

**SARDAR PATEL UNIVERSITY**



**FACULTY OF SCIENCE  
COURSE OF STUDY**

**RULES OF DEGREE OF THE MASTER OF SCIENCE (M.Sc.) ZOOLOGY**

R.PG.Sc.1: A candidate who has obtained the degree of Bachelor of Science of this University or of any other University recognized as equivalent thereto may, after successful completion of the course work etc. prescribed for the M.Sc. degree examination, be admitted to the examination for the degree of M.Sc. in the respective subject as per the regulation prescribed in that behalf.

A candidate possessing a bachelors degree in science with atleast 40% marks in theory papers in external examinations will be held eligible for admission to the Master degree course in Zoology offered by him / her at the Bachelors degree examination. However, the number of eligible applications as in above is less than available seats a candidate possessing bachelors degree in science with three subjects (optional-equal weightage) with atleast 40% marks in theory papers in external examinations will be held eligible for admission to the Masters degree course in Zoology.

The degree of Master of Science will be taken by papers and Practicals only.

R.PG.Sc.2: The examination for the various theory papers and laboratory work will be conducted under semester system. For this purpose each academic year will be divided into two semesters.

R.PG.Sc. 3: Candidates will be examined in each theory paper for 100 marks and each practical (Lab I & Lab II) for 100 marks wherever prescribed at the end of each semester. Project work will be undertaken during IV semester and examined for 200 marks. There shall be a viva-voce examination of 50 marks at the end of the each semester to be held by the university.

(i) For deciding result of M.Sc. examination at each semester the ratio between the internal assessment and external assessment will be 30:70.

For the purpose of internal assessment, the Department concerned will conduct at least one test in each semester. The Department will also arrange Quiz, Seminar etc. for internal assessment in theory course work and the Practicals. The distribution of marks will be as under: -

1.	Structure for each theory paper:				
a)	Quiz	..	..	..	5 marks
b)	Seminar	..	..	..	5 marks
c)	Test	..	..	..	20 marks
					-----
				Total	30 marks

2. Structure for each practical

a)	Regularity, records and results	...	10 marks
b)	Test	... ..	20 marks
			-----
	Total		30 marks

R.PG.Sc. 4: Candidate shall be required to attend at least 75% of total theory, lectures, practical and project work organized under each of the courses during the semesters.

R.PG.Sc.5: (i) The Head of the department in consultation with other teachers of the department will prepare in the beginning of the year a detailed scheme of seminars, home work, quizzes, etc, and the Programme for the test examinations and the same will be announced to the candidates.

(ii) The records of the test examinations as well as seminars, home work, quizzes etc. will be maintained by the department concerned.

(iii) Every candidate shall maintain a regular record of his / her practical work that shall be duly certified by his / her teacher(s) from time to time.

R.PG.Sc.6: Candidates will be required to obtain at least 33% marks in the internal evaluation separately in each head of passing. A candidate who fails to obtain 33% marks in not more than two heads of passing, may be allowed to appear at the University examination by the head of the department concerned on the recommendation of the committee appointed by him to assess the candidate's overall performance.

(Note: A Head of passing will mean a course in theory or practicals).

R.PG.Sc.7: A candidate desirous of appearing at each semester examination my forward his / her application in the prescribed form to the Registrar through the Head of the University Post-graduate Department concerned on or before the date prescribed for the purpose under the relevant ordinances.

R.PG.Sc.8: The final result for the award of the degree will be declared on the basis of the grand total of all the Theory papers, Practical, Project work and viva-voce prescribed for all semester examinations prescribed for the examination.

R.PG.Sc.9: Only those students who fail in not more than two heads of passing at each semester examination be allowed to keep terms at the semester. No candidate will be allowed to reappear in course in which he/she has already passed.

R.PGSc.10: Standard of passing:

The standard of passing at the M.Sc. degree examination will be as under:

- (a) To pass any semester for the M.Sc. degree, a candidate must obtain at least 40% marks at the University Examination and 40% marks in the aggregate of University and Internal examination in each course of Theory and Practicals and 40% marks in Viva-Voce Examination.

- (b) Award of Classes:
- (i) The successful candidates will be placed in Second Class if they obtain at least 50% or more but less than 60% marks in the aggregate of all semesters examination taken together.
  - (ii) The successful candidates will be placed in First Class if they obtain at least 60% or more but less than 70% of the marks in the aggregate of the all the semesters examination taken together.
  - (iii) The successful candidates in First Class who obtain at least 70% or more marks in the aggregate of all the semesters examinations taken together will be declared to have passed the examination in First Class with Distinction.

R.PG.SC.11: (i) A candidate who fails in more than two courses (any two of the total heads of passing) in a particular semester will not be admitted for further study at a subsequent semester and will be required to repeat the courses in which he / she has failed by joining the department as a regular student the semester in which these courses are again offered.

(ii) A candidate failing in not more than two courses at any semester examination will be allowed to continue to the subsequent semester. Such candidate of the First Semester will be permitted to continue his/her study upto Third Semester but will not be permitted to go to the Fourth Semester until he / she has cleared all the courses of the First Semester, even though he / she may have passed in Second and / or Third Semester.

R.PG.Sc. 12: The following will be the scheme of the examination for the M.Sc. Zoology.

M.Sc., ZOOLOGY SYLLABUS

**I- SEMESTER**

Z- 401: EVOLUTIONARY BIOLOGY AND BIODIVERSITY

Z-402: BIOINSTRUMENTATION

Z-403: MOLECULAR CELL BIOLOGY

Z-404: MOLECULAR AND CLINICAL GENETICS

Z-405: LAB I- PRACTICALS

Z-406: LAB II- PRACTICALS

Z-407: VIVA - VOCE

**II - SEMESTER**

Z-501: ENVIRONMENTAL BIOLOGY AND TOXICOLOGY

Z-502: APPLIED PHYSIOLOGY

Z-503: DEVELOPMENT AND DIFFERENTIATION

Z-504: ANIMAL BIOTECHNOLOGY

Z-505: LAB I- PRACTICALS

Z-506: LAB II- PRACTICALS

Z-507: VIVA - VOCE

**III -SEMESTER**

Z-601: AQUACULTURE AND TECHNOLOGIES

Z-602: IMMUNOLOGY

Z-603: MOLECULAR AND APPLIED ENDOCRINOLOGY

Z-604: BIOLOGY OF ANIMAL BEHAVIOR

Z-605: LAB I- PRACTICALS

Z-606: LAB II- PRACTICALS

Z-607: VIVA - VOCE

**IV - SEMESTER**

Z-701 :PROJECT WORK & VIVA-VOCE

## **SEMESTER- I**

### **Z- 401: EVOLUTIONARY BIOLOGY AND BIODIVERSITY**

1. Introduction to Evolutionary Biology: meaning and importance of evolution in biology. A brief history of life. The development of evolutionary theory- Lamarckism, Darwinism, Natural selection, Neo-Darwinism and Mutation theory.
2. Variations- nature and types. Mechanisms that decrease and increase variations (natural selection, genetic drift, mutation, recombination and gene flow). Speciation: Modes of speciation, isolating mechanisms, speciation in time.
3. Macro and micro-evolution: definitions, mechanisms and importance. Evidences, patterns of evolution and extinctions over the geological period. Phylogeny: introduction and concepts of phylogeny. Phylogenetic trees, cladistics and phylogenetic reconstructions, hierarchy of species, transitional forms and molecular phylogeny.
4. Biodiversity: Genetic, species and ecosystem diversity. Biodiversity at global, national levels. Biogeographic classification of India, India as a mega diversity nation.
5. National Parks, Wild life Sanctuaries and Biosphere Reserves, Hotspots of Biodiversity. Threats to biodiversity- habitat loss, poaching and man-wildlife conflicts. Endangered and Endemic species of India: Common plant and animal species.
6. Conservation of Biodiversity, *insitu* and *exsitu* conservation, Keystone species, measurement of biodiversity. Environmental Priorities, strategies and Environmental Legislation (Acts) in India, Environmental Impact Assessment.  
Bioremediation: Concept need and scope, environmental applications.

#### **Recommended References:**

- Population, Species and Evolution- Ernst Mayr
- The theory of Evolution- J. Maynard Smith
- Molecular Evolution and Origin of Life- Widney W. Fox and Klous Dose
- Animal species and their evolution- A.J. Cain
- 29+ Evidences for Macroevolution- Douglas Theobald (<http://www.talkorigins.org/faqs/comdesc/>)
- Textbook for Environmental Studies- Erach Bharucha, UGC, New Delhi (2004)
- Environmental Biology- K.C. Agrawal
- Ecology & Environment- P.D.Sharma
- Biodiversity- E.O. Wilson
- The Biology of Diversity- M.Kato
- The Diversity of Life- E.O. Wilson

### **Z-402: BIOINSTRUMENTATION**

1. Principle and application of light, phase contrast, fluorescence, scanning and transmission electron microscopy, scanning tunneling microscopy, atomic force microscopy, confocal microscopy, cytophotometry and flow cytometry.
2. Preparation of microbial, animal and plant samples for microscopy. Types of microtomes and microtomy.
3. Principles, methodology and applications of gel – filtration, ion –exchange and affinity chromatography; thin layer and gas chromatography; high performance liquid chromatography, FPLC.

4. Centrifugation: Basic principle and application. Differential, density and ultracentrifugation.
5. Electrophoresis: Principle and applications of Native, SDS, Agarose and 2D gel electrophoresis.
6. Principle and method of biophysical analysis of biopolymer structure; X ray diffraction, fluorescence. UV, visible Spectroscopy, Atomic absorption and plasma emission spectroscopy. IR, NMR and ESR spectroscopy, MS and MALDI-TOF.
7. Principle and applications of tracer technique in biology: Radioactive Isotopes and half life of isotopes; Effect of radiation on biological system; autoradiography; Cerenkov radiation; radiation dosimetry; scintillation counting.
8. Biosensors: Principle and application.

**Recommended References:**

- Instrumental method of chemical analysis -Shrama BK
- Instrumental methods of analysis- DA Skoog
- An introduction to practical Biochemistry -Plummer
- Instrumentation -Chatwal and Anand
- Modern experimental Biology- Boyer

**Z – 403 : MOLECULAR CELL BIOLOGY**

1. Introduction –Experimental systems in cell Biology.
2. Biomembranes: Molecular composition, arrangement and functional consequences. Membrane transport and its excitability .
3. Cytoskeleton: Microfilaments, intermediate filaments and microtubules – structure and dynamics. Microtubules and mitosis. Cell movements–intracellular transport, role of kinesin and dynein, signal transduction mechanisms.
4. Cell –Cell signaling: Cell surface receptors. Second messenger system. MAP kinase pathways. Signalling from plasma membrane to nucleus.
5. Cell – Cell adhesion and communication.  $Ca^{++}$  dependent homophilic cell-cell adhesion.  $Ca^{++}$  independent homophilic cell-cell adhesion. Cell junctions and adhesion molecules.
6. Cell matrix adhesion, Integrins, Collagen, Non-Collagen components. Movement of leukocytes into tissues.
7. Cell Cycle. Cyclines and cyclin dependent kinases. Regulation of CDK – cycline activity.
8. Intracellular protein traffic. Protein synthesis on free and bound polysomes. Uptake into ER. Membrane proteins, Golgi sorting, post- translational modifications. Trafficking mechanisms.
9. Biology of cancer.
10. Apoptosis- definition, mechanism and significance.

**Recommended References:**

- Molecular Cell Biology, J. Darnell, H. Lodish and D. Baltimore Scientific American Book, Inc. USA
- Molecular Biology of the Cell, B. Alberts, D. Bray, J. Lewis, M. Raff, K. Roberts and J. D. Watson. Garland Publishing Inc. New York.
- Cell and Molecular Biology. Concepts and Experiments, Gerald Karp. John Wiley and Sons, Inc. New York.
- Essentials of Cell and Molecular Biology. De Robertis E. D. P. and De Robertis E. M. F.
- Basic Histopathology. A Colour Atlas and Text. Paul Wheater, George Burkitt, Alan Stevens and James Lowe. ELBS with Churchill Livingstone.

**Z – 404 : MOLECULAR AND CLINICAL GENETICS**

1. Fundamentals of genes and chromosomes: structure, function and inheritance .DNA structure.
2. Genome replication and regulation.
3. Transcription: DNA methylation and gene expression. Synthesis and processing of RNA. Regulation of genome activity.
4. Mutation and mutagenesis, DNA repair.
5. Chromosome organization, methods of chromosome analysis and numerical as well as structural chromosome abnormalities.
6. Pedigree analysis, Mendelian and non-Mendelian pedigrees, mosaicism, chimerism, polygenic and multifactorial inheritance.
7. Recombinant DNA technology - Introduction, principles, methods and applications. Possible biological hazards of recombinant DNA technology.
8. Human genetic diseases and diagnostics- disorders associated with metabolism. Somatic mutations and cancer. Congenital abnormalities and single gene disorders. Genetic testing in individuals and populations. Prenatal diagnosis of genetic diseases.
9. Features of human genome- Evolution. Mapping of human genome. Human genome project. Manipulation of human genes. Creating animal models of diseases. Gene therapy and other molecular genetic based therapeutic approaches.

**Recommended References:**

- Karp, G.: Cell and molecular biology – concepts and experiments. John Wiley & sons, New York.
- Brown, T.A.: Genomes. John Wiley & Sons. NY.
- Hartl, D.M. and Clark, A.G: Principles of population genetics. Sinauer, Sunderland, MA.
- Watson, J.D., Gilman M., Witkowski, J and Zoller M.: Recombinant DNA. Scientific American Books.
- Emery, A.E.H.: Elements of medical genetics. Churchill Livingstone, Edinburgh.
- Weatherall, D. J.: The new genetics and clinical practice. Oxford University, UK.

**Z-405: LAB I- PRACTICALS**

**Z-406: LAB II- PRACTICALS**

**Z-407 VIVA VOCE**

## **SEMESTER- II**

### **Z-501: ENVIRONMENTAL BIOLOGY AND TOXICOLOGY**

1. The multidisciplinary nature of Environmental studies: definition, scope, importance, Need for Public awareness- institutions and people in Environmental studies. Renewable and non-renewable resources: forest, water, mineral, food and land resources. Conservation of natural resources, use of alternate energy sources and case studies.
2. Ecosystems: concept, structure, components and functions. Energy flow in the ecosystem- Water, Carbon, Oxygen and Nitrogen cycles and integration of energy cycles in nature. Ecological succession: Food chains, webs and ecological pyramids. Types, characteristics, structure and functions of ecosystems: Forest, Grassland, Desert and Aquatic ecosystems.
3. Population and Community Ecology: Basic concepts, characteristics, dynamics and regulation of population density. Characteristics, composition, structure, development and classification of communities.
4. Ecotoxicology and its environmental significance, Branches of Toxicology. Environmental Pollution: Air, water, soil and land pollution. Impact of pollutants on general fauna, flora and ecosystems. Factors influencing environmental concentration of toxicants and toxicity. Environmental monitoring of pollutants Environmental policy in control of pollution.
5. Toxicological Testing Methods: Acute, Subacute, Chronic and Special tests (Metabolic, neurotoxicity and reproductive toxicity, Carcinogenicity and Mutagenicity). Synergism and antagonism, Dose-Response relationships, determination of LD<sub>50</sub> and ED<sub>50</sub>, Acute and Chronic exposures. Statistical concept of toxicity-concentration, Margin of safety, Toxicity curves, cumulative toxicity and toxicity of chemical mixtures.
6. Pesticide Toxicity: Pesticides and Types: insecticides, herbicides, fungicides, rodenticides, nematicides, fumigants. Properties and effects of pesticides: Mechanism of action, Pharmacokinetics, Acute & chronic effects, treatment, Biological monitoring and regulation.
7. Toxicology of Food Additives and Metals: Types and functions of food additives, hazards of food additives. Pharmacokinetics of Metals (Absorption, distribution, inhalation, oral ingestion, dermal exposure), metabolism, storage and excretion.  
Toxicology of metals – Arsenic, cadmium, chromium, lead, mercury, zinc, Beryllium and Nickel.
8. Xenobiotic Metabolism: Xenobiotics – Transfer across Membrane barriers, Absorption, Distribution. Biotransformation – Phase I (Oxidation, reduction and hydrolysis) and phase – II (Glucuronidation, Sulfation, Glutathione Conjugation, Acetylation, aminoacid conjugation and Methylation) reactions. Excretion of xenobiotics.

#### **Recommended References:**

- Textbook for Environmental Studies- Erach Bharucha, UGC, New Delhi (2004)
- Environmental Biology- K.C. Agrawal
- Ecology & Environment- P.D.Sharma
- Biodiversity- E.O. Wilson
- The Biology of Diversity- M.Kato
- The Diversity of Life- E.O. Wilson

- Principles of Toxicology: (eds.) Phillip L. Williams, Robert C. James and Stephen M. Roberts, John Wiley & Sons Inc. New York.
- Environmental Biology: P. D. Sharma, Rastogi Publications, Marut.
- Toxicology : P. D. Sharma, Rastogi & co. Marut
- An Introduction to Toxicology: S. N. Prasad & Vasantika Kashyap, S. Chand & Co., New Delhi.
- Environmental Pollution : M. Manivasakam, National Book Trust, New Delhi
- Modern Toxicology: Vol. I, II, III: Gupta, P. K. and Salunkhe. D. K. Metropolitan Book Co. Pvt. Ltd. New Delhi.
- Environmental Biology: K. C. Agrawal, Agro Botanica, Bikaner.
- A text Book of Environmental Chemistry and Pollution Control: S. S. Dara S. Chand & Co. Ltd. New Delhi.

### **Z-502: APPLIED PHYSIOLOGY**

1. Physiology of Nutrition and Digestion:  
The essential nutrients, types of food, vitamins, minerals, water and the concept of 'balanced diet'. Carbohydrate, lipid and protein metabolism.  
An overview of human digestive tract.  
Digestion and absorption of carbohydrates, proteins and fats.  
Neural and endocrine regulation of gastro-intestinal movement and secretion.  
Obesity, starvation and stimulation of hunger and thirst.
2. Physiology of Respiration:  
An overview of human respiratory system.  
Respiratory movements and the exchange of respiratory gases at pulmonary surfaces.  
Neural and humoral control of respiration.  
Transport of respiratory gases in blood.  
Respiratory 'acidosis' and 'alkalosis' and the concept of 'alkali- reserve' and regulation of blood pH.  
Respiratory disorders: hypoxia and oxygen therapy, dyspnea, high altitude respiration
3. Physiology of Blood Circulation:  
An overview of human circulatory system.  
The myogenic heart. Pacemaker system and conducting fibers.  
Neural, humoral and pharmacological regulation of cardiac amplitude and frequency.  
Cardiac cycle, cardiac output, blood pressure and regulation.  
Blood-components and functional significance. Blood coagulation and factors involved in coagulation. Haemopoiesis and blood groups.  
Lymph- composition and dynamics, Disorders of circulatory system: coagulation disorders, hypertension, atherosclerosis and anemias.
4. Physiology of Excretion:  
An overview of human urinary system.  
The functional anatomy of human kidney and the functional units. Ultrafiltration, reabsorption and secretion as transport mechanisms involved in urine formation. Control of urinary concentrations of glucose, urea, sodium and potassium ions and hydrogen ions and pH of urine.  
Role of kidney in body water, electrolyte and acid-base balance.  
Physiological roles of aldosterone, anti-diuretic hormone and rennin-angiotensin system in renal functions.  
Renal malfunctions and hemodialysis.
5. Physiology of Nervous System:  
An overview of the human nervous system and organization.  
Structure of neuron, types of neurons, neuralgia, myelination.

Electrical signals and signal transmission. Membrane channels, resting and action potentials, propagation of nerve impulses, synapses and types, synaptic knobs and synaptic potentials.

Neurotransmitters: Physiological role of acetyl choline, aminoacids, GABA, catecholamines, nitric oxide and neuropeptides.

Disorders of the nervous system: multiple sclerosis, epilepsy, neuropathy, Guillain-Barre syndrome.

Neurotoxicity: neurotoxins, anaesthetics, neuro-transmission inhibitors.

General properties of sensory receptors, chemical senses, hearing and vision.

6. Physiology of Muscular System:

An overview of the muscular tissue: types of muscle tissue, properties and functions of the muscle tissues.

Skeletal muscle tissue and types. Contraction and relaxation processes and metabolism of skeletal muscle fibers. Physiology of smooth muscle.

Disorders of muscular system: Myasthenia Gravis, muscular dystrophy, fibromyalgia, muscular atrophy and hypertrophy, Rigor Mortis.

7. Physiology of Reproductive Systems:

An overview of organization of human male and female reproductive systems.

Histological features of male and female gonads. The process of gametogenesis (spermatogenesis and oogenesis). Phases and hormonal regulation of female reproductive cycles.

Birth control: Physiology of birth control methods.

Disorders of reproductive systems: testicular cancer, prostate disorders, cryptorchidism and hernias, PMS, PMDD, ovarian and cervical cancers.

**Recommended References:**

- Guyton, A.C and Hall J.E.: Textbook of Medical Physiology. W.B.Saunders Co. Philadelphia.
- Tortora, G. J.: Principles of Anatomy and Physiology. John Wiley & Sons, Inc.
- Chatterjee, C.C.: Human Physiology (Vol. I, II, III). Medical & Allied Agency.
- James A. Wilson: Principles of Anatomy and Physiology. Macmillan Publishing Co.

**Z-503: DEVELOPMENT AND DIFFERENTIATION**

1. Introduction to animal development.  
Developmental patterns in metazoans; Development in unicellular eukaryotes; Evolution of differentiation and morphogenesis.
2. Early development in selected invertebrates and vertebrates.  
Cleavage, Pattern of embryonic cleavage; Comparative account of gastrulation; Early development in: Sea urchin, C. elegance; Drosophila; Amphibia; Birds; Mammals
3. Later embryonic development  
Development of ectoderm: Neurulation and Central nervous system, Epidermis, Neural crest cell.  
Development of mesoderm: Paraxial mesoderm, Intermediate mesoderm, Lateral plate mesoderm.  
Development of endoderm
4. Differential gene expression during development.

- Differential gene transcription. Selective nuclear RNA processing.  
Selective messenger RNA translation. Differential protein modification.  
Progressive cell-cell interaction, communication and cell specification fate.
5. Body Axes.  
Establishment of body axes in mammals and birds.  
Genetics of axis specification in *Drosophila*
  6. Homeobox concept in different phylogenetic groups.
  7. Tetrapod limb development.  
Limb bud; Proximo-distal, Anterior-posterior, Dorsal-ventral axis specification  
Cell death pathway.
  8. Hormones as mediators of development:  
Amphibian metamorphosis: Morphological and biochemical changes, Hormonal control.  
Insect metamorphosis: Imaginal discs, Hormonal control, Molecular mechanism of action of ecdysone.
  9. Medical implications of developmental biology.  
Genetic errors of human development. Infertility. Teratogenesis
  10. Environmental regulation of animal development.
  11. Embryonic stem cells.

**Recommended References:**

- S.F. Gilbert, Developmental Biology, Sinauer Associates Inc. Massachusetts
- Ethan Bier, 'The Coiled Spring' Coiled Spring Harbor Laboratory Press New- York
- Karp G, and Berrill N.J., Development
- B.I. Balinsky, An introduction to Embryology, Saunders College Publishing
- Lewis Wolpert, Principles of Development, Current Biology Ltd., London, New York

**Z-504: ANIMAL BIOTECHNOLOGY**

1. Structure and organization of animal cells, tissues and biology of cultured cells.  
General out-line of epithelial tissue, connective tissue, muscular tissue and nerve tissue.  
Cell adhesion; Junctions; Extracellular matrix; Cytoskeleton; Cell cycle; Differentiation;  
Cell signaling; Energy metabolism.
2. Equipments and materials for animal cell culture technology.  
Aseptic conditions and requirement of equipment; Incubation; Storage;  
Different substrates.
3. Introduction to the balanced salt solutions and growth medium:  
Media –Physical properties, balance salt solutions, complete media, serum  
Serum-Free media :  
Chemical, physical and metabolic functions of different constituents of culture medium.  
Role of carbon dioxide. Role of serum and supplements. Serum and protein free media  
and their application.

4. Primary and established cell line culture. Measurement of viability and cytotoxicity. Biology; Characterization and growth of the cultured cells; Disaggregation of tissue and primary culture; Maintenance of cell culture; Cell cloning and cell separation; Cell differentiation; Cell synchronization and transformation; Measurement of cell death and apoptosis.
5. Basic techniques of mammalian cell culture *in vitro*.  
Culture of specialized cells: Epithelia; Mesenchymal and connective tissues; Muscles; Neuroectoderm; Endocrine; Hematopoietic cells; Tumor cells
6. Embryonic stem cells, stem cell culture and their applications.
7. Embryo technology and transgenic animals.

**Recommended References:**

- Freshney, R. I.: Culture of Animal Cells. Wiley-Liss.
- Masters, J. R. W. (ed): Animal Cell Culture – Practical Approach, Oxford Univ. Press.
- Basaga, R. (ed): Cell Growth and Division: A Practical Approach. IRL Press.
- Butler, M and Dawson, M. (eds.): Cell Culture Lab Fax, Eds., Bios Scientific Publications Ltd., Oxford.
- Clynes, M. (ed): Animal Cell Culture Techniques. Springer.
- Mather, J.P and Barnes, D. (eds). : Methods in Cell Biology, Vol. 57, Animal Cell Culture Methods. Academic Press.

**Z-505: LAB I- PRACTICALS**

**Z-506: LAB II- PRACTICALS**

**Z-507 VIVA VOCE**

**SEMESTER- III**

**Z-601: AQUACULTURE AND TECHNOLOGIES**

1. General characters and classification of fishes and prawns.
2. Culture practices: Indian major carps and exotic carps; Shrimps and prawns; Seaweeds.
3. Induced Breeding: Hormonal regulation of gonadal development, Activity of Gonadotropin releasing hormone, application of hormones in aquaculture.
4. Fish and Prawn/ Shrimp Diseases: Types of Diseases- viral, bacterial, fungal, protozoan and other parasitic diseases; Diagnosis; Control measures; Water quality parameters, Role of biopesticides; Application of monoclonal antibodies; Vaccines and immunostimulants; Drug resistance
5. Aquafeed: Nutrition, Feed formulation, Feed additives, Alternative feed ingredients.
6. Cytogenetics and molecular techniques in fisheries: Comet Assay, Micronuclei Test, Fish Cell Culture, Application of Hybridoma Technology, Transgenesis and Androgenesis and recent developments in marine biotechnology.
7. Jellyfish Green Fluorescent Proteins and their applications.
8. Fish products and byproducts, fish processing, production of fish sauce by lactic acid fermentation. Microbial hazards in seafood.

**Recommended References:**

- Jayaram K. C. 1981. The fresh water fishes of India, Pakistan, Bangladesh, Burma and Sri Lanka.
- Jhingran V. G. 1985. Fish and Fisheries of India.
- Kurian, C. V. and Sebastian, V. O. 1986. Prawns and Prawn fisheries of India.
- Jones, F. R. H. 1968. Fish Migration.
- Rao, K. L. 1975. India's water wealth.
- Balakrishnan, N. N. and Thampy, D. M. 1980. A textbook of marine ecology.
- Lakra W. S., Abidi SAH, Mukherjee SC and Ayyappan S. 2004. Fisheries Biotechnology.
- Harvey, B. J. and Hoar, W. S. 1979. Theory and practice of induced breeding in fishes.
- T. V. R. Pillay. 1993. Aquaculture – Principles and Practices. Fishing News Book.

### **Z-602: IMMUNOLOGY**

1. Adaptive immunity and innate immunity: inflammation, role of cells, receptors and proteins in innate immunity, ubiquity of the innate system.
2. Cells and organs of the immune system: Hematopoiesis, cells of the immune system, primary and secondary lymphoid organs.
3. Antigens and antibodies: properties of immunogens, haptens, epitopes, structure and classes of immunoglobulins, biological activities and effector functions, monoclonal antibodies and abzymes.
4. Antibody diversity: models, organization of Ig genes, mechanism of gene rearrangement, generation of diversity; expression, synthesis and class switching, antibody engineering.
5. Antigen-antibody interactions: principles and applications.
6. Major histocompatibility complex and antigen presentation: MHC- organization, inheritance, genes, molecules and peptide binding, expression, disease susceptibility, immune responsiveness, self MHC restriction, cytosolic and endocytic pathway for antigen processing.
7. T-cell receptor, T-cell maturation, activation and differentiation: TCR- genetic organization and rearrangement of genes, TCR-complex, peptide binding, thymic selection, activation and differentiation of T cells.
8. Generation, activation and differentiation of B cells: B cell maturation, activation and proliferation, germinal centers, regulation of the responses.
9. Complement: components of the system, activation, regulation, biological consequences and deficiency diseases.
10. Cytokines: properties, receptors, associated diseases, therapeutic applications.
11. Leukocyte activation and migration: CAM, chemokines, recirculation and extravasation, inflammation and anti-inflammatory agents.
12. Cell mediated cytotoxicity: effector T cells, cytotoxic T cells, NK cells, ADCC.
13. Hypersensitivity reactions: classification and types of hypersensitivity reactions. Immune tolerance and autoimmunity: establishment and failure of tolerance, autoimmune diseases, mechanisms for the induction, animal models, treatment. Transplantation immunology: basis and manifestation of graft rejection, immunosuppressive therapy, immune tolerance.
14. Experimental systems in immunology.

#### **Recommended References:**

- Kuby-Immunology: T. J. Kindt, R. A. Goldsby and B. A. Osborne; W. H. Freeman
- Immunology: Ivan Roitt, J. Brostoff and D. Male; Mosby
- Essential immunology: Ivan Roitt; Oxford: Blackwell
- Topic related review articles.

### **Z-603: MOLECULAR AND APPLIED ENDOCRINOLOGY**

1. Introduction: A brief history of discovery of hormones.
2. An overview of vertebrate endocrine system. Structural features and hormones of endocrine glands- hypothalamus, pituitary, pineal, thyroid, parathyroids, GI tract, pancreatic islets, adrenals and gonads. Endocrinology of pregnancy, parturition and lactation.
3. Endocrine methodologies: Ablation and replacement, bioassays, immunoassays, Immunocytochemistry, autoradiography, electrophysiological and pharmacological methods, hormone-receptor interactions, cloning techniques.
4. Hormones of endocrine glands: synthesis and control of synthesis, storage, metabolism and functions.
5. General classes of hormones: peptide, thyroid, steroid, neuro-transmitters, neuropeptides, chalcones, peptide-growth stimulating factors, eicosanoids and pheromones.
6. Mechanisms of hormone action: Receptors and types- membrane receptors, nuclear receptors; receptor regulation and signal transduction, second messengers, permissive actions of hormones and termination of hormone action.
7. Pathophysiology of hypothalamic, pituitary, pineal, thyroid, parathyroid, GI tract, pancreatic islets, adrenal and gonadal hormones. Imaging and nuclear medicine in endocrine disease and hormone-replacement therapies.

#### **Reference Books:**

- Molecular Endocrinology: Franklyn F. Bolander. Elsevier- Academic Press.
- Molecular Cell Biology: J. Darnell, H. Lodish and D. Baltimore Scientific American Book, Inc. USA
- Vertebrate Endocrinology: Norris, D. O. Academic Press, New York
- Endocrinology, Vol. I, II, III: D Groot. L. J. (ed.), W. B. Saunder Philadelphia
- Biochemical Actions of Hormones: Litwack, G. Academic Press. Principles of Anatomy and Physiology: Tortora, G. J. John Wiley & Sons, Inc.
- Essential Endocrinology: Brook, C.G.D. and Marshall, N.J. Blackwell Publishing.

### **Z-604: BIOLOGY OF ANIMAL BEHAVIOR**

1. Introduction: Ethology as a branch of biology Classification of behavioral patterns, Analysis of behavior, innate behavior.
2. Perception of the Environment: Sensory mechanisms: Mechanical, Electrical, Chemical, Olfactory, Auditory and Visual.  
Neural and Hormonal Control of behavior: Role of nervous system in emergence of behavioral patterns.  
Role of endocrine secretions in behavioral expressions.
3. Communication:

Dance language of the honey bees, Communication through pheromones  
Visual communication, auditory communication, Evolution of communication

4. Social Behaviour:  
Aggregations – Schooling in fishes, flocking in birds, herding in mammals Group section, Kin selection, altruism, reciprocal altruism, inclusive fitness, social organization in insects and primates.
5. Reproductive Behavior:  
Evolution of sex and reproductive strategies, Mating systems, courtship, Sexual Selection, parental care.
6. Biological Rhythms:  
Circadian and Circannual rhythms, Orientation and navigation  
Migration of fish, turtles and birds.
7. Learning and Memory  
Conditioning, Habituation, Insight learning, Association learning, Reasoning, Cognitive skills.

**Reference Books:**

- An Introduction to Animal Behaviour. Aubrey Maning and Dawkins, M. S. Cambridge university press, U.K.
- Animal Behaviour : An Evolutionary approach. Alcock J., Sinauer Associates Inc. Sunderland, Massachusetts.
- Animal Behaviour – psychobiology, Ethology and Evolution, Macfarland, D. pitman publication Ltd. London.
- Animal Behaviour – Reena Mathur, Rastogi and Co. Meerut
- Ethology : The Biology of Behaviour. Eibl – Ebesfeldt, I. Holt, Reinhart & Winston, New York.
- Animal Behaviour, Arora, M. P. Himalaya publishing House, Bombay
- An Introduction to Animal Behaviour, Harjindra singh, Anmol Publications, New Delhi.
- An Introduction to Behavioural Ecology, Krebs, J. R. and Davis, N. B. Blackvell Scientific publications, Oxford.

**Z-605: LAB I- PRACTICALS**

**Z-606: LAB II- PRACTICALS**

**Z-607 VIVA VOCE**

**SEMESTER- IV**

**Z-701: PROJECT WORK & VIVA-VOCE**