



**List of Courses Focus on Employability/ Entrepreneurship/
Skill Development**

Department : Zoology

Programme Name : M.Sc.

Academic Year : 2016-17

List of Courses Focus on Employability/ Entrepreneurship/Skill Development

Sr. No.	Course Code	Name of the Course
01.	LZL 105: Lab Exercises	Entomology
02.	LZL 205: Lab Exercises	Mammalian Physiology
03.	LZL 205: Lab Exercises	Biochemistry
04.	LZL 206: Lab Exercises	Bio-techniques
05.	LZL 206: Lab Exercises	Bioinformatics
06.	LZT 303 (B)	Fish Biology (Paper 1-Fish Culture and Pathology)
07.	LZL 304: Lab Exercises	Economic Zoology
08.	LZL 305 (B)	Fish Biology (Fish Physiology and Anatomy)
09.	LZT 402 (B)	Paper IV: Capture Fishery
10.	LZL 403 (A)	Mammalian Reproductive Physiology and Endocrinology
11.	LZL 403 (B)	Fish Biology (Fish Reproduction, Genetics and Biotechnology)

A. V. K. Khosla

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Scheme and Syllabus

Revised Syllabus

2 years PG Program in Zoology, 2015-16

SEMESTER-I

Course Code	Theory	End Semester Marks	Internal Marks	Total Marks
LZT 101	Non Chordata & Chordata	60	40	100
LZT 102	Entomology & Fish Biology	60	40	100
LZT 103	Endocrinology	60	40	100
LZT 104	Histology, Histochemistry and Biostatistics	60	40	100
LZT 105	Lab. Exercises based on courses LZT 101 & 102	60	40	100
LZT 106	Lab. Exercises based on courses LZT 103 & 104	60	40	100
Total		360	240	600

SEMESTER-II

Course Code	Theory	End Semester Marks	Internal Marks	Total Marks
LZT 201	Genetics, and Molecular Biology	60	40	100
LZT 202	Biochemistry and cell Biology	60	40	100
LZT 203	Mammalian Physiology	60	40	100
LZT 204	Biotechniques and Bioinformatics	60	40	100
LZL 205	Lab. Exercises based on course LZT 201 and 202	60	40	100
LZL 206	Lab. Exercises based on course LZT 203 and 204	60	40	100
Total		360	240	600

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SEMESTER-III

Course Code	Theory	End Semester Marks	Internal Marks	Total Marks
LZT 301	Developmental Biology & Immunology	60	40	100
LZT 302	Evolutionary Biology & Economic Zoology	60	40	100
LZL 303 A	Major Elective Course I <i>Mammalian Reproductive Physiology and Endocrinology</i>			
	Paper I – Neuroendocrinology and Non-Classical Hormones.	60	40	100
	Paper II – Male and Female Reproduction	60	40	100
LZL 303B	Major Elective Course II <i>Fish Biology</i>			
	Paper I – Fish Culture and Pathology	60	40	100
	Paper II – Fish Anatomy and Physiology	60	40	100
LZT 303C	Major Elective Course III <i>Neuroscience</i>			
	Paper I-Cellular Neurobiology and neuron organization	60	40	100
	Paper II – Cellular neurophysiology and Neurochemistry	60	40	100
LZT 303 D	Major Elective Course IV <i>Toxicology</i>	60	40	100
	Paper I: An Introduction to Toxicology			
	Paper II: Occupational and Environmental Toxicity	60	40	100
LZL 305	Lab. Exercises based on courses LZT 301 & 302	60	40	100
LZL 306	Lab. Exercises based on courses LZT 303 & 304	60	40	100
Total		360	240	600

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SEMESTER-IV

Course Code	Theory	End Semester Marks	Internal Marks	Total Marks
LZT 401	Animal Behaviour & Environmental Biology	60	40	100
LZT 402 A	Major Elective Course I <i>Mammalian Reproductive Physiology and Endocrinology</i> Paper III - Hormone Receptors and Signaling Mechanisms.	60	40	100
	Paper IV - Fertility and Sterility	60	40	100
LZT 402 B	Major Elective Course II <i>Fish Biology</i> Paper III - Fish Reproduction, Genetics and Biotechnology	60	40	100
	Paper IV - Capture Fishery	60	40	100
LZT 402 C	Major Elective Course II Paper III - Sensory, Motor System and Regulation	60	40	100
	Paper IV - Developmental Neurobiology	60	40	100
LZT 402 D	Major Elective Course III Paper III: Mechanism of Toxicity	60	40	100
	Paper IV: Systemic Toxicology	60	40	100
LZL 404	Lab. Exercises based on courses LZT 402 & 403	60	40	100
LZL 405	*Project work/*Dissertation/*Seminar	120	80	200
Total		360	240	600

Note: 1. Each student will be able to opt any one out of the three special papers (a, b and c).

2. Each group will set 4 theory paper and corresponding laboratory exercises

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* The project work/dissertation will be carried out in the field of respective group (a, b and c)

**On a current topic with in the 45 minutes to be evaluated by a panel of examiner

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LZL 105: LAB EXERCISES

(Based on papers LZT 101 and LZT 102)

1. Non Chordata: Preparation of permanent slides. Protozoa: *Paramecium* (whole mount) and demonstration of food vacuoles. Cnidaria: *Bougainvillea*, *Sertularia*, Arthropoda: Cyclops, Megalopa/Zoea, spiracles of cockroach. Mollusca: Glochidium larva, Echinodermata: Spheredium, pedicellaria, tubefect.
2. Dissections: Arthropoda: Salivary glands of cockroach, Mollusca: nervous system of *Mytilus* and *Aplysia/Sepia*. Study of museum specimens of Porifera, Cnidaria, Annelida, Arthropoda, Mollusca, Echinodermata.
3. Chordata: Study of external features of *Branchiostoma*. Study of whole mount preparations of following proto-chordates. *Doliolum*, *Pyrosoma*, *Salpa* and *Oikopleura*. T.S. through pharynx, gonads and post anal region of *Branchiostoma*. T.S. and L.S. through proboscis of *Balanoglossus*.
4. Study of adaptations: Fossorial adaptation and urino-genital system of rat. Study of adaptive features of: Amphibians, Reptiles, Birds, Mammals through Chart.

Entomology

1. Study of external morphology of cockroach;
2. Internal anatomy of cockroach: Alimentary canal, Salivary apparatus: dissection and *in toto* stained preparation.
3. Dissection of frontal ganglion, brain, corpora cardiac (CC), corpora allata (CA) and recurrent nerve.
4. Dissection and mounting of prothoracic gland
5. Dissection of male and female reproductive systems of cockroach
6. Study of external morphology of honey bee and dissection of sting apparatus
7. Study of following using permanent slides/specimens: L.S. of teleotrophic and polytrophic ovarioles, T. S. of testis, and brain showing median neuro secretory cells (MNSC), whole mount of head of louse, CC & CA, and *Chironomus* larva.

Fish Biology

1. Classification of the following locally available fishes using key: Carps: *Catla catla*; *Labeo rohita*, *Cirrhina mrigala*; Catfishes: *Heteropneustes fossilis*, *Clarias batrachus*.
2. Dissection and display of accessory respiratory organs of *Clarias batrachus*, *Channa sp.*, *Heteropneustes fossilis*.
3. Study of larvivorous fishes through museum specimens.
4. Mounting of respiratory epithelium of accessory respiratory organs of *H. fossilis* and air bladder epithelium of carp.
5. Study of museum specimens of fishes having electric organs, venomous organs and air breathing organs.
6. Study of T.S. of gills, accessory respiratory organs and swim bladder from prepared slides.

M. Subba

Stein

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LZL 205
(Based on)

LZL 205: LAB EXERCISES
(Based on papers LZT 201 and LZT 202)

Genetics:

1. Handling of *Drosophila* and study of its life cycle
2. Study of meiosis in grasshopper testes by squashing method
3. Temporary squash preparation of polytene chromosomes from salivary glands of *Drosophila* larvae
4. Study of colchicinated metaphase chromosomes in bone marrow of rodent by air dry method
5. Preparation of human karyotype
6. Study of sex chromatin in human female from buccal epithelial and hair bud cells
7. Examination of wild type (males and females) and mutants of *Drosophila*
5. Sex linked inheritance in *Drosophila melanogaster*
6. Linkage and crossing over in *Drosophila melanogaster*

Mammalian Physiology:

1. Differential leucocytes counting in blood
2. Determination of blood groups (ABO and Rh factor)
3. Estimation of ascorbic acid content in lemon extract using titration method
4. Preparation of casein from milk

Biochemistry:

1. Preparation of extract for enzyme assay (alkaline phosphatase)
2. Study of alkaline phosphatase activity
3. Standard curve preparation
4. Effect of enzyme concentration and determination of total and specific activity
5. Effect of temperature on enzyme activity
6. Effect of time on enzyme activity
7. Effect of substrate concentration on enzyme activity
8. Determination of K_m and V_{max} by Michaelis-Menten and Lineweaver-Burk Plot

M. Tubee

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LZL 206: LAB EXERCISES
(Based on papers LZT 203 and LZT 204)

Biotechniques

1. Principle and working of Centrifuges.
2. Principle and working of Chromatography (Paper chromatography)
3. Principle and working of colorimeter and spectrophotometer
4. Cell counting using haemocytometer (by using suitable stain)
5. Working and principle of Ocular micrometer
6. Measuring of pH using a pH meter
7. Electrophoresis: Nucleic acid and Protein electrophoresis.

Bioinformatics

1. Familiarization with computer operations and TCP/IP
2. Data archiving systems: FASTA format, BankIT, Accession and GI numbers
3. Use of search engines (Google, Altavista, Dogpile, Meta-crawler)
4. Demonstration of web-pages related to biological information (NCBI, ExPasy)
5. Hands on practice to features of following databases GenBank, PDB, DIP, PubMed, Toxnet, OMIM, Fly Base, AceDB, MGDB, HGMD, LSD, KEGG, RNAdb
6. Hands on practice to features of following software packages/tools: BLAST, Clustal-W, PHYLIP, M-fold

Comparative endocrinology & endocrine disorders

1. Preparation and study of distribution of pituitary cell types and functions (teleost model).
2. Study of endocrine control of colour change in amphibians with charts and models.
 3. Study of Comparative anatomy of thyroid gland from pre-stained slides.
 4. Study of Comparative anatomy of adrenocortical and medullary homologues.
 5. Bioassay of Pituitary gonadotropins.
 6. Study of endocrine disorders by charts and models.

M. P. Singh

S. P. Singh

P. K. Singh



LZT 303 (B): FISH BIOLOGY

Paper I: Fish Culture and Pathology

Unit 1: Fish culture systems: Ponds, Fish farm: Lay out and construction of different types of ponds, Formulation and operation of different types of hatcheries, Hatchery management and hatchery breeding, Brood pond management for cultivable indigenous and exotic carps, Fish culture in paddy fields, Sewage-fed fisheries, Larvivorous fishes, Weed fishes, Hill stream adaptations in fishes.

Unit 2: Pond management: Physico-chemical properties of pond water and soil and their maintenance, Manuring (organic and inorganic) and liming, Composite fish farming and polyculture, Predatory and weed fishes and their eradication, Other systems: cage, raft, pens, raceways.

Unit 3: Chemical composition and nutritional value of fish, Fish by-products: Production and utilization: Liver oils, Fish meal, Fish silage, Fish protein, Shark fins and fin rays, Fish roes, Isinglass, Fish skin, Pearl essence.

Unit 4: Fish pathology, prophylaxis and therapy: Protozoan diseases: Cyclochaetiasis, Costiasis, (sliminess of skin), Helminth parasites: *Gyrodactylus*, *Doctylogyrus*.

Unit 5: Crustacean parasites: *Ergasilus*, Fungal diseases: branchiomycosis (gill rot), Bacterial diseases: tail and fin rot, furunculosis, Viral diseases: papillomatosis (cauliflower disease), Nutritional diseases: avitaminoses.

Books Recommended

1. Bentley: Comparative Vertebrate Endocrinology (2000, Cambridge University Press)
2. Gorbman et al: Comparative Endocrinology (1978, John Wiley)
3. Hadley: Endocrinology Prentice Hall (2011, International Editions)
4. Norris: Vertebrate Endocrinology (2nd ed 2009, Academic Press)
5. Bond: Biology of Fishes (1979, Saunders)
6. Brown: The Physiology of Fishes Vol I, II (1953 & 1957, Academic Press)
7. Evans: The Physiology of Fishes (2006, CRC Press)
8. Hall: Ponds and Fish Culture (1994, Agro Botanical Publishers)
9. Hoar & Randall: Fish Physiology, Series Vol. I - XIV (Academic Press)

M. Fisher

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M. Fisher



LZL 304: LAB EXERCISE

Lab exercises based on papers LZT 301 & LZT 302

Developmental Biology

1. Study of frog embryonic development through models
2. Collection of frog spawns and observation of different developmental stages
3. Study of spiral cleavage in eggs of snail
4. Effect of vitamin A in tadpole tail regeneration
5. Study of embryonic development in chick through slides
6. Window preparation to study chick embryo development
7. Whole mount preparation of chick embryos at various stages of development
8. Study of expression of developmental genes in larval imaginal discs.

Immunology

1. Separation of macrophages from mice and their identification on the basis of non-specific esterase staining
2. Immunization of rabbit and collection of antisera
3. Demonstration of antigen-antibody reaction by immunodiffusion
4. Demonstration of direct ELISA

Evolutionary Biology

1. Study of quantitative inheritance in *Drosophila*: stemopleural bristle phenotypes in *D. melanogaster*
2. Demonstration of natural selection under laboratory conditions by making competition between red eyed and white eyed *D. melanogaster*
3. Demonstration of Hardy-Weinberg equilibrium in human populations by taking examples of MN and ABO blood group systems
4. Study of inversion polymorphism in *Drosophila*
5. Study of sexual isolation between two closely related and sympatric species of *Drosophila*: *D. bipunctinata* and *D. malerkotliana*.

Economic Zoology

- Study of life cycle of silkworm through chart/specimens
- Study of life cycle of honey bee through chart/specimens
- Study of external morphology of different castes of honey bee
- Dissection of sting apparatus of honey bee
- Study of life cycle of lac insect through chart.
- Visit to the local dairy farm to study the pests of cattle
- Visit to the local dairy farm to study the dairy management
- Visit to local poultry to study the rearing methods
- Visit to local fish culture site to study the fish culture methods

M. R. K.

S. S. S.

J. K. J.



MAJOR ELECTIVE LABORATORY EXERCISES

LZL 305 (B) : FISH BIOLOGY

Fish Physiology and anatomy

1. Dissection and display of afferent and efferent branchial vessels of a carp and a catfish
2. Study of available histological slides of: gills, accessory respiratory organs, skin. Kidneys, liver and digestive organs of a teleostean fish
3. Determination and comparison of hemoglobin content of water-breathing and air breathing fish
4. Study of ventilation rate and surfacing activity of a air-breathing fish under different experimental conditions
5. Determination of feeding habit of important edible fishes by morphological analyses of their buccopharyngeal region
6. Determination of feeding habit of carps and catfishes by analyses of their gut contents
7. Dissection of carp showing interrelationship between the gas (swim or air) bladder and Weberian ossicles.

M. Kumar

S. S. S.

M. K. J.



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LZT 402 (B): FISH BIOLOGY

Paper IV: Capture Fishery

Unit 1: Fishery resources of India: Inland fisheries, Riverine fishery: regulation and exploitation, river pollution, dams and their effect on fish migration, Lacustrine fishery: management, development and exploitation. Marine fishery: management, development and exploitation, Estuarine Fishery: management, development and exploitation

Unit 2: Inland fishing gears and fishing methods: Types of fishing gears, Preparation and maintenance of fishing nets. Modern techniques and equipment for finding and capturing fishes.

Unit 3: Fish Nutrition: Physiological roles of nutrients, Food and feeding habits of freshwater fishes, Nutrient requirement (proteins, lipids, carbohydrates, minerals and vitamins) for various growth stages of freshwater carps. Nutritional bio-energetics, Anti-nutritional factors and their removal, Supplementary feed, Types, Formulation and processing, storage and quality control.

Unit 4: Fish by-products: production and utilization: Liver oils, Fish meal, Fish silage, Fish protein, Shark fins and fin rays, Fish roes, Isinglass, Fish skin, Pearl essence.

Unit 5: Fish spoilage and preservation: Bacterial, Chemical and Enzymatic spoilage Drying, Salting, Smoking, Canning. Additives: classes of additives, preservatives and antimicrobial additives.

Unit 6: Age and growth: Growth rate and aging, Length weight relationship.

Books Recommended

1. Brown: The Physiology of Fishes Vol 1, II (1953 & 1957, Academic Press)
2. Chakroff: Freshwater Fish Pond Culture and Management (1987, Scientific Publishers)
3. Datta-Munshi & Hughes: Air-breathing fishes of India (1992, Oxford and IBH)
4. Duijn: Diseases of Fishes (1967, London Illiffe Books)
5. Jhingran: Fish and Fisheries of India (1985, Hindustan Publishing Corporation)
6. Khanna and Singh: Textbook of Fish Biology and Fisheries (Narendra Publishing House) 2003
7. Lagler, Bardach, Müller and May Passino, Ichthyology (2003, John Wiley)
8. Nilsson & Holmgren: Fish Physiology Recent Advances (1986, Croom Helm)
9. Ribelin & Migaki: The Pathology of Fishes (1975, The Univ. of Wisconsin Press)
10. Santhanam: Fisheries Science (1990, Daya Publishing House)
11. Srivastava, Gopalji: Fishes of U.P. and Bihar (2002, Vishwavidyalaya Prakashan)
14. Gupta and Gupta: General and applied Ichthyology (Fish and Fisheries) S Chand 2006.

M. P. Singh

Shaw

Sharma



MAJOR ELECTIVE LABORATORY EXERCISES

I.Z.L. 403 (A): MAMMALIAN REPRODUCTIVE PHYSIOLOGY AND
ENDOCRINOLOGY

Hormone Receptors and Signaling Mechanisms

1. Study of exocytotic cycle by photomicrographs
2. Demonstration of gonadotropin receptors in the ovary by Western blot/ICC
3. Demonstration of growth factors in the ovary by Western blot/ICC
4. Estrogen bioassay in female rat
5. Effect of glucagon and insulin on liver glycogen
6. Effects of hormones on lipid metabolism
7. Biochemical estimation of nitric oxide by nitrate/nitrite assay

M. Anand

S. K. Singh

R. K. Singh



MAJOR ELECTIVE LABORATORY EXERCISES

LZL 403 (B): FISH BIOLOGY

Fish Reproduction, Genetics & Biotechnology

1. Determination of fecundity in major carp and catfish
2. Determination of fertilization rate of carp
3. Determination of final oocyte maturation by scoring germinal vesicle breakdown
4. Study of functional morphology of testes and ovary by preparing permanent stained slides belonging to different reproductive phases
5. Determination of gonosomatic index and hepatosomatic index and their relations with regard to gonadal and body growth
6. Demonstration of induced breeding at a seed production centre
7. Visit to a fish farm and hatchery

Fish Physiology

1. Preparation of permanent stained slides of different endocrine glands and kidney of *Heteropneustes fossilis* or *Clarias batrachus*
2. Survey of different endocrine glands
3. Dissection and display of cranial nerves of *Mystus*
4. Demonstration of pinealectomy in catfish
5. Surgical ablation of gonad in a live fish

Inland fishery management

1. Seasonal analyses of pond water by measuring the following physico-chemical properties:
Dissolved CO₂ content, O₂ content, Alkalinity and pH.
2. Collection, mounting and study of helminth parasites infecting locally available fishes
3. Identification of locally available fishes of economic importance
4. Study of efficacy of different methods (freezing, drying, salting, and salting and drying simultaneously) of fish preservation.
5. Periodic survey of fish market to collect gonad and data related to length weight relationship
6. Visit to a fishing site to study the variety of fish catches at different seasons
7. Study of fishing nets being used at different seasons
8. Determination of protein and lipid contents in a fresh and preserved fish

M. K. S.

S. K.

G. K.