *A Text Book of Genetics.*KedarNath Ram Nath Publications, Meerut, Uttar Pradesh,India.
7. Rastogi VB. 1991. *Organic Evolution.*KedarNath Ram Nath Publications,Meerut,Uttar Pradesh,India.
8. Stahl FW. 1965. *Mechanics of Inheritance.* Prentice-Hall.
9. White MJD. 1973. *Animal Cytology and Evolution.* Cambridge Univ.Press.

B. Sc	Semester: IV	Credits:4
Paper: 4	**Animal Physiology, Cellular Metabolism** and **Embryology**	Hrs/Wk:4

Course Outcomes:

This course will provide students with a deep knowledge in Physiology, Cellular metabolism and Molecular Biology and by the completion of the course the graduate shall able to –

- Understand the functions of important animal physiological systems including digestion, cardio-respiratory and renal systems.
- Understand the muscular system and the neuro-endocrine regulation of animal growth, development and metabolism with a special knowledge of hormonal control of human reproduction.
- Describe the structure, classification and chemistry of Biomolecules and enzymes responsible for sustenance of life in living organisms
- Develop broad understanding the basic metabolic activities pertaining to the catabolism and anabolism of various Biomolecules
- Describe the key events in early embryonic development starting from the formation of gametes upto gastrula ion and formation of primary germ layers.

Learning Objectives

- To achieve a thorough understanding of various aspects of physiological systems andtheir functioning in animals.
- To instil the concept of hormonal regulation of physiology, metabolism andreproduction in animals.
- To understand the disorders associated with the deficiency of hormones
- To demonstrate a thorough knowledge of the intersection between the disciplines of Biology and Chemistry.
- To provide insightful knowledge on the structure and classification of carbohydrates, proteins, lipids and enzymes
- To demonstrate an understanding of fundamental biochemical principles such as the function of Biomolecules, metabolic pathways and the regulation of biochemical processes
- To make students gain proficiency in laboratory techniques in biochemistry and orient them to apply the scientific method to the processes of experimentation and hypothesis testing.

UNIT I:

Animal Physiology -I: Process of digestion and assimilation, Respiration - Pulmonary ventilation, transport of oxygen and CO_2, (Note: Need not study cellular respiration here), Circulation - Structure and functioning of heart, Cardiac cycle, Excretion - Structure and functions of kidney urine formation, counter currentMechanism

UNIT II:

Animal Physiology -II: Nerve impulse transmission - Resting membrane potential, origin and propagation of action potentials along myelinated and non-myelinated nerve fibers. Muscle contraction - Ultra structure of muscle, molecular and chemical basis of muscle contraction. Endocrine glands - Structure, functions of hormones of pituitary, thyroid, parathyroid, adrenal glands and pancreas, Hormonal control of reproduction in a mammal

UNIT III:

Cellular Metabolism – I(Biomolecules) Carbohydrates - Classification of carbohydrates. Structure of glucose Proteins - Classification of proteins. General properties of amino acids Lipids - Classification of lipids. Enzymes: Classification and Mechanism of Action

UNIT IV:

Cellular Metabolism –II: Carbohydrate Metabolism - Glycolysis, Krebs cycle, Electron Transport Chain, Glycogen metabolism, Gluconeogenesis, Lipid Metabolism – Synthesis of fatty acids, β-oxidation of palmitic acidProtein metabolism - Transamination, Deamination and Urea Cycle

UNIT V:

Embryology: Gametogenesis Fertilization, Types of eggs Types of cleavages,Development of Frog upto formation of primary germ layers

Co-curricular activities (Suggested)

- Chart on cardiac cycle, human lung, kidney/nephron structure etc.
- Working model of human / any mammalian heart.
- Chart of sarcomere/location of endocrine glands in human body
- Chart affixing of photos of people suffering from hormonal disorders
- Student study projects such as identification of incidence of hormonal disorders in the local primary health centre, studying the reasons thereof and measures to curb or any other as the lecturer feels good in nurturing health awareness among students
- Chart on structures of Biomolecules/types of amino acids (essential and non- essential) Chart preparation by students on Glycolysis / kerb's cycle/urea cycle etc.
- Model of electron transport chain
- Preparation of models of different types of eggs in animals
- Chart on frog embryonic development, fate map of frog blastula, cleavage etc.

REFERENCE BOOKS:

1. Eckert H. *Animal Physiology: Mechanisms and Adaptation.* W.H. Freeman &Company.
2. Floray E. *An Introduction to General and Comparative Animal Physiology.* W.B. Saunders Co., Philadelphia.
3. Goel KA and Satish KV. 1989. *A Text Book of Animal Physiology,* Rastogi Publications, Meerut,U.P.
4. Hoar WS. *General and Comparative Physiology.* Prentice Hall of India, NewDelhi.
5. Lehninger AL. Nelson and Cox. *Principles of Biochemistry.* Lange MedicalPublications, NewDelhi.
6. Prosser CL and Brown FA. *Comparative Animal Physiology.* W.B. SaundersCompany,Philadelphia.
7. Developmental Biology byBalinksy
8. Developmental Biology by GerardKarp
9. Chordate embryology by Varma andAgarwal
10. Embryology by V.B.Rastogi
11. Austen CR and Short RV. 1980. *Reproduction in Mammals*. Cambridge UniversityPress.
12. Gilbert SF. 2006. *Developmental Biology,* 8th Edition. Sinauer Associates Inc., Publishers, Sunderland,USA.
13. Longo FJ. 1987. *Fertilization.* Chapman & Hall, London.
14. Rastogi VB and Jayaraj MS. 1989. *Developmental Biology.* KedaraNath Ram Nath Publishers, Meerut, UttarPradesh.
15. Schatten H and Schatten G. 1989. *Molecular Biology of Fertilization.* AcademicPress, NewYork.

B. Sc	Semester: IV	Credits:1
Paper: 4(L)	Animal Physiology, Cellular Metabolism and Embryology Lab	Hrs/Wk:2

Learning Objectives:

- Identification of an organ system with histological structure
- Deducing human health based on the information of composition of blood cells
- Demonstration of enzyme activity *invitro*
- Identification of various Biomolecules of tissues by simple colorimetric methods and also quantitative methods
- Identification of different stages of earl embryonic development in animals

I. Animal physiology

1. Qualitative tests for identification of carbohydrates, proteins and fats
2. Study of activity of salivary amylase under optimum conditions
3. T.S. of duodenum, liver, lung, kidney, spinal cord, bone and cartilage
4. Differential count of human blood

II. Cellular metabolism

1. Estimation of total proteins in given solutions by Lowry's method.
2. Estimation of total carbohydrate by Anthrone method.
3. Qualitative tests for identification of ammonia, urea and uric acid
4. Protocol for Isolation of DNA in animal cells

III. Embryology

1. Study of T.S. of testis, ovary of a mammal
2. Study of different stages of cleavages (2, 4, 8 cell stages)
3. Construction of fate map of frog blastula

REFERENCE BOOKS:

- Harper's Illustrated Biochemistry
- Cell and molecular biology: Concepts & experiments. VI Ed. John Wiley &sons. Inc.
- Lab Manual on Blood Analysis and Medical Diagnostics, S. Chand and Co. Ltd.
- Laboratory techniques by Plummer

B. Sc	Semester: IV	Credits:4
Paper: 5	Immunology and Animal Biotechnology	Hrs/Wk:4

Course Outcomes:

This course will provide students with a deep knowledge in immunology, genetics, embryology and ecology and by the completion of the course the graduate shall able to –

- To get knowledge of the organs of Immune system, types of immunity, cells and organs of immunity.
- To describe immunological response as to how it is triggered (antigens) and regulated(antibodies)
- Understand the applications of Biotechnology in the fields of industry and agriculture including animal cell/tissue culture, stem cell technology and genetic engineering.
- Get familiar with the tools and techniques of animal biotechnology.

Learning Objectives

- To trace the history and development of immunology
- To provide students with a foundation in immunological processes
- To be able to compare and contrast the innate versus adaptive immune systems and humoral versus cell-mediated immune responses
- Understand the significance of the Major His to compatibility Complex in terms of immune response and transplantation
- To provide knowledge on animal cell and tissue culture and their preservation
- To empower students with latest biotechnology techniques like stem cell technology, genetic engineering, hyridoma technology, transgenic technology and their applicationin medicine and industry for the benefit of living organisms
- To explain *in vitro* fertilization, embryo transfer technology and other reproduction manipulation methodologies.
- To get insight in applications or recombinant DNA technology in agriculture, production of therapeutic proteins.
- To understand principles of animal culture, media preparation.

UNIT I:

Immunology – I (Overview of Immune system): Introduction to basic concepts in Immunology, Innate and adaptive immunity, Vaccines and Immunization programme , Cells of immune system,Organs of immune system

UNIT II: Immunology – II (Antigens, Antibodies, MHC and Hypersensitivity)

Antigens: Basic properties of antigens, B and T cell epitomes, happens and adjuvant; Factors influencing immunogenicity

Antibodies: Structure of antibody, Classes and functions of antibodies Structure and functions of major his to compatibility complexes, Exogenous and Endogenous pathways of antigen presentation and processing Hypersensitivity – Classification and Types

UNIT III:

Techniques: Animal Cell, Tissue and Organ culture media: Natural and Synthetic media, Cell cultures: Establishment of cell culture (primary culture, secondary culture, types of cell lines; Protocols for Primary Cell Culture); Established Cell lines (common examples such as MRC, HeLa, CHO, BHK, Vero); Organ culture; Cryopreservation of cultures

Stem cells: Types of stem cells and applications, Hybridoma Technology: Production & applications of Monoclonal antibodies (mAb)

UNIT IV:

Applications of Animal Biotechnology: Genetic Engineering: Basic concept, Vectors, Restriction Endo nucleases andRecombinant DNA technology

Gene delivery: Microinjection, electroportion, biolistic method (gene gun), liposome and viral-mediated gene delivery

Transgenic Animals: Strategies of Gene transfer; Transgenic - sheep, fish; applications Manipulation of reproduction in animals: Artificial Insemination, *Invitro* fertilization, super ovulation, Embryo transfer, Embryo cloning

UNIT V:

PCR: Basics of PCR.

DNA Sequencing: Sanger's method of DNA sequencing- traditional and automated sequencing (2hrs)

Hybridization techniques: Southern, Northern and Western blotting DNA fingerprinting: Procedure and applications

Applications in Industry and Agriculture: Fermentation: Different types of Fermentation and Downstream processing;

Agriculture: Monoculture in fishes, polyploidy in fishes

Co-curricular activities (suggested)

- Organizing awareness on immunization importance in local village in association with NCC and NSS teams.
- Charts on types of cells and organs of immune system
- Student study projects on aspects such as – identification of allergies among students (hypersensitivity), blood groups in the class (antigens and antibodies duly reported) etc., as per the creativity and vision of the lecturer and students
- Visit to research laboratory in any University as part of Zoological tour and exposure and/ or hands-on training on animal cell culture.
- Visit to biotechnological laboratory in University or any central/state institutes and create awareness on PCR, DNA finger printing and blot techniques or Visit to a fermentation industry or Visit to a local culture pond and submit report on culture of fishes etc.

REFERENCE BOOKS:

1. Immunology by Ivan M.Riott
2. Immunology by Kubey
3. Sree krishna V. 2005. *Biotechnology –I, Cell Biology and Genetics*. New AgeInternational Publ. New Delhi, India.

B. Sc	Semester: IV	Credits:1
Paper: 5(L)	Immunology and Animal BiotechnologyLab	Hrs/Wk:2

Learning Objectives:

a. Acquainting student with immunological techniques vis-à-vis theory taught in the classroom
b. Interconnect the theoretical and practical knowledge of immunity with the outer world for the development of a healthier life.
c. Demonstrate basic laboratory skills necessary for Biotechnology research
d. Promoting application of the lab techniques for taking up research in higher studies

I. Immunology

1. Demonstration of lymphoid organs (as per UGC guidelines)
2. Histological study of spleen, thymus and lymph nodes (through prepared slides)
3. Blood group determination
4. Demonstration of

    a. ELISA
    b. Immune electrophoresis

II. Animal biotechnology

1. DNA quantification using DPA Method.
2. Techniques: Western Blot, Southern Hybridization, DNA Fingerprinting
3. Separation, Purification of biological compounds by paper, Thin-layer and Column chromatography
4. Cleaning and sterilization of glass and plastic wares for cell culture.
5. Preparation of culture media.

REFERENCE BOOKS:

1. Immunology Lab Biology 477 Lab Manual; Spring 2016 Dr. Julie Jameson
2. Practical Immunology A Laboratory Manual; **LAP LAMBERT AcademicPublishing**
3. Manual of laboratory experiments in cell biology by Edward
4. Laboratory Techniques by Plummer

MODEL QUESTION PAPERS(Semester - End)

B .Sc DEGREE EXAMINATIONS

SEMESTER - I

Course - 1:ANIMAL DIVERSITY – BIOLOGY OF NONCHORDATES

Time: 3hrs. **Max. Marks: 75**

Section - A

Answer any FIVE of the following: **5x5=25M**

Draw labeled diagrams wherever necessary

1. Bionomial nomenclature
2. Whittaker's concept
3. Hexactinellida
4. Polymorphism
5. Parasitic adaptations
6. Coelom and coelomic ducts
7. Cephalic appendages in Prawn
8. Pearl formation

Section - B

Answer ALL the following: **5x10=50**

Draw labeled diagrams wherever necessary

9. a. Describe the structure and life history of *Elphidium.*

OR

b. Classify the phylum Protozoa with suitable examples up to species level.

10. a. Describe various types of canal systems in sponges.

OR

b. Write an essay on corals and coral reef formation.

11. a. Write in detail about the life history of *Fasciola hepatica.*

OR

b. Discuss the life cycle of Ascaris lumbricoides. Add a note on its Pathogenecity.

12. a. Explain the process and economic importance of vermiculture.

OR

b. Describe the structure of *Peripatus.* Add a note on its affinities.

13. a. Give an account on water vascular system in star fish.

OR

b. Write in detail about the structure and affinities of Balanoglossus.

MODEL QUESTION PAPERS(Semester - End)

B .Sc DEGREE EXAMINATIONS

SEMESTER - II

Course - 2: **ANIMAL DIVERSITY – BIOLOGY OF CHORDATES**

Time: 3hrs. **Max. Marks: 75**

Section - A

Answer any FIVE of the following: **5x5=25M**

Draw labeled diagrams wherever necessary

1. *Amphioxus*
2. Placoidscale
3. Quillfeather
4. Prototheria
5. Anadromousmigration
6. *Draco*
7. Emu
8. Apoda

Section - B

Answer ALL the following: **5x10=50M**

Draw labeled diagrams wherever necessary

9. a. Explain the life history of Herdmania

OR

b. Explain the origin and general characters of chordates

10. a. Compare the characters of *Petromyzon* and *Myxine*

OR

b. Describe the structure of heart in *Scoliodon*

11. a. Describe the brain of *Ranahexadactyla*

OR

b. Explain the external features of *Calotes*

12. a. Write an essay on flight adaptations in birds

OR

b. Explain the respiratory system of *Columba livia*

13. a. Compare the characters of Metatheria and Eutheria

OR

b. Write an essay on dentition in mammals

MODEL QUESTION PAPERS(Semester - End)

B .Sc DEGREE EXAMINATIONS

SEMESTER - III

Course - 3: **CELL BIOLOGY, GENETICS, MOLECULAR BIOLOGY AND EVOLUTION**

Time: 3hrs. **Max. Marks: 75**

Section - A

Answer any FIVE of the following: **5x5=25**

Draw labeled diagrams wherever necessary

1. Prokaryotic cell
2. Golgi complex
3. Polygenes
4. Multiple alleles
5. Mutations
6. Karyotyping
7. Lac operon concept
8. Genetic drift

Section - B

Answer ALL the following: **5x10=50**

Draw labeled diagrams wherever necessary

9. a. Describe the ultra structure of animal cell

OR

b. Explain the structure of mitochondria. Add a note on its functions.

10. a. Write an essay on gene interactions

OR

b. Discuss sex linked inheritance.

11. a. What are chromosomal disorders? Explain various types of autosomal and allosomal disorders

OR

12. a. Give an account of DNA replication.

OR

b. Explain the mechanism of Prokaryotic transcription.

13. a. An essay on modern synthetic theory of evolution.

OR

b. Define isolation. Discuss various isolating mechanisms.

MODEL QUESTION PAPERS(Semester - End)

B .Sc DEGREE EXAMINATIONS

SEMESTER - IV

Course - 4: **ANIMAL PHYSIOLOGY, CELLULAR METABOLISM AND EMBRYOLOGY**

Time: 3hrs. **Max. Marks: 75**

Section - A

Answer any FIVE of the following: **5x5=25**

Draw labeled diagrams wherever necessary

1. Assimilation
2. Cardiac cycle
3. Ultra structure of muscle
4. Pancreas
5. Structure of glucose
6. Lipids
7. Gluconeogenesis
8. Types of eggs

II.Section - B

Answer ALL the following: **5x10=50**

Draw labeled diagrams wherever necessary

9. a. Explain the process of digestion.

OR

b. Describe the structure and function of heart

10. a. Give an account of nerve impulse transmission.

OR

b. Write an essay on the hormonal control of reproduction in mammals

11. a. Write an essay on the classification of carbohydrates

OR

b. Classify the enzymes. Discuss the mechanism of enzyme action.

12. a. Write an account on Kreb's cycle.

OR

b. Explain B- oxidation of palmitic acid

13. a. Discuss the process of fertilization.

OR

b. Write an essay on gameto genesis.

MODEL QUESTION PAPERS(Semester - End)

B .Sc DEGREE EXAMINATIONS

SEMESTER - IV

Course - 5: **IMMUNOLOGY AND ANIMAL BIOTECHNOLOGY**

Time: 3hrs. **Max. Marks: 75**

Section - A

Answer any FIVE of the following: **5x5=25**

Draw labeled diagrams wherever necessary

1. Vaccines
2. Primary lymphoid organs
3. Hapten
4. Hypersensitivity
5. Natural media
6. Cell lines
7. Endo nucleases
8. Polyploidy in fishes

Section - B

Answer ALL the following: **5x10=50**

Draw labeled diagrams wherever necessary

9. a. Define immunity. Write in detail about innate immunity.

OR

b. Explain various cells of immune system

10. a. Describe the structure of antibody. Add a note on their functions.

OR

b. Describe the structure of MHC molecules. Discuss their role in the mechanism of exogeneous and endogeneous pathway of antigen processing and presentation

11. a. Write an essay on different types of stem cells and their applications

OR

b. Explain the production and applications of monoclonal antibodies.

12. a. Write an account on recombinant DNA technology.

OR

b. Write an essay on transgenic animals

13. a. Explain hybridization techniques.

OR

b. Write an essay on PCR.

B. Sc	**Semester: V**(Skill Enhancement Course - Elective)	**Credits:4**
Paper: 6A	**Sustainable Aquaculture Management**	**Hrs/Wk:4**

Learning Outcomes:

Students at the successful completion of this course will be able to

- Evaluate the present status of aquaculture at the Global level and National level
- Classify different types of ponds used in aquaculture
- Demonstrate induced breeding of carps
- Acquire critical knowledge on commercial importance of shrimps
- Identify fin and shell fish diseases

II. Syllabus: (Total Hours: 90 including Teaching, Lab, Field Skills Training, Unit tests etc.)

UNIT I:

1.1 Present status of Aquaculture – Global and National scenario
1.2 Major cultivable species for aquaculture: freshwater, brackish water and marine.
1.3 Traditional, extensive, modified extensive, semi-intensive and intensive cultures of fish and shrimp.
1.4 Design and construction of fish and shrimp farms

UNIT II:

2.1 Functional classification of ponds – head pond, hatchery, nursery ponds
2.2 Functional classification of ponds -rearing, production, stocking and quarantine ponds
2.3 Need of fertilizer and manure application in culture ponds
2.4 Physio-chemical conditions of soil and water optimum for culture (Temperature, depth, turbidity, light, water, PH, BOD, CO2 and nutrients)

UNIT III:

3.1. Induced breeding in fishes
3.2. Culture of Indian major carps: Pre-stocking management (Dewatering, drying, ploughing/desilting; redators, weeds and algal blooms and their control, Liming and fertilization)
3.3. Culture of Indian major carps - Stocking management
3.4. Culture of Indian major carps - post-stocking management

UNIT IV:

4.1 Commercial importance of shrimp & prawn
4.2 Macrobrachium rosenbergii- biology, seed production.
4.3 Culture of L. vannamei – hatchery technology and culture practices
4.4 Mixed culture of fish and prawns

UNIT V:

5.1 Viral diseases of Fin Fish & shell fish
5.2 Fungal diseases of Fin & Shell fish
5.3 Bacterial diseases of Finfish & Shell fish
5.4 Prophylaxis in aquaculture

REFERENCES:

1. Pillay TVR & M.A.Dill, 1979. Advances in Aquaculture. Fishing News Books Ltd., London
2. Stickney RR 1979. Principles of Warm Water Aquaculture. John Wiley & Sons Inc.1981
3. Boyd CE 1982. Water Quality Management for Pond Fish Culture. Elsivier Scientific Publishing Company.
4. Bose AN et.al. 1991. Costal Aquaculture Engineering. Oxford & IBH Publishing Company Pvt. Ltd.

Web Links:

1. http://www.fao.org/fishery/docs/CDrom/FAO_Training/FAO_Training/General/x6708e/x6708e06.htm
2. http://aquaticcommons.org/1666/1/Better-Practice3_opt.pdf
3. https://www.notesonzoology.com/india/fishery/fish-diseases-symptoms-and-control-fishery/871

B. Sc	**Semester: V**(Skill Enhancement Course - Elective)	**Credits:1**
Paper: 6A	**Sustainable Aquaculture Management Lab**	**Hrs/Wk:2**

Learning Outcomes:
On successful completion of this practical course, student shall be able to:

- Identify the characaters of Fresh water cultivable species
- Etimate physico chemical characateristics of water used for aquaculture
- Examine the diseases of fin and shell fish
- Suggest measures to prevent diseases in aquaculture

Practical (Laboratory) Syllabus: (30hrs) (Max.50Marks)

1. Fresh water Cultivable species any (Fin & Shell Fish Specimens – Observation of morphological characters by observation and drawings)-5

2. Brackish water cultivable species (Fin &Shell fish- Specimens- Observation of Morphological Character by observing drawing) -5

3. Hands on training on the use of kits for determination of water quality in aquaculture (DO, Salinity, pH, Turbidity- Testing kits to be used for the estimation of various parameters/ Standard procedure can be demonstrated for the same)

4. Demonstration of Hypophysation(Procedure of hypophysation to be demonstrated in the practical lab with any edible fish as model)

5. Viral diseases of Fin & Shell Fish (Observation of his to pathological slides / Charts/ Models of viral pathogens in fin/ shell fish – one edible specimen can be used for observation of same in the laboratory)

6. Bacterial diseases of Fin & Shell Fish (Observation of his to pathological slides / Charts/ Models of Bacterial pathogens in fin/ shell fish – One edible specimen can be used for observation of same in the laboratory)

7. Fungal diseases of Fin & Shell Fish (Observation of his to pathological slides / Charts/ Models of Bacterial pathogens in fin/ shell fish – One edible specimen can be used for observation of same in the laboratory)

LAB REFERENCES

1. Boyd CE 1982. Water Quality Management for Pond Fish Culture. Elsevier Scientific Publishing Company
2. http://www.fao.org/fishery/docs/CDrom/FAO_Training/FAO_Training/General/x6708e/x6708e06.htm
3. http://aquaticcommons.org/1666/1/Better-Practice3_opt.pdf
4. https://www.notesonzoology.com/india/fishery/fish-diseases-symptoms-and-control-fishery/871

Web resources suggested by the teacher concerned and the college librarian including reading material

Co-Curricular Activities

a) Mandatory:(Student training by teacher in field skills: Total 15 hrs., Lab:10 + field 05)

1. For Teacher: Training of students by the teacher in laboratory/field fornotlessthan15 hours on Breeding-Induced breeding in carps -hatchery technology of L. Vennami- Farming techniques- disease diagnostic techniques—concepts –Demonstration @ any aqua laboratory
2. For Student: Students shall (individually) visit a Hatchery/Farm/ Aqua diagnostic center and make careful observations of the process method and implements- protocols and report on the same in 10 pages hand written Fieldwork/Project work Report.
3. Max marks for Fieldwork/Project work Report: 05.
4. Suggested Format for Fieldwork/Project work: Title page, student details, index page, details of place visited, observations made, findings and acknowledgements.
5. (IE).Unit tests.

b) Suggested Co-Curricular Activities

1. Preparation of Model/Charts of Cultivable species of fin fish shell fish
2. Preparation of Model/Chart of Ideal fish Pond- with the standards prescribed.
3. Observation of aquaculture activities in their area (Observation of any activity related to aquaculture in the vicinity of the college/village)
4. Preparation of Model – charts of Fin /Shell fish Diseases with eco-friendly material.
5. Assignments, Group discussion, Seminar, Quiz, Collection of Material, Video preparation etc., Invited lecture

MODEL QUESTION PAPERS(Semester - End)

B .Sc DEGREE EXAMINATIONS

SEMESTER - V (Skill Enhancement Course - Elective)

Course - 6A: **Sustainable Aquaculture Management**

Time: 3hrs. **Max. Marks: 75**

Section - A

Answer any FIVE of the following: **5x5=25M**

1. History of Aquaculture
2. Brackish water aquaculture
3. Culture species of Sea weeds
4. Organic Manures
5. Water Quality
6. Fungal diseases of Fin fish
7. Post stocking Management
8. Procurement of seed for stalking

Section - B

Answer ALL the following: **5x10=50M**

9. a. What is the current status of aquaculture at global and National level?

OR

b. Describe the layout of fish farm.

10. a. Explain the construction and management methods of nursery ponds.

OR

b. Write a detailed account on the need of fertilizer and manure application in culture ponds.

11 a. Write an essay on Induced breeding

OR

b. Discuss the culture of Indian Major Carps.

12 a. Give an account of commercial importance of Shrimp culture.

OR

b. Write an essay on mixed culture of fishes.

13. a. Describe the viral diseases of shell fishes.

OR

b. Write about bacterial diseases of Fin fishes.

B. Sc	**Semester: V**(Skill Enhancement Course - Elective)	**Credits:4**
Paper: 7A	**Postharvest Technology of Fish and Fisheries**	**Hrs/Wk:4**

Learning Outcomes:

Students at the successful completion of this course will be able to

- Identify the types of preservation methods employed in aquaculture
- Choose the suitable Processing methods in aquaculture
- Maintain the standard quality control protocols laid down in aqua industry
- Identify the best Seafood quality assurance system

Syllabus: Total Hours: 90 including Teaching, Lab, Field Skills Training, Unit tests etc.)

UNIT I: Handling and Principles of fish Preservation

1. 1 Handling of fresh fish, storage and transport of fresh fish, post mortem changes (rigor mortis and spoilage), spoilage in marine fish and freshwater fish.

1.2 Principles of preservation – cleaning, lowering of temperature, rising of temperature, denudation, use of salt, use of fish preservatives, exposure to low radiation of gamma rays.

UNIT II: Methods of fish Preservation

2.1 Traditional methods - sun drying, salt curing, pickling and smoking.

2.2. Advanced methods – chilling or icing, refrigerated sea water, freezing, canning, irradiation and Accelerated Freeze drying (AFD).

UNIT III: Processing and preservation of fish and fish by-products

3.1 Fish products – fish minced meat, fish meal, fish oil, fish liquid (ensilage), fish protein concentrate, fish chowder, fish cake, fish sauce, fish salads, fish powder, pet food from trash fish, fish manure.

3.2 Fish by-products – fish glue, Using glass, chitosan, pearl essence, shark fins, fish Leather and fish maws.

UNIT IV: Sanitation and Quality control

4.1 Sanitation in processing plants - Environmental hygiene and Personal hygiene in processing plants.

4.2 Quality Control of fish and fishery products – pre-processing control, control during processing and control after processing.

UNIT V: Quality Assurance, Management and Certification

5.1. Seafood Quality Assurance and Systems: Good Manufacturing Practices (GMPs); Good Laboratory Practices (GLPs); Standard Operating Procedures (SOPs); Concept of Hazard Analysis and Critical Control Points (HACCP) in seafood safety.

5.2 National and International standards – ISO 9000: 2000 Series of Quality Assurance System, Codex Aliment Arius.

REFERENCES:

1. Santharam R, N Sukumaran and P Natarajan 1987. A manual of aquaculture, Oxford- IBH, NewDelhi
2. Lakshmi Prasad's, Fish Processing Technology 2012, Arjun Publishing House
3. Dr Sunitha Rai, Fish Processing Technology, 2015, Random Publications
4. Safety and Quality Issues in Fish Processing (Woodhead Publishing Series in Food Science,Technology and Nutrition)by H A Bremner
5. K.A Mahanthy, Innovations in Fishing and Fish Processing Technologies, January 2021

Web Resources:

1. http://ecoursesonline.iasri.res.in/mod/page/view.php?id=145743
2. https://ecourses.icar.gov.in/e-Leaarningdownload3_new.aspx?Degree_Id=03

B. Sc	**Semester: V**(Skill Enhancement Course - Elective)	**Credits:1**
Paper: 7A	**Postharvest Technology of Fish and Fisheries Lab**	**Hrs/Wk:2**

Learning Outcomes: On successful completion of this practical course, student shall beable to:

- Identify the quality of aqua processed products.
- Determine the quality of fishery by products by observation
- Analyze the protocols of aqua processing methods

Practical (Laboratory) Syllabus:

1. Evaluation of fish/ fishery products for organo leptic, chemical and microbial quality.
2. Preparation of dried, cured and fermented fish productsFor detailed procedure method visit sites:
3. Examination of salt, protein, moisture in dried / cured products
4. Examination of spoilage of dried / cured fish products, marinades, pickles, sauce.
5. Preparation of isinglass, collagen and chitosan from shrimp and crab shell.
6. Developing flow charts and exercises in identification of hazards – preparation of hazardanalysis worksheet
7. Corrective action procedures in processing of fish- flow chart- work sheet preparation

(** Refer the following web sites for complete procedure method and estimations of abovelisted practicals)

REFERENCES:

1. Dr Sunitha Rai, Fish Processing Technology, 2015, Random Publications
2. https://ecourses.icar.gov.in/e-Leaarningdownload3_new.aspx?Degree_Id=03
3. https://vikaspedia.in/agriculture/fisheries/post-harvest-and-marketing/processing-in-fisheries/fermented-products
4. https://krishi.icar.gov.in/jspui/bitstream/123456789/20500/1/Fermentation%20technology%20for%20fish.pdf
5. http://jebas.org/00200620122014/Abujam%20et%20al%20JEBAS.pdf
6. https://krishi.icar.gov.in/jspui/bitstream/123456789/20770/1/Training%20Manual_Hygienic
7. %20drying%20and%20packing%20of%20fish.pdf
8. https://krishi.icar.gov.in/jspui/bitstream/123456789/20770/1/Training%20Manual_Hygienic
9. %20drying%20and%20packing%20of%20fish.pdf
10. https://agritech.tnau.ac.in/fishery/fish_byproducts.html
11. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5352841/
12. http://www.fao.org/3/i1136e/i1136e.pdf
13. http://www.fao.org/3/x5989e/X5989e01.htm#What%20is%20sensory%20assessment)

Web resources suggested by the teacher concerned and the college librarian including readingmaterial

Co-Curricular Activities

a) **Mandatory:** *(Lab/field training of students by teacher (lab 10 + field 05):*

1. For Teacher: Training of students by the teacher in laboratory/fieldfornotlessthan15hourson various steps of post-harvest techniques of fishes, on the advanced techniques in post-harvest technology – Training of students on other employability skills in the Post-harvest sector of Aquaculture Industry-like Processing, Packing, marketing of processed aqua products.
2. For Student: Students shall (individually) visit - Any fish/shrimp Processing Plant/Packing industry and make observations on post harvesting techniques and submit a brief handwritten Fieldwork/Project work Report with pictures and data /survey in 10 pages.
3. Max marks for Fieldwork/Project work Report: 05.
4. Suggested Format for Fieldwork/Project work: *Title page, student details, index page, details of place visited, observations made, findings and acknowledgements*
5. (IE): Unit tests,

b) Suggested Co-Curricular Activities

1. Observation of fish/shrimp processing plants – visit web sites of processing companies and record the details of that Unit
2. Interaction with local fishermen to know the method of preservation and details with the available traditional technology
3. Collection of web resources on the Quality assurance, quality control measures in Aqua Industries-cross checking the standards during the visit to any processing units.
4. Assignments, Seminar, Group discussion. Quiz, Collection of Material, Invited lecture, Video preparation etc.,

MODEL QUESTION PAPERS(Semester - End)

B .Sc DEGREE EXAMINATIONS

SEMESTER - V (Skill Enhancement Course - Elective)

Course - 7A: **Postharvest Technology of Fish and Fisheries**

Time: 3hrs. **Max. Marks: 75**

Section - A

Answer any FIVE of the following: **5x5=25M**

1. Storage and transport of fresh fish
2. Sun drying
3. Canning
4. Fish glue
5. Preparation of Agar
6. Fish liver oil
7. Quality control of fishery products
8. GMP's and SOP's

Section - B

Answer ALL the following: **5x10=50M**

9. a. Write an essay on Principles of Post harvesting technology.

OR

b. Explain the spoilage in marine and fresh water fish.

10 a. Describe the Traditional methods of Fish preservation.

OR

b. Write about advanced methods of fish preservation.

11. a. Enlist the important fish products.

OR

b. Give an account of fish by-products.

12 a. Discuss the sanitation in processing plants of Post harvesting technology.

OR

b. Write an essay on quality control of fish and fishery products.

13 a. Explain the sea food quality assurance and systems.

OR

b. Discuss the national and international standards of quality assurance system ISO 9000 : 2000 series of quality assurance system.