DEPARTMENT OF ZOOLOGY

M.Sc - ZOOLOGY

CURRICULUM AND SYLLABUS

(CBCS PATTERN)

Effective from the academic year 2019-2020

KANCHI MAMUNIVAR CENTRE FOR POSTGRADUATE STUDIES
(AUTONOMOUS)
Ranked 49 in INDIA RANKING 2019 - NIRF
(College with Potential for Excellence)
Reaccredited by NAAC with 'B ++' Grade (Third Cycle)
Puducherry

M.Sc. ZOOLOGY

SCHEME OF PAPERS FOR ALL THE FOUR SEMESTERS UNDER CBCS

Semester	Course	Code	Title of Paper	Hours / Week (30)	Credits	Total Credits
S1	Hard Core Course I	ZOHT101	Structure and functions of Invertebrata	4	4	24
	Hard Core Course II	ZOHT102	Structure and functions of Chordata.	4	4	
	Hard Core Course III	ZOHT103	Biomolecule and Structural Biology	4	4	
	Hard Core Course IV	ZOHT104	Cell and Molecular Biology	4	4	
	Soft Core	ZOSC105	Public Health and Hygiene / Economic Zoology	4	4	
	Practical I	ZOHP106	Practical - I. (ZOHT101 to ZOHT104)	8	4	
S2	Hard Core Course I	ZOHT201	Genetics	4	4	25
	Hard Core Course II	ZOHT202	Endocrinology	4	4	
	Hard Core Course III	ZOHT203	Animal Ecology and Ethology	4	4	
	Hard Core Course IV	ZOHT204	Animal Physiology.	4	4	
	Soft core	ZOSC205	Public Health and Hygiene (For others only)	4*	4*	
	Practical II	ZOHP206	Practical – II (ZOHT201 to ZOHT 204)	8	4	
	Internship Programme	ZOSI 207	Summer Internship Programme#	-	1	
S3	Hard Core Course I	ZOHT301	Developmental Biology	4	4	24
	Hard Core Course II	ZOHT302	Immunology	4	4	
	Hard Core Course III	ZOHT303	Fisheries and Aquaculture	4	4	
	Soft Core	ZOSC304	Fish Preservation and Value Addition Techniques	4	4	
	Soft Core	ZOSC305	Environmental Toxicology/ Health Profession Education (Interdisciplinary: for others also)	4	4	
	Practical III	ZOHP306	Practical - III (ZOHT301 to ZOHT304)	8	4	
S4	Hard Core Course I	ZOHT401	Biological Techniques and Bioinformatics	4	4	20
	Hard Core Course II	ZOHT402	Evolution and Conservation Biology	4	4	
	Hard Core Course III	ZOPW403	Individual Project - Dissertation	18	9	
	Hard Core Course IV	ZOPV404	Individual Project – *VivaVoce*	-	1	
	Practical IV	ZOHP405	Practical - IV (ZOHT401& ZOHT402)	4	2	
	Soft Core	ZOSC406	Aquariculture (Interdisciplinary: for others only)	3*	3*	
	Total					**93**

*Soft core ZOSC205 Public Health and Hygiene and ZOSC307Aquariculture are offered only for students of other departments.

#Summer Internship ZOSI207 - Duration of Internship - Two weeks

M.Sc. DEGREE
SCHEME OF EXAMINATION (WITH EFFECT FROM JULY 2019)

CONTINUOUS INTERNAL ASSESSMENT (CIA)
THEORY (SEMESTER)

1. Threetests	:	5+5+5 = 15 Marks
2. End Semester Model Examination	:	15 Marks
3. Seminar / Assignment	:	10 Marks
Total	:	40 Marks

CONTINUOUS INTERNAL ASSESSMENT (CIA)
PRACTICAL (SEMESTER)

1. Threetests	:	5+5+5 = 15 Marks
2. End Semester Model practical Exam	:	15 Marks
3. Record Submission	:	10 Marks
Total	:	40 Marks

FOR THEORY AND PRACTICALS

	Maximum Marks	Minimum Marks 40%	Pass Mark (in Aggregate)
Internal	**40**	**16**	
External	**60**	**24**	**50**
Total	**100**		

TOTAL MARKS FOR M. Sc. PROJECT - 200 Marks

INTERNAL	:	50 Marks
PROJECT	:	100 Marks (External)
VIVA	:	50 Marks (External)
Total	:	200 Marks

Internal Marks Split up

Topicselection	:	5 Marks
Experimentation/Data collection	:	10 Marks
Punctuality	:	5 Marks
Compilation	:	10 Marks
Content	:	10 Marks
Presentation	:	10 Marks

Total : 50 Marks

M.Sc. ZOOLOGY DEGREE

THEORY QUESTION PAPER (END OF EACH SEMESTER)

Time: 3 hours. Maximum: 60 Marks

SECTION – A (5 x 2 = 10 Marks)

Answer ALL questions, each in not more than 50 words

Define / Explain the following(Minimum one question from each unit)

SECTION – B (4 x 5 = 20 Marks)

(Answer ALL questions (Internal Choice), **each in not more than 200 words**

(Minimum one question from each unit)

SECTION – C (3 x 10 = 30 Marks)

Answer any **THREE** questions(5 questions to be given), **each in not more than 1000 words**

(Minimum one question from each unit)

PRACTICAL EXAMINATION (END OF EACH SEMESTER)

Time: 3 Hours Maximum: 60 Marks

Question I	Practical Exercise - 15 (10+5)
Questions II	Practical Exercise - 10 (7+3)
Questions III	Spotters (5x 3) - 15
Question IV	Record - 10
Question V	Viva Voce - 10

DEPARTMENT OF ZOOLOGY, KMCPGS.

M.Sc. PROGRAMME
SCHEME OF PAPERS AND MARK ALLOTMENT

Sl. No.	Paper Code	Title of Paper	Internal Mark	External Mark	Total Marks
Semester I					
1	ZOHT101	Structure and functions of Invertebrata	40	60	100
2	ZOHT102	Structure and functions of Chordata.	40	60	100
3	ZOHT103	Biomolecule and Structural Biology	40	60	100
4	ZOHT104	Cell and Molecular Biology	40	60	100
5	ZOSC105	Public Health and Hygiene / Economic Zoology	40	60	100
6	ZOHP106	Practical - I. (ZOHT101 to ZOHT104)	40	60	100
Semester II					
7	ZOHT201	Genetics	40	60	100
8	ZOHT202	Endocrinology	40	60	100
9	ZOHT203	Animal Ecology and Ethology	40	60	100
10	ZOHT204	Animal Physiology.	40	60	100
11	ZOSC205	Public Health and Hygiene (For others only)	40	60	100
12	ZOHP206	Practical – II (ZOHT201 to ZOHT 204)	40	60	100
13	ZOSI 207	Summer Internship Programme	-	-	-
Semester III					
14	ZOHT301	Developmental Biology	40	60	100
15	ZOHT302	Immunology	40	60	100
16	ZOHT303	Fisheries and Aquaculture	40	60	100
17	ZOSC 304	Fish Preservation and Value Addition Techniques	40	60	100
18	ZOSC305	Environmental Toxicology/ Health Profession Education (Interdisciplinary: for others also)	40	60	100
19	ZOHP306	Practical - III (ZOHT301 to ZOHT304)	40	60	100
Semester IV					
20	ZOHT401	Biological Techniques and Bioinformatics	40	60	100
21	Z0HT402	Evolution and Conservation Biology	40	60	100
22	ZOPW 403	Individual Project - Dissertation	50	100	150
23	ZOPV404	Individual Project – *Viva Voce*	-	50	50
24	ZOHP405	Practical - IV (ZOHT401& ZOHT402)	40	60	100
25	ZOSC406	Aquariculture (Interdisciplinary: for others only)	40	60	100
		Total	**930**	**1470**	**2400**

Semester I
Hard Core Course I

Code: ZOHT 101- STRUCTURE AND FUNCTIONS OF INVERTEBRATA

No. of hours/ week 4 **Credits 4**

OBJECTIVES

To give a thorough understanding in the principles and practice of taxonomy and systematics of animals.

To enlighten the students with adequate scientific details on lower and higher invertebrate organizations and their adaptations.

UNIT I Taxonomy: International Code of Zoological Nomenclature. Connecting links in Invertebrates. Species concepts in Taxonomy.Trends in taxonomy - Chemotaxonomy, cytotaxonomy and molecular taxonomy, Dendrogram, Cladistics - 3 domain classification - Recent developments in animal taxonomy.

UNIT II Lower Invertebrata I: General organization of animals – Protozoan parasites in relation to human health - Sponges – Canal system - Origin of Metazoa.

UNIT III Lower Invertebrata II: Polymorphism - Evolutionary significance of larvae of Coelenterata - Origin of Bilateria - Helminth parasites- Adaptations.

UNIT IV Higher Invertebrata: Metamerism and excretion in Annelids, Significance of Trochophore - Parasitic Arthropods - Larval forms of Arthropods –Torsion in molluscs -Larval forms of Echinoderms.

Recommended Books

1. Barrington, E.J.W. 1983. Invertebrate structure and function. Thomas Nelson and Sons Ltd., London.
2. Hyman, L.H. 1962. The Invertebrates. Vol, 2 . McGraw Hill Co., New York.
3. Barnes, R.D. 1987. Invertebrates Zoology, V edition. W.B. Saunders Co. Philadelphia.
4. Kapoor, V.C.2010. Theory and Practice of Animal Taxonomy. Oxford & IBH Pub. New Delhi
5. Jordan E.L & Verma, P.S. 2018. Invertebrate Zoology. S. Chand Publications. New Delhi
6. Kotpal R.L.2016. Modern Textbook of Invertebrates. Rastogi Publications, New Delhi

7 Russel-Hunter, W.D. 1962.A Biology of higher Invertebrates, the Macmillan Co. Ltd., London.
8 Read, C.P. 1975. Animal Parasitism. Prentice Hall Inc., New Jersey.
9 Sedgwick, A.A. 1972. Student Text Book of Zoology. Vol. I, II and III. Central Book Depot, Allahabad.
10 Simpson, G.G. 1966. Principle of animal taxonomy. Oxford IBH Publication Company, New Delhi

SemesterI
Hard Core Course II

Code: ZOHT 102STRUCTURE AND FUNCTIONS OF CHORDATA

No. of hours/ week 4 **Credits 4**

OBJECTIVES

To comprehend the origin and structural organization of protochordata and vertebrates.

To study the salient features and adaptations of vertebrata.

UNIT I Origin and characteristic features of Chordates: Protochordata – Classification upto orders:Structural organization of Cephalochordates, Hemichordata and Urochordata – interrelationships and affinities.

UNIT II Pisces and Amphibia: Fins in Fishes; Evolution of fishes; Integumentary system in vertebrates; Jaw suspension.Origin of Amphibia; Neoteny in Amphibia; Terrestrial adaptations in Amphibia

UNIT III Reptilia and Aves: Reptilia: Dinosaurs – origin, evolution and extinction.General characteristics of birds– feathers, beak and feet; Origin and evolution of birds.

UNIT IV Mammalia: Salient features of Mammalia, Prototheria, Metatheria and Eutheria, Flying mammals with special reference to bat; aquatic mammals with special reference to dolphin.

Recommended Books

1. Weischert, C.K., 1965. Anatomy of Chordates, McGraw Hill Book Co., Inc., NewYork.
2. Kenneth V. Kardong, 2015. Vertebrates: Comparative Anatomy, Function, Evolution 7thEdition.Tata McGraw Hill Education Pvt. Ltd. New York.
3. Ekambaranatha Ayyer and Ananthakrishnan. 2008. Manual of Zoology - Chordata. Volume II. S. Viswanathan (Printers and Publishers) Pvt. Ltd. Chennai
4. Jordan E. L and Verma, P.S. 2016. Chordate Zoology. S. Chand publications. New Delhi
5. Kotpal R.L.2014. Modern Textbook of Zoology. Rastogi Publications. New Delhi
6. John Zachary Young, 2001. The Life of Vertebrates, Oxford University Press, New Delhi

7. Arnold G.K and Frye.B.E. 1977. Chordate structure and function. Second edition. Macmillan Pub Co, UK
8. Romer, A.S., 1979. Hyman's Comparative Vertebrate Anatomy, 3rd Edition, The University of Chicago Press, London.
9. VirenderTomar, 2012, Anatomy of Vertebrates, Sonali Publications. New Delhi.
10. Alexander, R.M. 1998. The Chordates – Cambridge University press, London.

Semester I
Hard Core Course III
Code: ZOHT 103 -BIOMOLECULES AND STRUCTURAL BIOLOGY

No. of hours/ week 4 **Credits 4**

OBJECTIVES

To acquire knowledge on biomolecules of living system.

To understand the functions of biomolecules in a cell.

To study various metabolic pathways in living system.

Unit I: Proteins and Nucleic acids: Chemical bonds – Biological importance of biomolecules; Amino acids – structure , classification - uncommon amino acids; Proteins - structure (primary, secondary, tertiary and quaternary, Ramachandran Plot), classification, properties – protein denaturation and folding – chaperones – prions. Nucleic acids – structure, base composition of DNA, double helix, A, B and Z forms of DNA, super coiled DNA, types of RNA.

Unit II: Carbohydratesand lipids: Structure and classification of Carbohydrates: mono, di and polysaccharides, properties: glycoconjucates (proteoglycans, glycoproteins, glycolipids). Lipids – structure and classification: simple, derived and conjugated.

Unit III: Laws of Thermodynamics: Concepts of free energy in biology – Redox potentials – high energy phosphate bonds. Enzymes – classification, nomenclature, Kinetics, effect of pH, temperature and substrates; enzyme inhibitors.

Unit IV: Metabolism: Glycogenesis, Glycogenolysis, Gluconeogenesis. Glycolysis – Embden - Meyerhoff pathway, Citric acid cycle, oxidative phosporylation, hexose monophosphate shunt; Lipids – biosynthesis and oxidation of fatty acids – Energetic of carbohydrate and fat metabolism.

Recommended Books

1. Lehninger A. L 1972. Biochemistry 6th Edition., Worth publishers, Inc, New York.
2. Jain.J.L. 2013. Biochemistry. S. Chand Publication, New Delhi.
3. Ambika Shanmugam.2012. Fundamentals of Biochemistry for Medical Students: Indian Edition. Lippincott Williams & Wilkins. Philadelphia.
4. Voet, D. and J.G. Voet. 2010. Biochemistry, John Wiley & Sons. Hoboken.
5. Freifelder, D. 1996. Physical Biochemistry W.H. Freeman & Co Ltd., US
6. Segal, I.H. 1972. Biochemical calculations, John Wiley and Sons. Hoboken.
7 Thomas.E. Creighton,. 2010. Protein Structure and Molecular Properties W.H. Freeman &Co. Ltd., US

8 Malacinski, G.M. 2008. Freifelder'sEssentials of Molecular Biology. Jones and Bartlett Publishers. US
9 Garret, R.H. and C.M. Grisham.2004. Biochemistry. Saunders College Publishers. US
10. Jeremy M. Berg, John L. Tymoczko, Lubert Stryer.2010.Biochemistry. W.H. Freeman & Co Ltd., US

Semester I
Hard Core Course IV
Code: ZOHT 104 - CELL AND MOLECULAR BIOLOGY

No. of hours/ week 4 **Credits 4**

OBJECTIVES

To understand the structural and functional details of the basic unit of life at the molecular level.
To study the molecular basis of cellular interactions, energy transformation, regulation and control of genes, cell cycle and information transfer.
To understand the role oncogenes and its abnormalities.

Unit I Organization of Eukaryotic cells: Structural organization and function of Plasma Membrane, Mitochondria (Glycolysis, Acetyl Coenzyme A, Kreb's Cycle, ETC) Endoplasmic reticulum, Golgi Complex and Ribosomes.Cell-cell interactions, intercellular junctions: Ca++dependent and Ca++ independent cell-cell adhesion.

UnitII Cell cycle and Cell Signaling: Structural organization of DNA; Mitosis and Meiosis; Control mechanism of cell division; Cell cycle and its regulation; Cell signaling-types; cell surface receptors- types.

UnitIII Transcription and Translation in Eukaryotes: Genetic code - degeneracy and universality of genetic code. DNA Replication, different models of replication for linear and circular DNA. Transcription, Post-transcriptional modifications and inhibitors of transcription. Translation, Post translational modification of proteins, inhibitors of translation.

Unit IV DNA repair and mutagenesis: DNA damage, Nucleotide excision repair, Mismatch repair, Recombination repair, Double strand break repair. Tumor Vs Cancer, Types of Cancer, Proto-oncogenes, oncogenes, tumor suppressor genes. Ageing and apoptosis.

Recommended Books

1. De Robertis, E.D.F. and De Robertis. E.M.F. (2001). Cell and Molecular Biology, B.I Publications Pvt Ltd, India.
2. S. C. Rasthogi, 2006, Cell and Molecular Biology, New Age International Publishers. New Delhi.
3. Powar, C.B, 2002 Cell Biology. Himalaya Publishing House. Mumbai, India
4. Verma, P.S. and Agarwal. 2004. Text book of Cell Biology. S. Chand Ltd.India
5. Bruce alberts, Dennis Bray,Julian Lewis, Keith Roberts, James D. Watson, 2017, Molecular Biology of the Cell, Garland Science, New York.
6. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. John Wiley & Sons. Hoboken.
7. Avers. C.J., 1986. Cell Biology. Addison-Wesley Publishing Company.

8. Lodish, H., BerkA .,Matsudaira, P., Kaiser, C.A., Krieger, M., Scott, M.P., Zipursky, S.L.and Darnell, J. Molecular Cell Biology. (2004). W.H. Freeman & Co., New York.
9. Keith Wilson, John Walker.2010. Principles and Techniques of Biochemistry and Molecular Biology.(2010). Cambridge University Press.
10. Freifelter, 2006, Essentials of Molecular Biology 4th Edition, Narosa Publishing House, New Delhi.

Semester I
Soft Core

Code: ZOSC 105 / 205- PUBLIC HEALTH AND HYGIENE

No. of hours/ week 4 **Credits 4**

OBJECTIVES

To understand importance of hygienic life

To understand the transmission of diseases and loss of health.

To study various diseases, causes, mode of transmission, symptoms of diseases and their control.

UnitI Communicable diseases and remedial measures: Food and Water borne diseases - cholera, polio, jaundice and remedial measures. Air borne diseases - Chicken pox, influenza, tuberculosis and remedial measures.

UnitII Non-Communicable diseases and remedial measures: Vector borne diseases – mechanism of transmission – malaria, filaria, chikungunya, dengue.Contact diseases -leprosy, scabies. Inherited disorders of blood -haemophilia, sickle cell anemia. Sexually Transmitted Diseases –Syphilis, gonorrhoea, AIDS and remedial measures.

Unit III Environmental health: Pollution –Air, water and e-waste, Industrial wastes, Solid Waste management; Modern gadgets and human health; Water quality – sentinel organisms - coliform groups.

UnitIV Human epidemics: Carcinogen, carcinogenesis – Radiation hazards - Metabolic disorders (Obesity, Diabetes) and Life style associated diseases in man (Alcoholism and Drug abuse) Heart Diseases- Hypertension; Occupational health Hazards.

Recommended Books

1. Wyler, D.J, 1990.Modern parasite Biology. W.H. Freeman and Company, New York.
2. William Hobson, 2006. Theory and practice of Public Health. Oxford Medical Publishers. UK
3. Park M. Park's Textbook of Preventive and Social Medicine, 2015, M/s Banarsi Das Bhanot Publishers.
4. J. P. Modi, 2015, Elements of Hygiene and Public health, Butterworth and Company.
5. William Hallock 1863 – 1939 Park Public, Health and Hygiene (English, Paperback) Wentworth Press.

6. George Moses Price, 2017, Hygiene and Public Health (Classic Reprint), Fb&c Limited.
7. Charles M. D. Porter, 2016, Elements of Hygiene and Public Health a Textbook for Students and Practitioners of Medicine, Wentworth Press
8. C. L. Dunn,D. D. Pandya, 2013, Indian Hygiene and Public Health Butterworth and Company.
9. Roger. Detels 2009. Oxford Textbook of Public Health, Oxford University Press. UK
10. William Hobson, 2006. Theory and Practice of Public Health. Oxford Medical Publishers. UK

Semester I
Soft Core

Code: ZOSC 105- ECONOMIC ZOOLOGY

No. of hours/ week 4 **Credits 4**

OBJECTIVES

To give a thorough understanding about the beneficial and harmful animals to human welfare

To introduce various types of animals breeding and farming practices and their economic importance.

To learn about pest and their management.

Unit IMedical Entomology: Parasites of domestic animals and humans, structures, life cycles, pathogenicity, diseases, symptoms and control. Insects as vectors, mode of disease transmission: Malaria, Filaria, Dengue, chikunguniya, Plague, Leishmaniasis - Surveillance, control measures: Biological, environmental, chemical, mechanical; Integrated Vector Management.

Unit II Veterinary Biology: Animal Breeding, Breeds of cattle, sheep, piggery and poultry. Heterosis, Economic importance and control of fleas, lice, bugs, mosquitoes, flies and parasitoids. Vector-parasite interaction; host-pathogen interaction, Insects transmitting bacteria and viruses of animals - control of insect vectors of animals.

Unit IIIFarming Practices: Pearl oyster culture, Poultry farming, Sericulture, Apiculture,

Unit IV Pest Management: Household pests, pests of crops (paddy, sugarcane). Classification of pesticides - mode of action - Integrated Pest Management (IPM): Physical, Chemical, Biological control- Resistance development in insects.

Recommended Books

1. Mani, M.S.1982. General Entomology. Oxford & IBH Publishing CO. UK.
2. Vasantharaj, David B.2012.Elements of Economic Entomology. Namrutha Publications, Chennai. India.
3. Prasad,T.V.2014. Handbook of Entomology. New vishal Publishers. Delhi. India.
4. Shukla, G.S, Upadhyay V.B., 2000. Economic Zoology, Rastogi Publications Meerut, India.

5. Dinesh Kumar Naznee, Ashok Kumar Rathoure,2015, Applied and Economic Entomology, Daya Publishing House, Delhi. India.

6. Temphare, D.B, 1984. A text book of insect morphology, physiology and endocrinology. S.Chand&Co., New Delhi. India.

7. Chapman, R.F,2013. The Insects: Structure and Functions. Cambridge University Press. UK.

8. Gullan, P.J. &Cranston, P.S.2004.The Insects: An Outline of Entomology. John Wiley & Sons. US.

9. KamaleswarPandey and Shukla, J.P., 2005. Fish and Fisheries, Rastogi Publications. Meerut, India.

10 M. Yadav, 2010, Economic Zoology, Discovery Publishing House Pvt. Limited, Delhi. India.

Semester I
Hard Core Course VI
Code: ZOHP 106 -PRACTICAL I
(Papers covered: ZOHT 101 to 104)

No. of hours/ week 8 **Credits 4**

Invertebrata:

1. Study of water balance in Paramecium PC based (Demo).
2. Observation and identification of microscopic slides. Models of coelom, gills, booklungs, trachea, gill books, nephridia, malpighian tubules and nerve cells.
3. Observation and identification of larval forms of free living invertebrates.
4. Observation and identification of parasites.
5. Study of museum specimen related to theory.
6. Mounting of mouthparts of mosquito/cockroach/ Radula/ Setae.
7. Identification, collection and submission of any 5 economically important insects.

Chordata:

8. Osteology – skull, lower jaw and vertebrae.
9. Observation and identification of microscopic slide and museum specimen related to chordates.
10. Mounting of olfactory rosette in a fish.
11. Mounting of different types of scales of fishes / fins of fishes.
12. Observation of larvivorous fishes.

Biomolecules and Structural Biology

13. Estimation of serum glucose.
14. Estimation of serum protein.
15. Estimation of serum cholesterol.

Cell and Molecular Biology:

16. Observation of cell and sub cellular organelles.
17. Measurement of cell dimensions.
18. Study of various stages of Mitosis in onion root tip.
19. Mounting of Polytene chromosome in Chironomous larva / Drosophila.

Semester II
Hard Core Course I
Code: ZOHT 201 - GENETICS

No. of hours/ week 4 **Credits 4**

OBJECTIVES

To understand the basic concept of genetics, Mendel's rule, principles and mechanisms of inheritance and sex determination in human beings.

To know the various genetic disorders and anomalies of chromosomes

To give an in-depth understanding on the principles and techniques of recombinant DNA technology.

Unit I Basics of Genetics: Mendel's law of inheritance, chromosomal theory of inheritance-dominance, co-dominance and incomplete dominance – pleiotropism- lethal and sublethal genes-genetic interactions: epistasis- mechanism of epistasis.

Unit II Chromosome structure – Genetic disorders: Histone, non-histone proteins - DNA - nucleosome morphology-heterochromatin, euchromatin, Chromosomal rearrangement. Inborn errors of metabolism: one gene-one enzyme hypothesis, Chromosomal basis of genetic disorder-PKU- Alkaptoneuria, Galactosemia. Genetic counseling – ethics and principles.

Unit III Human genetics: Sex determination, dosage compensation of X-linked genes– inactivation of X-linked genes in female. Genetic analysis of complex traits - complex pattern of inheritance, quantitative traits, chromosome anomalies and diseases- chromosomal anomalies in malignancy (chronic myeloid leukemia, Burkitt's lymphoma, retinoblastoma and Wilms' tumor).

Unit IV Recombinant DNA Technology: Basic recombinant DNA techniques, restriction modification systems, various enzymes used in recombinant DNA technology, nucleic acid probes, blotting techniques, DNA fingerprinting, construction of genomic and cDNA libraries.

Recommended Books

1. Verma.P.S. and Agarwal. 2012. Genetics. S.Chand Ltd. New Delhi, India
2. Watson *et al.,* Recombinant DNA: Genes and Genomics - a short course, W. H. Freeman and Company, New York, USA
3. Primrose, S. B. and Twyman, R. M., Principles of Gene Manipulation and Genomics, (7th Ed. 2006), Blackwell Publishing, West Sussex, UK.
4. Bernard R. and Jack. Molecular Biotechnology: Principles and application of recombinant DNA, ASM Press, Herndon, USA.

5. Gardner, E. J.,Simmons, M.J. D.P. Snustad Principles of Genetics (2006).Wiley Publishers. UK.

6. Benjamin A. Pierce 2001. Genetics: a Conceptual Approach, W H Freeman Publishers, New York, US

7. Hartle D.L. and Jones E.W. 2010. Genetics: Analysis of Genes and Genomes, Jones and Bartlett
8. D.Peter Snustad, Michael J. Simmons.2003. Principles of Genetics,– John Wiley & Sons, US
9. Griffith AF 2003. An introduction to Genetic Analysis, -W H Freeman Publishers, New York, US
10. Mange E.J. and Mange A.P. 1997. Human genetics, Rastogi Publications, Meerut. India

Semester II

Hard Core Course II

Code: ZOHT 202- ENDOCRINOLOGY

No. of hours/ week 4 **Credits 4**

OBJECTIVES

To acquire knowledge in basic endocrine function and various endocrine glands.

To understand mechanism of hormone action of various types of hormones.

To study various hormones of human beings.

Unit I Scope of Molecular Endocrinology: Classification of hormones: Peptide, Steroid and Amines. Mechanism of hormone action:Cellular hormone receptors – membrane, cytosolic and nuclear receptors. G-protein – structure and signal transduction mechanism; Second messengers (cAMP, cGMP, DAG, IP3 and Calmodulin).

Unit II Neuro Endocrinology: Hypothalamo-hypophysealgonadal axis, Feedback regulation – Positive and Negative. Structure, functional relationship between Adenohypophyseal hormones and Neurohypophyseal hormones; Indolamine, Endorphin and Enkephalin.

UnitIII Hormones and Metabolism: Structure, function and regulation of Thyroid hormones, catecholamine, Corticosteroid and Pancreatic hormones, Role of hormones in carbohydrate and lipid metabolism;Role of hormones in mineral homeostasis. Renin Angiotensin System, Gastrointestinal hormones.

Unit IV Hormones and Reproduction: Structure and functional relationship of Sex steroid hormones - Androgen, Estrogen and Progesterone; Reproductive cycles in mammals (Estrous and Menstrual cycles). Hormones of Pregnancy, Parturition and Lactation; Contraception.

Recommended Books

1. Haris, G.W. and B.T. Donovan. 1968. The Pituitory Gland. S. Chand and Co., New Delhi, India.
2. Bentley, P.J. 1998. Comparative vertebrate endocrinology, Second Edition, Cambridge University Press. Cambridge. UK.
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. Netherlands.
5. Turner, C.D. and J.T. Bangara. 1986. General endocrinology. Saunders International Student edition. Toppan Company Limited. Tokyo. Japan.

6. Barrington, E.J.W. 1985. An introduction to general and comparative endocrinology. Claredon Press, Oxford. UK.
7. Mac E.Hadley, 1997. Endocrinology. Pearson Education, Indian Reprint.
8. Anthony W. Norman and Gerald Litwack, Hormones, 2nd Ed..Academic press, New York.
9. A.K. Berry, 2011, A Textbook of Endocrinology, Emkay publications. Delhi, India.
10. Franklyn F. Bolander, 2004, Molecular Endocrinology 3rd Edition, Elsevier, Netherlands.

Semester II
Hard Core Course III

Code: ZOHT 203 ANIMAL ECOLOGY AND ETHOLOGY

No. of hours/ week 4 **Credits 4**

OBJECTIVES

To generate up-to-date knowledge on the components of ecosystem, population ecology and animal interactions.

To expose students to the basics and advances in behavioral study and generate an interest in the subject of social behavior.

Unit I Concept of ecosystem: Structure and functions of ecosystems- freshwater, marine, energy flow-food chain-food webs.Population Ecology**:** Population characteristics (natality, mortality, density, growth,life history strategies (r and k selection), age distribution, dispersion - survivorship curves.

Unit II Species interactions: Types- inter specific and intraspecificinteractions:symbiosis : mutualism, commensalism, Amensalism, parasitism,competition, predation, protoco-operation.

Unit III Development of Behaviour: Approaches and methods in study of behaviour, communication-chemical, light, visual, audio; songs of birds. Learning and Memory: habituation Instinct, conditioning: classical, operant. Imprinting, reasoning, insight and cognitive learning.

Unit IV Social behaviour:Group selection, kin selection, Altruism, Reciprocal altruism, social communication in insects, aggressive behavior, habitat selection and foraging. Biological rhythms: Circadian, circann
ual rhythms; Migration, Orientation and Navigation (fishes and birds); sexual conflict-Selfishness-mating systems, parental care, parental investment and reproductive success.

Recommended Books

1. Odum.E.P. 1988. Fundamentals of Ecology. Saunders. Co.Philadelphia,
2. Verma P.S. and Agarwal. V.K., 2000. Environmental Biology, S. Chand Publishers. New Delhi, India.
3. Agarwal. V.K., 2010. Animal Behaviour. S. Chand Publishers.New Delhi, India.
4. Arora.C.K. and Harjindra Singh, 2003. A text book of animal behavior, Anmol publications Pvt. Ltd. Delhi, India
5. Chapmann, J.L and Reiss, M.J. 1995. Ecology: Principles and Applicaion. Cambridge University Press. England.

6. Alock,J. 1997. Animal behavior: An evolutional approach. Sinauer assoc. Sunderland Mass U.S.A.
7. Aubrey Manning. 1995. An introduction to animal behavior.Edward Arnold Publishers Ltd., Great Britain .
8. David McFarland. 1987. Animal Behaviour, Psychobiology, Ethology and Evolution. ELBS /Longman. England.
9. Krebs,J.R and Davies,N. B.1991 Behavioural Ecology. Blackwell. Oxford.U.K.
10. Ludwig,J.A and J.F.Reynolds.1988. Statistical Ecology. John Wiley &Sons. NewYork. US.

SemesterII
Hard Core Course IV
Code: ZOHT 204 - ANIMAL PHYSIOLOGY

No. of hours/ week 4 **Credits 4**

OBJECTIVES

To study the functioning of organ systems across the animal world

To understand nutrition, respiration, circulation, excretion and neural coordination of animals with reference to human

Unit I Nutrition and Locomotion: Types of feeding: mucoid, ciliary and flagellar feeding.Typesof digestion: Extra cellular and intra cellular digestion, digestion and absorption of carbohydrates, proteins and fats.Structure of voluntary muscle fibres, Neuro-muscular junction, Physiology of muscle contraction and locomotion.

Unit II Circulation and Respiration: Types of transport mechanism: Blood and its components; Physiology of heart, cardiac cycle, neural and hormonal control of heart beat; Blood pressure and ECG- principle and interpretation. Respiration: Types of respiration, chemistry of respiratory pigments, Physiology of respiration, Transport of oxygen and carbon dioxide, neural and chemical regulation of respiration.

Unit III Excretion and Osmoregulation: Organs of excretion in animals, Formation of nitrogenous wastes- Ammonia, Urea and Uric acid and their relationship, Urine formation in man; Regulation of water, electrolyte and acid – base balance. Factors influencing urine formation.

Unit IV Control andCo-ordination: Neuron structure, Physiology of nerve conduction, Central Nervous system – Autonomic- Peripheral nervous system. Sense organs - Simple receptors – organs of olfaction and taste – Acoustico – lateralis system. Electroreception, vision and hearing in mammals.Nervous System: Comparative anatomy of the brain and spinal cord of vertebrates.

Recommended Books

1. Hoar, W.S.1991. General and Comparative Physiology. Prentice Hall of India, New Delhi.
2. R. Eckert and D. Randall, 2005. Animal physiology – Mechanisms and adaptations, CBS Publishers and Distributors Pvt Ltd, New Delhi.
3. Knut Schmidt - Nielsen.2008. Animal Physiology: Adaptation and Environment. Cambridge University Press, New Delhi
4. Richard Hill, Gordon A. Wyse, Margaret Anderson 2016. Animal Physiology. Sinauer. Oxford University Press, Oxford.

5. John. E. Hall and Arthur C. Guyton. 2015. Text book of Medical Physiology. Saunders Elsevier.
6. Schmidt Nelssen, K.1985. Animal Physiology. Adaptation and Environment Club, London
7. Herkat, P.C.andMathur, P.N.1976. Text Book of Animal Physiology. S. Chand Co. Pvt, Ltd., New Delhi.
8. Christopher D. Moyes, patricia M. Schulte, 2016. Principles of Animal physiology, Pearson Education.
9. P. S Verma, B S Tyagi, V K Agarwal, Animal Physiology, 2000, S. Chand, New Delhi, India.
10. Lauralle Sherwood, Human Physiology- From cells to Systems, 2015, Brooks/Cole, Cengage Learning, US.

Semester II

Soft Core (for others only)

Code: ZOSC 205- PUBLIC HEALTH AND HYGIENE

No. of hours/ week 4 **Credits 4**

OBJECTIVES

To understand importance of hygienic life

To understand the transmission of diseases and loss of health.

To study various diseases, causes, mode of transmission, symptoms of diseases and their control.

UnitI Communicable diseases and remedial measures: Food and Water borne diseases - cholera, polio, jaundice and remedial measures. Air borne diseases - Chicken pox, influenza, tuberculosis and remedial measures.

UnitII Non-Communicable diseases and remedial measures: Vector borne diseases – mechanism of transmission – malaria, filaria, chikungunya, dengue.Contact diseases -leprosy, scabies. Inherited disorders of blood -haemophilia, sickle cell anemia. Sexually Transmitted Diseases –Syphilis, gonorrhoea, AIDS and remedial measures.

Unit III Environmental health: Pollution –Air, water and e-waste, Industrial wastes, Solid Waste management; Modern gadgets and human health; Water quality – sentinel organisms - coliform groups.

UnitIV Human epidemics: Carcinogen, carcinogenesis – Radiation hazards - Metabolic disorders (Obesity, Diabetes) and Life style associated diseases in man (Alcoholism and Drug abuse) Heart Diseases- Hypertension; Occupational health Hazards.

Recommended Books

1. George Moses Price, 2017, Hygiene and Public Health (Classic Reprint), Fb&c Limited, London.
2. Charles M. D. Porter, 2016, Elements of Hygiene and Public Health a Textbook for Students and Practitioners of Medicine, Wentworth Press, Sydney, Australia.
3. C. L. Dunn and D. D. Pandya, 2013, Indian Hygiene and Public Health, Butterworth & Co (Publisher) Ltd, London.
4. Roger. Detels , 2009. Textbook of Public Health, Oxford University Press, US.
5. William Hobson, 2006. Theory and Practice of Public Health. Oxford Medical Publishers, US.

6. Wyler, D.J, 1990.Modern parasite Biology. W.H. Freeman and Company, New York.
7. Park M. Park's Textbook of Preventive and Social Medicine, 2015, M/s Banarsi Das Bhanot Publishers, Jabalpur, India.
8. J. P. Modi, 2015, Elements of Hygiene and Public health, Butterworth &Co (Publishers)Ltd, London.
9. William Hallock 1863 – 1939 Park Public Health and Hygiene (English, Paperback) Wentworth Press, Sydney, Australia.

Semester II
Hard Core Course VI

Code: ZOHP 206- PRACTICAL II
(Papers covered: ZOHT 201 to 204)

No. of hours/ week 8 **Credits 4**

Genetics:

1. Study of wild and mutant forms of *Drosophila melanogaster*
2. Preparation of Karyotype / ideogram of normal and syndromes (Human).
3. Identification of Barr body.
4. Estimation of frequency of genetic traits in human population.

Endocrinology:

5. Histological study of endocrine glands.
6. Test for pregnancy.
7. Dissect and display the endocrine glands in a fish

Animal Ecology and Ethology

8. Estimation of dissolved oxygen by Winkler's method.
9. Estimation of dissolved carbondioxide
10. Estimation of Salinity
11. Observation of animal association – Intra and Inter-relationship among animals.
12. Observation of population growth pattern of Drosophila in the laboratory.
13. Observation of beehive/bird nest/ termite hill/ male to male aggregation.
14. Observation of feeding mechanism in insects.

Animal Physiology:

13. Measurement of blood pressure – sphygmomanometer.
14. Estimation of haemoglobin content in the blood.
15. Differential count of WBC.
16. Recording and interpretation of ECG (Demo).
17. Quantitative estimation of ammonia/ urea/ uric acid/ creatine.
18. Study on enzyme activity – temperature/substrate concentration.
19. Study on oxygen consumption /salt loss or salt gain by fish.
20. Study of Fauna through field visits.
21. Blood – Bleeding and clotting time

Semester III
Hard Core Course I

Code: ZOHT 301- DEVELOPMENTAL BIOLOGY

No. of hours/ week 4 **Credits 4**

OBJECTIVES

To introduce the concepts and process in developmental biology

To understand about the genetic mechanisms of organogenesis and to learn about the post embryonic development.

Unit I Early Development: Fertilization - Structure of the gametes- sperm and egg; recognition of sperm, egg and sperm attraction; acrosome reaction, contact of gametes in mammals. Species - specific recognition, gamete fusion and prevention of polyspermy; fusion of genetic material, activation of egg metabolism, rearrangement of egg cytoplasm.

Unit II Morphogenetic movements: General features of cleavage, blastula and gastrula of fruitflyand Chick. Morphogenetic movements- Epiboly, Emboly, Invagination, Ingression, Delamination; Axes formation in fruitfly and Chick.

Unit III Organogenesis: Primary Embryonic Induction, Mechanism of Primary Induction, Function of Organizer, Regional specificity of Induction. Organogenesis – Brain, limb, heart, haematopoiesis, kidney and formation of extra embryonic membranes (Chick).

Unit IV Post Embryonic Development: Morphological and biological changes associated with metamorphosis (Insect). Hormonal regulation of metamorphosis. Epimorphic andMorphallactic regeneration.

Recommended Books

1. Balinsky B.I.2012. An Introduction to Embryology, W.B. Saunders Co, Philadelphia
2. Scott F. Gilbert. 2014. Developmental Biology, 9th Edition, Sinauer Assoc. Inc. Sunderland, MA.
3. Subramoniam,.T, 2013. Molecular Developmental Biology. Narosa publishing House. New Delhi
4. Mary S. Tyler, 2000. Developmental Biology: A guide for experimental study, 2nd Edition, Sinauer Assoc. Inc. Sunderland, MA.

5. Slack J. M.W. 1992. 2nd Edition. From Egg to Embryo, Cambridge.

6. Richard M. Twyman, 2001.Instant notes on Developmental Biology, Springer Verlag, BIOS Scientific. England.

7. Fred H. Wilt and Sarah C. Hake, 2001. Principles of Developmental Biology, W.W. Norton & Comp. Inc. New York.

8. Lewis Wolpert, 2012. Principles of Development, Oxford Univ. Press, US

9. Slack J. M.W. 2003, Essential Developmental Biology, Blackwell, US.

10 N J. Berrill, 1986, Developmental Biology, TATA McGraw-Hill Publishing Company Ltd, New Delhi, India

Semester III
Hard Core Course II

Code: ZOHT 302-IMMUNOLOGY

No. of hours/ week 4 **Credits 4**

OBJECTIVES

To provide an overview about the various types of immune systems.

To help the students to understand the role of immunology in human health and well-being

To familiarize the students in the field of antigen and antibody types and interactions.

Unit I Immune system: Overview of immune system. Types of immunity: innate and acquired immunity, humoral and cell mediated immunity. Lymphoid organs: Primary and secondary lymphoid organs. CD marker cells, Macrophages, Dendritic cells, NK cells.

UnitII Antigen and antibody: Antigen: Properties, immunogen, super antigen and haptens. Antibody: Structure and types, autoantibodies. Antigen and antibody interactions. Major Histocompatibility Complex (MHC): haplotypes, Types and mechanism of antigen presentation.

Unit III Differentiation of Immune cells and immune response:T cell- types, maturation, activation, differentiation and receptors. B cell- maturation, activation, differentiation and receptors. Cell mediated and humoral immune response; Cytokines; Complement system-Classical and alternate pathway.

Unit IV Immunity and Human Health: Hypersensitivity reactions: Types with examples. Autoimmunity and its disorders. Vaccines: Properties, types and immunisation. Immuno-deficiency disorders- AIDS, SCID.

Recommended Books

1. Roitt,I.M.1994. Essential Immunology. Blackwell Scientific, Oxford, US.
2. Janis Kuby, 1994, Immunology.Freeman and Co., New York. US.
3. Stites,D.P.,Terr,A.I. and Parsloio,T.G. 1997.Medical Immunology. Prentice Hall, New Jersey.US.
4. Janeway,C.A and Travers,P. 1997. Immunobiology.Current Biology Ltd., London.
5. Champion, M. D. and Cooke,A.1987. Advanced Immunology. J. B. Lippincott Ltd.,Philadelphia.

6. Coligan JE, Kruisbeek AM, Margulies DH, 1997, Current Protocols in Immunology, Wiley, New York, US.
7. Srivastava,R.,Ram,B.P.& Tyle,P.1991. Molecular Mechanism of Immune Regulation. VCH Publishers, New York.
8. Kannan,I. 2007. Immunology. MJP Publishers, Chennai, India.
9. Rao.C.V., 2005. Immunology. Narosa Publications. New Delhi, India.
10. Paul,W.E.M.1989. Fundamentals of Immunobiology. Raven Press, New York, US.

Semester III
Hard Core Course III

Code: ZOHT 303- FISHERIES AND AQUACULTURE

No. of hours/ week 4 **Credits 4**

OBJECTIVES

To acquire the basic knowledge on biology of fishes
To gain in-depth knowledge on capture and culture fisheries of India and World
To learn the basic aspects of fish pond construction and management.
To understand the role of various institutions of India
To acquire knowledge on fish and shellfish diseases, pathogens and their control measures.
To identify avenues for employment opportunities and entrepreneurship development.

UnitI Fish Biology: Systematic classification and basic anatomy of fishes. Morphometric and Meristic characters, Food and feeding habits. Population dynamics, Length and weight relationship,Age and growth determination, Reproductive cycles - fertility and fecundity. Hybridization and induced breeding.

Unit IICapture fisheries of India: Present status and scope of inland and marine capture fisheries- Riverine, estuarine, off-shore and deep sea fisheries. Migration, Fish tagging and marking, major fisheries of India- oil sardine, mackerel and Bombay duck. Stock- recruitment.

Unit III Fishing technology and survey of fishery resources: Principal methods of exploitation of fishes- Indigenous and modern gears and crafts- spawn collection. Transport of seed and brooders- Methods of surveying the fishery resources- acoustic and aerial methods.Survey of fish eggs and larva.Role of R and D institutions of fisheries and Aquaculture - (CMFRI, CIBA, MPEDA, CIFRI, CIFNET, CIFE, NIO, NBFGR, FSI, CIFT).

Unit IV Culture fisheries of India: Present statusand scope of aquaculture in India. Types of culture- Criteria for selection of fishes for culture. Culture practices of carps, sea bass and shrimp. Construction and management of aquaculture pond. Fish diseases and control in culture ponds.

Recommended Books

1. R.Santhanam, N. Sukumar, P. Natarajan, 1990. A Manual of Fresh Water Aquaculture. V. Oxford & IBH Publications, New Delhi, India.

2. Jhingran, 1991. Fish and Fisheries of India - Hindustan Pub. Corpn. New Delhi, India.
3. T.V.R. Pillay, 2005. Aquaculture: Principles and practices. Wiley Publication, New York, US.
4. Karl F. Lagler. 1977. Ichthyology 2nd edition.: Wiley Publication. New York, US.
5. Francis Day.1883. Indian Fish and Fishing. William Clowes and Sons Ltd, London.
6. Alikunhi, 1957. Fish culture in India. Indian Council of Agricultural Research. New Delhi, India.
7. Rajendra Kumar Rath, 1993. Freshwater Aquaculture, Scientific publishers, Jodhpur, India.
8 Shailendra Ghosh, 2009. Fisheries and aquaculture management, Adhyayan, New Delhi. India.

9. Dr.S.Ayyapan, Dr.J.K.Jena, Dr.A.Gopalakrishnan.Dr. A.K. Pandey(Editors) ,2006. Hand book of fisheries and Aquaculture.Indian Council of Agricultural Research. New Delhi, India.
10. K. Shanmugam. 1992. Fishery Biology and Aquaculture, LEO Pathippagam. Chennai.

Semester III
Soft Core
Code: ZOSC 304- FISH PRESERVATION AND VALUE ADDITION TECHNIQUES

No. of hours/ week 4 **Credits 4**

OBJECTIVES

To impart skill-based knowledge and training to the students on different aspects of fish processing technologies related to production of value added quality fish products from freshwater and marine resources and their preservation.

Unit I Fish Biochemistry: Fish as healthy food. Major and minor constituents of fishes – Distribution and function of Protein, Lipid, Carbohydrates, Vitamins, Minerals, Moisture. Toxins and toxic substances in fishes.

Unit II Fish spoilage and Quality management: Post-mortem changes and phenomena of rigor mortis. Criteria for assessing the freshness of fishes and fish spoilage. Factors affecting spoilage of fish- Autolytic spoilage, Microbial spoilage, Auto-oxidation, Sources of contamination. Concepts of total quality management- HACCP, Hazards in seafood,Food safety and Standards Act of India 2006, Role of BIS and EIA.

Unit III Fish processing technology: Principles of fish preservation. Preservation by curing (Drying, Salting and Smoking), Chilling, freezing of fish, accelerated freeze drying, Canning of fish and fish products, Modified Atmosphere Packaging (MAP) of fish and fish products.

Unit IV Fishery products and value addition: Fishery products, by-products and value added products. Exports of fish andshrimp, fish meal, fish oil, protein concentrate, fish wafers, ensilage, fish pickles, surumi, roe, ready to cook and ready to eat products. Additives and classes of additives.Packaging and transportation of fish and fishery products. Chitin and chitosan. Marketing and economics.

Recommended Books

1. Govindan, T.K., 1985. Fish Processing Technology. Oxford and IBH publishing Company Private Ltd., New Delhi, India.
2. Gopakumar, K.1997. Tropical Fishery Products. Oxford & IBH Publications.New Delhi, India.
3. Charles L .Cutting. 2002. Fish processing and preservation. Laurier Books Limited, Canada.
4. Ayyappan, 2012. Fisheries of India.Directorate of Information and Publications of Agriculture, Indian Council of Agricultural Research, New Delhi, India.
5. V. Venugopal, 2006. Seafood Processing: Adding Value Through Quick Freezing, Retortable Packaging and Cook-Chilling.CRC Press, Taylor and Francis group, US.

6. Kreuzer, R., 1965. The Technology of Fish Utilisation. Fishing News (Books) Ltd., London.
7. Burges, G.H.O., C.L. Cutting, J.A. Lovern and J.J. Waterman, 1965. Fish Handling and processing, Her majesty's Stationery Office, Edinburg, UK.
8. Kreuzer, R., 1974. Fishery Products. FAO Fishing Mews (Books) Ltd., England.
9. Anon, 1979. Handling, Processing and Marketing of Tropical Fish. Tropical Products Institute London
10. Chandran, K.K., 2000. Post Harvest Technology of Fish and Fish Products. Daya publishing House, New Delhi.

Semester III
Soft Core (Interdisciplinary: for others also)

Code: ZOSC 305-ENVIRONMENTAL TOXICOLOGY

No. of hours/ week 4 **Credits 4**

OBJECTIVES

To acquire knowledge about environmental toxicity.

To understand the impact of toxic chemical on environment.

To study about environmental pollution ,protection of environment and effects of toxic compounds on environment.

UnitI. Introduction to Environment: Natural resources,renewable and non-renewable energy resources; environmental pollution:Causes, effects and control measures of air, water and noise pollution;Radioactive pollution;effects on human beings, Acid rain, PAN chemicals, Global warming, Eutrophication; Impact of Noise on human health.

Unit II. Environmental Protection: Global deforestation rate and extinction crises. Causes for extinction: habitat loss, industrialization, hunting and invasive species. Soil and water conservation, Rain water harvesting, solid waste management. Role of informationtechnology in environmental protection. Environmental policies - national and international; agencies,programmes. legislations for environmental protection- public awareness.

Unit III Toxicants: Scope of Environmental Toxicology. Toxic chemicals in the environment and their biological effects. .Xenobiotics, Biomagnification, Bioaccumulation. Pesticides: Classification, mode of action. Heavy metal poisoning (Copper, Cadmium, Lead, Mercury, Arsenic and Chromium). Safety measures.

Unit IV: Toxicity Assessment: Methods of Toxicology: Toxicity tests: types - acute, subacute and chronic toxicity tests. Dose - Response relationship; LC_{50}, $LD_{50,}$ Probit analysis; Insecticide resistance; Surveillance of pesticide poisoning; National policies for Pesticide regulation.

Recommended Books

1. William, P. Cunningham and Mary Cunningham. 2011. Principles of Environmental Sciences, Tata McGraw Hill Publications, New Delhi, India.
2. ShyamDiwan. 2001. Environmental law and Policy in India. OUP India.
3. Shelley Bhattacharya, 2011. Environmental Toxicology. Books and allied (p) Ltd. India.
4. Ernest Hodgron, 2004. A textbook of modern toxicology, Wiley publisher. US
5. Clark, G.L., 1954. Elements of Ecology, John Wiley & Sons.US.
6. Chapmann,J.L and Reiss,M.J. 1995. Ecology Principles and application.Cambridge Univ. Press.UK.

7. Mahesh Rangarajan. Pearson Longman, 2009. Environmental issues in India.Pearson Education India
8. Verma, P.S and Agarwal ,V.K. 2000. Environmental Biology. S. Chand Publishers, India.
9. Gupta, P.K, and V. Ramprakash, 1985. Advance in Toxicology and Environmental Health. JagmenderBook Agency, New Delhi.
10. Subramanian, M.A, 2004. ToxicologyPrinciples and Methods, MJP Publishers, Chennai, India.

SemesterIII
Soft Core (Interdisciplinary: for others also)

Code: ZOSC 305 HEALTH PROFESSION EDUCATION

No. of hours/ week 4 **Credits 4**

OBJECTIVES

- To explain the principles of adult learning
- To frame objectives for their teaching sessions
- To appropriately select and use teachinglearning and assessment methods
- To facilitate learning in different learning environments and clinical settings
- To appreciate the importance of the educational process in health profession education
- To function as effective educator in a variety of settings

Unit I HPE as a discipline: Aims and objectives of health professions education, need and scope of HPE, philosophical, psychological, sociological and technological foundations of HPE, learning domains, issues in HPE, implications of capacity building in HPE.

Unit II Teaching and learning in HPE: Adult learning principles, learning theories (cognitivism, behaviourism, constructivism). Characteristics of learners, process of communication in HPE, factors influencing learning, principles of teaching, writing educational objectives , lesson planning, essential teaching skills (skill of writing specific learning objectives, skill of planning a lesson, skill of stimulus variation/interaction, skill of using audio visual aids, skill of closure). Large group and small group interactive teaching techniques effective use of educational media/technological tools. Microteaching, effective strategies for facilitating clinical teaching and learning in different educational environments (bedside, laboratory, community and skill lab). Teaching of psychomotor skills, teaching of attitude, ethics and professionalism.

Unit III Assessment in HPE: Introduction to assessment and evaluation, formative and summative written and oral assessment (Viva-voce), selection of tools for assessments, types of questions (objective type, short and descriptive type) and their educational, characteristics of a good question paper, continuous and comprehensive internal assessments.

Unit IV Curriculum and educational strategies: Curriculum (concept, determinants, types elective program evaluation), self-directed learning, problem based learning, integrated learning,multi-professional education, creating teaching-learning materials, observation skills, supporting students in difficulty and academic counselling, providing effective

feedback,introduction to educational research leadership in HPE and importance of accreditation in HPE.

Recommended Books

1. A Handbook for Medical Teachers D.J Newble Springer [Interner].

2. Dent JA. Harden RM,editors, A practical guide for medical teachers, 4th ed. London; New York: Churchill Livingstone/Elsevier: 2013. 436 p.

3. ABC of Learning and Teaching in Medicine, 3rd Edition Medical Education Medicine, Nursing & Dentistry Subjects Wiley [Internet].

4. Assessment in Health Professions Education : 97808-5861280: Mediine & Health Science

5.The Health Professions Educator [Internet].

6. Harden RM. Laidlaw JM. Esential skills for a medical teacher an introduction to teaching and learning in medicine Second edition, Edinburgh; New York: Elsevier; 2017,288 p.

7. D. Kadambari, S.Kumar, Z.Zayapragassarazan, SCParija. Improving discipline-based undergraduate medical curriculum: an evidence informed approach. 2018.

Semester III
Hard Core Course VI
Code: ZOHP 306 PRACTICAL III
(Papers covered: ZOHT 301 to303)

No. of hours/ week8 **Credits 4**

Developmental Biology

1. Different stages in development - frog (egg, cleavage, blastula, gastrula and neural stages of Frog)
2. Observation of various stages in development - chick (18, 24, 33, 48, 72, 96 hours).
3. Vital staining of chick blastoderm.
4. Development of chick stage - slide showing C.S.of heart, kidney, lens and limb.

Immunology

5. Observation of lymphoid organs – Thymus, Spleen, Bone marrow, Tonsil, Lymph node.
6. Agglutination reaction of ABO and Rh blood groups.
7. Widal test.
8. Haem-agglutination - Quantitative analysis – haem-agglutination titration.
9. Preparation of Antigen - RBC - Demonstration.

Fisheries & Aquaculture

10. Observation of common edible fin and shell fishes.
11. Identification of aquatic weeds.
12. Observation of ichthyoplanktons.
13. Analysis of gut/stomach content in a fish.
14. Observation of fish parasites.
15. Mounting of scales in fishes.
16. Morphometric and meristic characteristics in fishes.
17. Fish or prawn farm visit.
18. Demonstration of hypophysation technique

Semester III
Soft Core(Interdisciplinary: for others only)
Code: ZOSC 307 AQUARICULTURE

No. of hours/ week 4 **Credits 4**

OBJECTIVES

To inculcate importance of ornamental fish farming in relation with entrepreneurship development.

To acquire the knowledge about various techniques of ornamental fish breeding, rearing and its marketing.

To know the techniques of fabrication of glass aquarium and its maintenance.

UNIT I Ornamental Fish Culture: Importance of ornamental fish culture; Diversity of ornamental fish; Major hotspots of ornamental fishes in global and Indian perspective; Aquatic ornamental plants in India/globe; National and international trade in ornamental fishes and plants.Major ornamental fish species of India. Regulations in ornamental fish trade in India.

UNIT II Water quality management: Water quality management in ornamental fish culture; Biological, Physico-chemical properties of water; Acclimatization of marine ornamental fishes to fresh water. Nitrification and conditioning of Aquaria; Aquarium fabrication and aquascaping; Implements in aquariculture and their uses.

UNIT III Breeding techniques: Basic breeding techniques in ornamental fishes. Selection of brood stock and rearing; Natural breeding facilitation; Induced breeding. Taking care of hatchlings; Breeding techniques for live bearers and for egg layers. Feed preparation and feeding - livefeed and supplementary feed.Diseases management in aquariculture.Packing and transport of aquarium fishes and plants.

UNIT IV Types of Aquaria: Marine aquarium – special features; Outdoor aquariculture ponds; Planted aquarium, .Biotope aquarium, Vivarium, insectarium, terrarium, paludarium, oceanarium, dolphinarium, Reef aquarium, nano aquarium.Role of public aquaria.

Recommended Books

1. Mary Bailey and Gina Sandford. 2015. Ultimate encyclopedia of Aquarium Fish and fish care. South Water Publishers.
2. David Alderton, 2011.Encyclopedia of Aquarium and Pond fish. Penguin UK Publishers.

3. Gopakumar G. 2011. Marine Ornamental fish Culture: Package of Practices. CMFRI Cochin.
4. Dholakia, A.D. 2009. Ornamental fish Culture & Aquarium Management. DayaPublishing House, Delhi.
5. Biju Kumar, A. & H.J. Alappat 1996. A Complete Guide to Aquarium Keeping. Books for All, Delhi,
6. Mills, D. 1987. The Practical Encyclopedia of the Marine Aquarium. Salamander Books Limited, London.
7. Rataj, K. & R. Zukal 1971. Aquarium Fishes and Plants. The Hamlyn Publ. Group Ltd., London.
8. AmitaSaxena, Aquarium Management, 2013, Daya publishing House.,New Delhi.
9. Jagtap, H S, Mukherjee S. N. and V. K.Garad 2009. Textbook of Pisciculture and Aquarium Keeping, Daya publishing House, New Delhi.
10. Felix, S, T V Anna Mercy and Saroj Kumar Swain, 2013,Ornamental Aquaculture: Technology and Trade in India.

Semester IV
Hard Core Course I

Code: ZOHT 401 BIOLOGICAL TECHNIQUES AND BIOINFORMATICS

No. of hours/ week 4 **Credits 4**

OBJECTIVES

To learn about the basics of most often used tools, techniques,methodologies and methods of analysis used in biological research.
To become comfortable and proficient working in the lab and in the field.

To know about the basic statistics, variables, primary and secondary data, different kinds of data, presentation of data in the form of diagrams and various types of statistical applications.

To obtain knowledge on bioinformatics and molecular taxonomy.

Unit I Microscopy and Histochemistry: Microscopy - Light, Phase Contrast, Fluorescence and Electron microscopes - principle, structure and application; Histology: histochemical and immunochemical techniques, Autoradiography.

Unit II Quantification and Separation Techniques: Centrifugation (High Speed and Ultra-centrifugation; Spectrophotometer (UVVisible), Fluorimetry and Flame photometry, atomic absorption spectroscopy. Quantification of molecules and trace elements - Molecular separation: Chromatography (GLC and HPLC), Electrophoresis (PAGE and Agarose); DNA Sequencing, Blotting, PCR, Microarray, ELISA;Radiochemical types, uses of tracer technique, RIA.

Unit III Biostatistics: Collection of data; Diagrammatic and Graphical representations; Measures of central tendency and dispersal; Probability distributions (Binomial, Poisson and normal); Sampling distribution; Parametric and non parametric statistics; Confidence Interval; Standard errors; levels of significance; Regression and correlation; students t-test; ANOVA, Chi square test. Evaluation of biodiversity indices; Shannon-Weiner index, Dominance index.

Unit IV Bioinformatics: Introduction- Biological database- types, tools, Internet basics; Database management system; Sequence alignments (basis-dot matrix-multiple sequence) & web

site designing; Phylogenetic analysis, dendrogram, DNA barcoding, Genomics, Proteomics; Molecular modeling and drug designing; Preparation of a manuscript for research.

Recommended Books

1. Gurumani, N. 2005. An Introduction to Biostatistics 2nd Ed., MJP Publishers, Chennai, India .
2. Sharma, A.K., 2005. Text book of Biostatistics, Discovery Publishers House, New Delhi, India.
3. Lehninger A. L. Biochemistry 2nd Edition., Kalyani publishers, New Delhi, India.
4. Wilson and Walker.2001. Practical biochemistry- Cambridge University Press, Low Price Edition. India
5. Arthur Lesk, 2014, Introduction to Bioinformatics, OUP Oxford.US.
6. Zar. 2014.Biostatistical Analysis.Pearson Education Limited, India
7. David W. Mount, 2001. Bioinformatics-Sequence and Genome Analysis- CSHL Press, USA.
8. Upadhay and Upadhay, 2009. Biophysical chemistry- principles and techniques. Himalaya publishing House. India.
9. Arora P.N and Malhan P.K., 2007. Biostatistics – Himalaya publishers House, Mumbai.India.

Semester IV
Hard Core Course II
Code: ZOHT 402- EVOLUTION AND CONSERVATION BIOLOGY

No. of hours/ week 4 **Credits 4**

OBJECTIVES

To understand basic concepts of evolution

To study the molecular evolution and conservation of organisms

To study various causes of biodiversity loss.

Unit I Concepts of evolution: Concept of organic evolution during pre- and post-Darwin era. Theories of organic evolution, Adaptive radiation and modification- isolating mechanism, Speciation- allopatric and sympatric speciation – convergent evolution-sexual selection and gene flow- co-evolution.

Unit IIOrigin and evolution of gene: Molecular evolution- amino acids and nuclear substitutions, causes of variation, Origin of new genes and proteins, gene duplication and divergence. Hardy-Weinberg equilibrium - Genetic drift.

UNITIII Conservation of biodiversity: Valuation of biodiversity, consumptive and productive use values; threats, red data book; global ecosystem services; global conservation efforts- Earth Summit, Hotspots, Protected areas and functions; UNESCO, Indian case studies on conservation/management strategy (Project Tiger, Biosphere reserves), *In situ* and *ex situ* conservation. IUCN, WWF, IBWL, BNHS, UNEP, UNDP.

UNITIV Habit Fragmentation and Extinction: Theory of island biogeography - habitat fragmentation: area and edge effect, Causes for extinction: habitat loss, industrialization, hunting and invasive species. Extinction through geological time scale: mass extinction and impact on flora and fauna- Current extinction trends- rarity and endangered species conservation.

Recommended Books

1. Barton, N. H., Briggs, D. E.G., Eisen, J. A., Goldstein, A. E., Patel, N. H., 2007, Evolution, Cold Spring Harbor Laboratory Press, New York, USA
2. Futuyma, D. J., Evolution, Sinauer Associates, Inc., Sunderland, USA
3. Ernst Mayr, 2001. What Evolution Is, Basic Books, New York, USA
4. Andrew S. Pullin, Conservation Biology. 2002., Cambridge University Press, UK.

5. Richard B. Primack, 2016, An Introduction to Conservation Biology, Sinauer Associates. Oxford University Press, USA.
6. Theodosius Dobzhansky, Francisco J. Ayala, G. Ledyard Stebbins, James W. Valentine., 1977, Evolution, W.H. Freeman & Company, USA.
7. Edward Ottaway Dodson, 1976. Evolution: Process and Product. Van Nostrand Reinhold Company.New York, USA.
7. 8. Martha J. Groom, Gary K. Meffe, C. Ronald Carroll, 2012, Principles of Conservation Biology, SinauerAssociates. Oxford University Press, USA.
9. Fred Van Dyke, 2008, Conservation Biology: Foundations, Concepts, Applications. McGraw-Hill Science/Engineering/Math, New York, USA.

Semester IV
Hard Core Course III

Code: ZOPW 403 Individual Projects

No. of hours/ week 18 **Credits 10**

OBJECTIVES

Student can take up individual project course during IV semester. The objective of the project is to help the student to inculcate research aptitude and skills in using various biological techniques; to develop concepts and to apply them in real life situations. Students are guided to select projects of their interest in consultation with the respective supervisors.

Regulations of Project Work

1. The project work should be carried out from January to April. 3days per week (18 hours) is allotted to project work in the IV semester.
2. Each teacher shall be allotted to the maximum of eight students.
3. Periodically the project work should be reviewed (minimum three times) by the advisory committee constituted for this purpose which includes faculty of the department.

Submission of Project Report

The Students should prepare two copies of the project work and submit the same to the COE, KMCPGSat the time of IV semester practical examination. The length of the project may be 40-50 pages typed in double space. After evaluation, one copy is to be retained in the department library.

Evaluation of Project Report

Two examiners (one external and one internal) will be evaluating the project report for 200 marks. External evaluation is for a maximum of 100 marks and internal evaluation is for a maximum of 50 marks and *viva-voce* carries a maximum of 50 marks. The *viva-voce* examination will be conducted by the External Examiner and Internal Examiner (respective supervisor). The Students can use Power Point Presentation during the *viva – voce* examination.

Nine (9) credits will be given for Project work and one (1) credit for *viva- voce* as per CBCS regulations.

Semester IV
Hard Core Course VI
Code: ZOHP 404- PRACTICAL IV
(Papers covered: ZOHT 401 and 402)

No. of hours/ week 4 **Credits 2**

Biological Techniques and Bioinformatics

1. Calculation of Rf values of selected Amino acids by Paper Chromatography.
2. Fractionation of lipid profiles by TLC (Demonstration).
3. Electrophoretic separation of haemolymph/serum protein(Demonstration).
4. Isolation of sub cellular organelles (Nucleus, Mitochondria) by Centrifugation (Demonstration).
5. Estimation of sodium in water/serum samples.
6. Estimation of Potassium in water/serum samples.
7. Estimation of Magnesium/Calcium in water/serum samples.
8. Calculation of Correlation Coefficient.
9. Regression Analysis.
10. Analysis of Variance (Single Way).
11. Students't' test.
12. Chi square test.
13. Normal, Bionomial distributions.
14. Numerical problems related to Shannon Index/Dominance.
15. Web based tools for sequence Searches (nucleic Acid & Protein Sequence data base).
16. Phylogenetic tree construction.
17. Usage of statistical package- SPSS.

Evolution and Conservation Biology

18. Estimation of soil parameters –Surface and Sub-surface temperature; Soil moisture (below ground) and biodiversity
19. Study of campus flora and fauna/study of nearby forests and grasslands.
20. Study of habitat specificity in birds or small mammals on campus
21. Field visits for habitat evaluation, visit to wetland areas.