

# Program Structure & Syllabus

for

## M.Sc. Zoology

*(Syllabus for Semesters I & II is common for M.Sc. Zoology and M.Sc. Aquaculture)*

**2019-2020**



**Department of Zoology**

**School of Life and Health Sciences**

**ADIKAVI NANNAYA UNIVERSITY**

**Rajamahendravaram**

**ADIKAVI NANNAYA UNIVERSITY: RAJAMAHENDRAVARAM  
BOARD OF STUDIES MEETING - AQUACULTURE/ ZOOLOGY**

**Date: 04-04-2019**

**AGENDA:**

1. Eligibility and Entrance Examinations
2. Revision of the Syllabus
3. Syllabus for practicals
4. Number of teaching hours / Periods theory / Practical
5. Model Question Papers
6. Credits / Evaluation
7. Scheme of Valuation
8. List of Examiners for paper setting
9. List of Practical Examiners

**Members:**

Dr. D. Kalyani,  
Convener, BoS – Aquaculture/Zoology

Prof. Pala Indira

Dr. A. Matta Reddy

Dr. K. Ramaneswari

Dr. P. Vijaya Nirmala

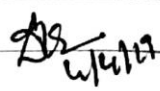

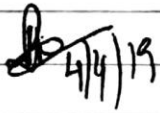
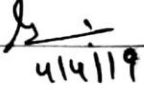
Dr. J. Lalitha Bharathi

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Minutes of the meeting of Board of Studies held on 4/4/19 at 12-00 Noon at Department of Zoology, Adikavi Nannaya University, Rajamahendravaram

Board of Studies Meeting for Zoology / Aquaculture

Members Present:

1. Dr. D. Kalyani, Asst. Professor in Zoology, ANUR.  4/4/19  
Convenor
2. Prof. Pala Indira, Sri Krishna Devaraya University, Anantapur, Member
3. Dr. A. Malha Reddy, Associate Professor, ANUR.  4/4/19  
Member
4. Dr. K. Ramareddy, Associate Professor, ANUR.  4/4/19  
Member
5. Dr. P. Vijaya Nirmana, Asst. Professor, ANUR.  4/4/19  
Member
6. Dr. J. Lalitha Bhasathi, SKR, College for women, Rajamahendravaram, Member
7. Officer from Avanti Seeds, Bhi

## RESOLUTIONS:

The common Board consisting of the above members have met in the Department of Zoology, Adikavi Nannaya University, Rajamahendravaram and considered the enclosed agenda. After thorough deliberations and discussions, the Board members have resolved the following.

1. A B.Sc graduate with “Zoology” as one of the subjects is eligible to apply for admission into M.Sc Zoology / Aquaculture.
2. The members formulated the syllabus for M.Sc Zoology and M.Sc Aquaculture a 2 year program on par with other Universities in the Country to be implemented from academic year 2019-20.
3. The syllabus for practicals of the above courses was formulated on par with UGC model curriculum.
4. There shall be 4 to 5 hours per week for each theory paper & 3 hrs for each practical.
5. I & II Semesters are common for M.Sc Zoology & Aquaculture whereas III & IV Semesters have separate syllabus for M.Sc Zoology & Aquaculture respectively.
6. Marks and credits are allotted to theory & practical papers in each semester. There will be 100 marks for each theory, and 200 marks for 4 practicals each 50 marks and total marks for each semester 600 x 4 semester 2400 marks.
- 7. Examination pattern will be as follows.**
  - a) Each theory paper will be evaluated for 100 marks out of which 75% of marks, for Semester End Examination (SEE) while the remaining 25% marks for Continuous Internal Assessment(CIA)

Continuous Internal Assessment		
S.No	Scheme of Evaluation	Marks
1	Mid-Semester Examination	10M
2	Assignment/Seminar Presentation	5M
3	Attendance	5M
4	Swachhata Activity	5M
	Total	25M

Details of Attendance Marks		
S.No	Attendance	Marks Allotted
1	95% above	5
2	85-94%	4
3	75-84%	3
4	65-74%	2
5	55-64%	1
6	< 54%	0

- b) The Semester End Examination question paper comprises of two sections –Section A & B, Section A consists of 4 questions one question from each unit of syllabus with internal choice ‘a’ or ‘b’. Section-B consists of 8 short questions two from each unit of the syllabus, with internal choice out of which only 5 are to be attempted
  - c) Similarly each practical will be evaluated for a total of 50 marks, out of which 75% of marks for Semester End Examination (38 Marks) and 25% (12 Marks) for Continuous Internal Assessment.
8. A comprehensive viva-voce will be conducted for students at the end of IV semester for 100 marks.

**M.Sc. ZOOLOGY**  
**SEMESTER - END EXAMINATION**  
**Theory Model Question Paper Pattern**

Time: 3 hrs

Max. Marks: 75

**Section-A**

Answer all questions. Each question carries 15 marks.

4x15=60

**Q1. Unit-1**

a or b

**Q2. Unit-2**

a or b

**Q3. Unit-3**

a or b

**Q4. Unit-4**

a or b

**Section-B**

5x3=15

**Q5.** It contains 8 short questions with at least two from each unit, carrying 3 marks.

5 questions are to be answered.



# ADIKAVI NANNAYA UNIVERSITY

## RAJAMAHENDRAVARAM

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The Department of Zoology, Adikavi Nannaya University has been offering M.Sc. programs in Aquaculture & Zoology since 2016 and 2006 respectively. There is a need to envisage and accordingly revise syllabi so as to incorporate rising concepts / aspects in relevant subjects to be in sync with emerging national and global higher educational trends. These programs have been meticulously designed to enrich the students' theoretical knowledge in basic, core and specialized papers. Each theory paper is linked with practicals which gives them hands on experience and enhance their critical thinking, constructive planning and analytical skills. Thus by the end of the program students would be confident enough either in attaining higher studies or boldly face the competitive world and grab different job opportunities.

## M.Sc. Zoology Program Structure

Code	Title of the paper	Total Marks	Credits	Teaching Hours
<b>I Year</b>				
<b>I SEMESTER</b>				
A/Z 101	Tools and Techniques for Biology	100	4	4
A/Z 102	Biosystematics, Biodiversity and Evolution	100	4	4
A/Z 103	Biomolecules	100	4	4
A/Z 104	Molecular Cell Biology	100	4	4
	<b>Lab Course</b>			
A/Z 105	Tools and Techniques for Biology lab	50	2	3
A/Z 106	Biosystematics, Biodiversity and Evolution lab	50	2	3
A/Z 107	Biomolecules lab	50	2	3
A/Z 108	Molecular Cell Biology lab	50	2	3
<b>II SEMESTER</b>				
A/Z 201	Biostatistics & Bio-informatics	100	4	4
A/Z 202	Animal Physiology	100	4	4
A/Z 203	Immunology	100	4	4
A/Z 204	Molecular Biology	100	4	4
	<b>Lab Course</b>			
A/Z 205	Biostatistics & Bio-informatics lab	50	2	3
A/Z 206	Animal Physiology lab	50	2	3
A/Z 207	Immunology lab	50	2	3
A/Z 208	Molecular Biology lab	50	2	3
<b>II Year</b>				
<b>III SEMESTER</b>				
Z 301	Applied Zoology	100	4	4
Z 302	Developmental Biology	100	4	4
Z 303	Principles of Ecology	100	4	4
Z 304	Metabolic Cell Function & Regulation	100	4	4
	<b>Lab Course</b>			
Z 305	Applied Zoology Lab	50	2	3
Z 306	Developmental Biology lab	50	2	3
Z 307	Principles of Ecology lab	50	2	3
Z 308	Metabolic Cell Function & Regulation lab	50	2	3
<b>IV SEMESTER</b>				
Z 401	Neurobiology & Animal Behavior	100	4	4
Z 402	Animal Cell Culture & Stem Cell Technology	100	4	4
Z 403	Aquaculture	100	4	4
Z 404	Animal Biotechnology & Bio-ethics	100	4	4
	<b>Lab Course</b>			
Z 405	Neurobiology & Animal Behavior lab	50	2	3
Z 406	Animal Cell Culture & Stem Cell Technology lab	50	2	3
Z 407	Aquaculture lab	50	2	3
Z 408	Animal Biotechnology & Bio-ethics lab	50	2	3
Z 409	Comprehensive Viva-voce	100	4	
	<b>Total</b>	<b>2500</b>	<b>100</b>	



**M.Sc. ZOOLOGY**  
**I SEMESTER**

**A/Z 101 TOOLS AND TECHNIQUES FOR BIOLOGY**

**UNIT- I**

Assay- Definition, Biological & Chemical assay. Microscopy- Principles and applications of light, dark field, phase contrast, fluorescence, transmission, electron, scanning electron microscopes. Different fixation and staining techniques for EM. Freeze-etch, freeze-fracture methods for EM, Image processing methods in microscopy. pH meter: Operation of pH electrodes, Principles and applications of Ion-selective and gas sensing electrodes, Oxygen electrodes.

**UNIT - II**

Centrifugation -Basic principles of centrifugation, types of centrifuges, applications of preparative and analytical ultra-centrifuges. Principles and applications of sedimentation, lyophilization. Chromatography: Principles and applications of gel-filtration, ion-exchange and affinity chromatography; TLC, GC & HPLC.

**UNIT - III**

Properties of electromagnetic radiations; Principles, instrumentation and applications of UV, visible, infrared, NMR spectroscopy; Spectrofluorimetry and mass spectrometry. X-ray diffraction, Incorporation of radio-isotopes in biological tissues and cells. Radiolabeling techniques: Detection and measurement of different types of radio-isotopes used in biology, Molecular imaging of radio-active material, safety guidelines.

**UNIT - IV**

Micro-biological Techniques: Media preparation & sterilization, Inoculation & Growth monitoring, Biochemical Mutants & their uses, Microbial assays.

**Suggested Reading Material:**

1. Introduction to Instrumental Analysis. Robert Braun. McGraw Hill International Editions
2. A Biologist Guide to Principles and Techniques of Practical Biochemistry. K. Wilson & K.H. Goulding, ELBS Edn.

## A/Z 102 BIOSYSTEMATICS, BIODIVERSITY AND EVOLUTION

### UNIT - I

Biosystematics- Definition and basic concepts. Importance and applications of biosystematics. Material Basis of Biosystematics. Biological classification-Theories and objectives. Procedures in taxonomy - Taxonomic collections. taxonomic keys. Types of taxonomy- Conventional types, Cytotaxonomy. Chemotaxonomy and Molecular taxonomy. Concept of Zoological Nomenclature.

### UNIT - II

Origin of basic biological molecules. Abiotic synthesis of organic monomers and polymers. Concept of Oparin and Haldane. Experiment of Miller. Evolutionary time scale – Eras, Periods and epochs. Origin and diversification of eukaryotes - Origin of cells and first organisms. Evolution of eukaryotic cell from prokaryotes. Evolution of eukaryotic genomes. duplication and divergence. Molecular divergences, molecular clocks and molecular drive. Phylogenetics- Molecular tools in phylogeny.

### UNIT - III

Universal common ancestor and tree of life – three domain concepts of living kingdom. hierarchical components of bio-diversity. Evolutionary relationships among taxa. Concepts of species. Species category, subspecies and other infraspecific categories. Hierarchy of categories. Speciation- Genetics of speciation, modes of speciation, Patterns and mechanisms of reproductive isolation. Allopatry, sympatry, Convergent evolution, Sexual selection, Co-evolution.

### UNIT - IV

Concepts of evolution – An overview of evolutionary biology, & theories of organic evolution. Concepts of Neutral Evolution, Population genetics- Populations, gene pool, Gene frequency; Hardy Weinberg law. Concepts and rate of change in gene frequency through Natural selection, mutation, migration and random genetic drift. Phylogenetic gradualism , punctuated equilibrium and origin of higher categories

#### **Suggested Reading Material:**

1. M. Kato. The Biology of Biodiversity, Springer.
2. J.C. Avise. Molecular Markers. Natural History and Evolution, Chapman & Hall, New York.
3. E.O. Wilson. Biodiversity, Academic Press, Washington.
4. G.G. Simpson. Principles of Animal Taxonomy. Oxford IBH Pub. Co.
5. E. Mayr. Elements of Taxonomy.
6. E.O. Wilson. The Diversity of Life (The College Edition), W.W. Northern & Co.
7. Dobzhansky, Th. Genetics and origin of species, Surjeet Publication, Delhi
8. Dobzhansky, Th., F.J. Ayala, G.L., Stebbens and J.M. Valentine Evolution, Surjeet Publication, Delhi
9. Futuyama, D.J. Evolutionary Biology, Sinauer Associates, INC, Publishers, Dunderland
10. Hartl. D.L.A. Primer of population Genetics, Sinauer Associates, INC Massachusetts.
11. Jha, A.P. Genes and Evolution, John Publication, New Delhi
12. King, M. Species Evolution -the role of chromosomal change. The Cambridge University Press, Cambridge.
13. Strikberger, M.W. Evolution, Jones and Bartett Publishers, Boston London
14. Tandon RK. 1999. Biodiversity, Taxonomy & Ecology. Prithipal Singh Scientific Publishers, Jodhpur.

## A/Z 103 BIOMOLECULES

### UNIT - I

Chemical foundations of biology, Amino acids – classification, Peptide bond, Proteins – classification, structural organization of proteins, primary structure, secondary structure, tertiary structure, quaternary structure, Conformation of proteins (Ramachandran plot) - domains, motifs and folds. Denaturation & renaturation of proteins.

### UNIT - II

Carbohydrates: Definition and classification of carbohydrates, nomenclature, Reaction of Mono-saccharides, Acid derivatives of Mono-saccharides, amino-sugars, Oligo-saccharides, structure and properties, Chemistry and biological roles of homo and hetero-polysaccharides, peptidoglycan, glycosaminoglycans, glycoproteins and other glycoconjugates.

### UNIT - III

Classification of Lipids & Fatty acids and their physicochemical properties, characterization of fats and oil; Structure, properties and biological roles of triacylglycerol, phospholipids, sphingolipids, Gangliosides, Prostaglandins, Thromboxanes, Leukotrienes and steroids.

### UNIT - IV

Nucleic acids – nitrogen bases, nucleosides, nucleotides, physicochemical properties of nucleic acids, cleavage of nucleic acids by enzymatic and non-enzymatic methods, chemical synthesis of DNA; Nucleic acid sequencing, chromatin structure, Three dimensional structure of DNA; Types of RNA, Structure of RNAs – Secondary and Tertiary structure; DNA denaturation and renaturation.

### Suggested Reading Material:

1. Nelson.D.L, Cox. M. M. Lehninger's Principle of Biochemistry. Freeman.
2. Murray. R.K, Granner.D.K, Mayes. P. A, Rodwell. V. W. Harper's Biochemistry, McGraw Hill.
3. Fundamentals of Biochemistry by Donald Voet.
4. Textbook of Biochemistry West, E.S., Todd, Mason & Vanbruggen, Macmillian&Co.
5. Biochemistry, Lubert Stryer.

## A/Z 104 MOLECULAR CELL BIOLOGY

### UNIT - I

Introduction: Experimental system in Cell Biology

Biomembranes

Molecular composition and arrangement, functional consequences

Transport across cell membrane: diffusion, active transport, pumps, uniports, symports and antiports

Membrane potential

Co-transport by symporters or antiporters

Transport across epithelia: Transport of macromolecules

### UNIT - II

Cytoskeleton

Microfilaments and microtubules – structure and dynamics

Microtubules and mitosis

Cilia and flagella

Cell movements – intracellular transport, role of kinesin and dynein, signal transduction mechanisms

### UNIT - III

Cell-Cell Signaling

Cell surface receptors

Second messenger system

MAP kinase pathways

Apoptosis: Definition, mechanism and significance

Cell-Cell adhesion and communication

Ca<sup>++</sup> dependent homophilic cell-cell adhesion

Ca<sup>++</sup> independent homophilic adhesion

Gap junctions and connections

Integrins

Collagen

### UNIT - IV

Cell cycle

Cyclins and cyclin dependent kinases

Regulation of CDK-cyclin activity

Genome organization

Hierarchy in organization

Chromosomal organization of genes and non-coding DNA

Mobile DNA

Morphological and functional elements of eukaryotic chromosomes

Intracellular protein traffic

Protein synthesis on free and bound polysomes

Uptake into ER

Membrane proteins, Golgi sorting, post-translational modifications

Biogenesis of mitochondria and nuclei

Trafficking mechanisms

### Suggested Reading Material:

1. Molecular Cell Biology, J. Darnell, H. Lodish and D. Baltimore, Scientific American Book INC, USA.
2. Molecular Biology of the Cell, B. Alberts, D. Bray, J. Lewis, M. Raff, K. Roberts and J.D. Watson Garland Publishing INC, New York.

## I SEMESTER PRACTICALS

### **A/Z 105 Tools and Techniques for Biology lab:**

1. Spectrophotometer – Estimation of biomolecules
2. Centrifugation – Demonstration and working
3. Separation Techniques - Paper chromatography
4. Electrophoresis – Demonstration and usage
5. PH Meter – Preparation of Phosphate buffer Preparation
6. Microscope –
  - a) Demonstration of oil immersion – WBC & RBC
  - b) Preparation of tissue for SEM & TEM procedure

### **A/Z 106 Biosystematics, Biodiversity and Evolution Lab:**

1. Invertebrate and Vertebrate Phyla
2. Types of Speciation-Models/Charts
3. Problems on Hardy-Weinberg law
4. Random genetic drift causing change in gene frequency-Practical demonstration.
5. Recent studies in Evolution- Examples

### **A/Z 107 Biomolecules lab:**

1. Estimation of glycine by formal titration
2. Estimation of proteins by Lowry and Biuret methods
3. Analysis and identification of monosaccharides
4. Estimation of maltose by DNS method
5. Determination of Iodine value of oils
6. Estimation of Cholesterol
7. TLC of Amino acids

### **A/Z 108 Molecular cell Biology lab:**

1. Light microscopic examination of tissues
2. Preparation of different cell – types Hepatic parenchymal cells, adipocytes, macrophages, neuronal cells, epithelial cells
3. Stages of Mitosis and Meiosis
4. Squash preparation
5. Sub-cellular fractionation – separation of macromolecules

**M.Sc. ZOOLOGY**  
**II SEMESTER**

**A/Z 201 BIOSTATISTICS & BIOINFORMATICS**

**UNIT - I**

Biostatistics- Introduction and Scope of biostatistics, Sampling. Primary and Secondary data, Frequency distribution, Graphic representation of data- bar diagram, histograms, pie diagram, frequency polygon and Ogive. Measures of central tendency- mean, median, mode. Measures of Dispersion- variance, standard deviation, coefficient of variation

**UNIT - II**

Probability and probability distributions-definition of probability - Bernoulli, binomial, Poisson and normal distributions; Correlation and regression Tests of Significance - hypothesis, critical region and error probabilities, t- test, chi-square test for independence, one way and two- way analysis of variance.

**UNIT - III**

Basic components of computers– hardware (CPU, input, output, storage devices), Software (operating systems), Application software; Introduction to MS-EXCEL. Use of in-built statistical functions for computations of mean, SD, correlation, regression coefficients, Use of bar diagram, histogram, scatter plots, Graphical tools in EXCEL for presentation of data; Introduction to MS- WORD, word processor- editing, copying, moving, formatting, table insertion, drawing flow charts etc; Introduction to Power Point, image and data handling.

**UNIT - IV**

Bio-informatics –Introduction, History, Internet, Knowledge. Review of relevant definitions in molecular biology. Biological Databases –introduction. Examples of databases together with steps involved in use and interpretation of results). Sequence alignment. Phylogenetic analysis with the program PHYLIP, Introduction to computational genomics and proteomics

**Suggested Reading Material:**

1. Batschelet, E., Introduction to Mathematics for Life Scientists. Springer- Verlag, Berlin.
2. Principles of Biostatistics, Pagano M., Gauvreau, K, (2000), Duxbury Press, USA
3. Murray, J.D. Mathematical Biology. Springer – Verlag, Berlin.
4. T.K. Attwood & D.J. Parry-Smith 1999. Introduction to Bioinformatics. Pearson Education Asia.
5. Stephen Misener & S.A. Krawez 2000. Bioinformatics: Methods and Protocol.
6. Bioinformatics: Sequence and Genome Analysis, Mount, D. W. (2nd Ed., 2001), Cold Spring Harbor Laboratory Press, New York, USA
7. Bioinformatics for Dummies, Claverie J. M., Notredame C., (2nd Ed., 2007), Wiley Publishing, Inc., New York, USA
8. Sokal, R.R. & F.J. Rohlf. Biometry. Freeman, San Francisco.
9. Snedecor, G.W. and W.G. Cochran, Statistical methods for environmental biologists. John Wiley Sons, New York.

## A/Z 202 ANIMAL PHYSIOLOGY

### UNIT - I

**Muscle:** Molecular Structure and properties of Muscle and muscle contraction , Sliding filament theory

**Blood and Circulation** – Blood corpuscles, haemopoiesis and formed elements, plasma function, blood volume, blood volume regulation, Blood groups, Haemoglobin, immunity, haemostasis , factors affecting blood coagulation

**Nerve impulses** , Synaptic transmission & Neurotransmitters, **Nervous system** : Neurons, action potential, gross neuro anatomy of the brain and spinal cord, central and peripheral nervous system, neural control of muscle tone and posture

### UNIT - II

**Thermoregulation:** Comfort zone, body temperature- Physical, chemical, neural regulation, acclimatization.

**Osmoregulation** in aquatic and terrestrial Environments mechanism of ionic regulation

**Stress Physiology:** Responses to biotic and abiotic factors: Light, temperature, salts

### UNIT – III

**Digestion:** absorption, energy balance of BMR

**Respiratory system** - comparison of respiration in different species, anatomical considerations, transport of gasses, exchange of gases, waste elimination, neural and chemical regulation of respiration.

**Excretory System** : Comparative physiology of excretion, Kidney, Urine formation, Urine concentration, waste elimination, micturition, regulation of water balance, blood volume, blood pressure, electrolyte balance, acid-base balance.

**Cardiovascular System:** Comparative anatomy of heart structure, myogenic heart, specialized tissue ECG - its principle and significance, heart as a pump, blood pressure.

### UNIT - IV

**Sensory physiology:** Photoreceptors, Auditory, Chemoreceptor, Mechanoreceptors

**Physiological Adaptation:** Marine environment, shores, Estuaries

Fresh water and Terrestrial environment

Role of Yoga and meditation on Health.

### Suggested Reading Material:

- 1) Eckert, R .Animal Physiology: Mechanisms and adaptation, W .H.Freeman and Company, New York
- 2) Hochackka,P.W. and Somero, G.N.Biochemical adaptation,Princeton,N.J.
- 3) Hoar,W.S.General and comparative Animal physiology prentice Hall of India.
- 4) Schimdt Neisen,Animalphysiology ,Adaptation and Environment,Cambridge.
- 5) Stamd,F.L.Physiology: A regulatory systems approach,Macmillan publishing Co., NewYork.
- 6) Punmer, L.Practical Biochemistry,Tata McGraw-Hill.
- 7) Prosser,C.L. and Brown .Comparative Animal physiology.
- 8) Wilson,K.and Walker, j.Practical Biochemistry.
- 9) Willmer, PIG Sone and I.Johnson, Environmental physiology,BlackWell Science,Oxford, U.K .944p
- 10) Newell,R.C.(ed)1976.Adaptation to environment, Essays on the physiology of marine animals. Butterworths,London,UK539pp
- 11) Townsend ,C.R and P.Callow, physiological Ecology An evolutionary approach resource use, Blackwell Sci.publication, Oxford, UK.

## A/Z 203 IMMUNOLOGY

### UNIT - I

**Immunity**-innate and acquired, innate immune mechanisms, acute phase reactants, properties of acquired immunity

**Immunogens and antigens**- Properties, factors governing immunogenicity, haptens, epitopes size and identification. Adjuvants- properties and mechanism of action.

**Immunoglobulins**- structure, isotypes, allotypes and idiotypes. Functions of antibody in relation to structure

### UNIT - II

**Antigen-antibody interactions**- affinity of antibody, avidity, bonus effect, classical precipitin reaction, antigen-binding site of antibody, forces involved in antigen - antibody complex formation.

**Lymphoid tissue**- primary and secondary lymphoid organs, structure and cellular organization. Lymphocyte traffic.

**Cells involved in the immune response**- T cells, B cells, CD antigens, neutrophils, eosinophils and natural killer cells.

**Antigen presentation** - pathways of antigen processing and presentation of intracellular and extracellular antigens.

### UNIT - III

**Antibody response** - Primary and secondary antibody response, antibody response to haptens, enumeration of antibody-forming cells, T- dependent and T- independent antigens.

**Macrophage**- role in immune response and activation.

**Cell mediated immunity**- helper, cytotoxic, suppressor T cells. *In vivo* and *in vitro* assays for assessment of cell mediated immunity

**Complement**- classical and alternative pathways of activation. Regulation of complement activation and functions.

**Antigen receptors** -On T and B cells. Generation of receptor diversity.

### UNIT - IV

**Development of immune system**- T cell ontogeny in thymus, thymic hormones, cell development. **Immunological tolerance** - pathways of tolerance and mechanisms of tolerance in T and B cells. **Immunological tests**- Immunodiffusion, immunoelectrophoresis, immunofluorescence, radioimmunoassay and enzyme-linked immunosorbent assay.

### Suggested Reading Material:

1. Immunology and Immunopathology by Stewart.
2. Cellular and Molecular Immunology by Abul K. Abbas *et. al.*
3. Textbook of Immunology by Barret.
4. Essential Immunology by Roitt, Brostoff, Male, Harcourt Brace & Company (5<sup>th</sup> Ed), Mosby (6<sup>th</sup> Ed).
5. Immunology by Kuby, Richard A. Goldsby, Thomas, J. Kindl, Barbara A. Osborn, Freeman & Company, Mosby publishers.
6. Immunobiology – The immune system in Health disease by Janeway and Travers.
7. Immunology – An introduction by Tizard.
8. Text book of Immunology by Unani and Benacerraf.
9. Fundamentals of Immunology by Paul.
10. Immunology – A short course by Benjaini, Sunshine and Lesrowitz.



## A/Z 204 MOLECULAR BIOLOGY

### UNIT - I

History and scope of Molecular Biology

DNA Structure and Replication

Prokaryotic and Eukaryotic DNA Replication

Mechanics of DNA Replication

Enzymes and accessory proteins involved in DNA Replication

### UNIT - II

Transcription

Prokaryotic Transcription

Eukaryotic Transcription

RNA Polymerases

Post-transcriptional modifications in RNA

Cap formation

Transcription

Nuclear Export of m-RNA

### UNIT - III

Translation

Genetic Code

Prokaryotic and eukaryotic Translation

Mechanisms of initiation, elongation and termination

Regulation of translation

Antisense and Ribozyme technology

Molecular mechanisms of antisense molecules

Inhibition of splicing, polyadenylation and translation

### UNIT - IV

Recombination and Repair

Holiday junction, gene targeting and gene disruption

RecA and other Recombinases

DNA repair mechanisms

Molecular mapping of genome

Genetic and physical maps

Physical mapping and map-based cloning

Southern fluorescence in situ hybridization (FISH) for genome analysis

### Suggested Reading Material:

1. J.D. Watson, N.H. Hopkins, J.W. Roberts, J.A. Steitz and A.M. Weiner. Molecular biology of Gene. The Benjamin/Cummings Pub. Co. Inc., California.
2. Alberts, B., D. Bray, J. Lewis, M. Raff, K. Roberts and J.D. Watson. Molecular Biology of the Cell. Garland Publishing Inc., New York.
3. Benjamin Lewin, Gene IV, Oxford University Press, U.K.
4. Meyers, R.A. (Eds.) Molecular Biology and Biotechnology : A comprehensive desk reference. VCH Publishers Inc., New York.
5. Sambrook, J., E.F. Fritch and T. Maniatis. Molecular cloning : A Laboratory Manual. Cold Spring Harbor Laboratory Press, New York.
6. Daber, P.D. Introduction to practical Molecular Biology. John Wiley & Sons Ltd., New York.
7. Brown, T.a. (Eds.). Molecular Biology Lab Fax. Bios Scientific Publishers Ltd., Oxford.

## II SEMESTER PRACTICALS

### **A/Z 205 Biostatistics & Bioinformatics lab:**

1. Sampling and Frequency distribution
2. Graphical presentation of the data
3. Measures of Central Tendency – Mean, median and mode
4. Measures of Dispersion – Standard deviation and Coefficient of variation
5. Correlation and Regression
6. Nucleic acid and protein databases.
7. Retrieval and analysis of DNA or protein sequence from NCBI
8. Sequence Alignment in excel sheet for data processing.

### **A/Z 206 Animal Physiology lab:**

1. Digestive enzymes
2. Effect of body size vs oxygen consumption
3. oxygen consumption vs temperature
4. Osmotic regulation
5. Ion concentration measurements
6. Spotters
7. Dissection- Pituitary gland of fish
8. Dissection- Nervous system of prawn.

### **A/Z 207 Immunology lab:**

1. Blood grouping
2. Widal test for detection of typhoid bacteria
3. VDRL Test
4. SRID
5. Ouchterlony DID
6. Immunoelectrophoresis
7. Blood clotting time and bleeding time.
8. RIA -Demonstration
9. ELISA - Demonstration

### **A/Z 208 Molecular Biology Lab:**

1. Estimation of DNA (Colorimetric method)
2. Estimation of RNA in tissue (Colorimetric method)
3. Fulgen reaction method for DNA localization
4. Localization of RNA by methyl green pyronin – ‘Y’
5. SDS PAGE of serum proteins.
6. Testing purity of DNA

**M.Sc. ZOOLOGY**  
**III SEMESTER**

**Z 301 APPLIED ZOOLOGY**

**UNIT - I**

Microbial fermentations: Batch, continuous culture techniques, Design, operation, principle and types of fermenters and biosensors. Industrial production of chemicals - solvents (alcohol), acids (citric, lactic), antibiotics (penicillin and streptomycin), Vitamins (Riboflavin and Vitamin B12), amino acids (lysine and glutamic acid), Single Cell Protein (SCP).

**UNIT - II**

Animal Breeding: Principles, Structure of livestock breeding – poultry, sheep and cattle. Marker - assisted selection. Artificial insemination (AI) techniques, *in vitro* fertilization. Preservation of endangered species. Germplasm bank.

**UNIT - III**

Production of transgenic animals and their applications: mice, sheep and fish. Molecular farming and animal cloning. Somatic cell nuclear transfer in humans – Legal and ethical aspects. Potential applications of transgenic animals – Animal models for diseases and disorders.

**UNIT - IV**

Bioremediation - solid and liquid waste treatment. Biomass and energy production from waste. Bioleaching – Microbial recovery of metals and acid mine drainage. Water pollution and its control. Microbiological approach of waste water treatment. Biofertilizers – Blue green algal fertilizers – Azolla, Anabaena, symbiotic association. Sea weed fertilizers. Mycorrhizal biofertilizers, bacterial fertilizers. Biopesticides in agricultural production.

**Suggested Reading Material:**

1. Fermentation Technology, Standury (Pergman press)
2. Industrial Microbiology, L.E.Casida, JR. New Age International.
3. Industrial Microbiology by Presscot and Dunn.
4. Biotechnology by BD Singh (Kalyani).
5. Plant Biotechnology by A. Slater, N.W. Scott and M.R. Fowler (Oxford University press). Biotechnology in Agriculture by Swaminathan, M.S (Mc. Millan India Ltd).
6. Biotechnology and its applications to Agriculture, by Copping LG and P.Rodgers (British Crop Projection).

## Z 302 DEVELOPMENTAL BIOLOGY

### UNIT - I

#### **Gametogenesis, Fertilization and Cleavage:**

Introduction to animal development, pattern of embryonic development, Fertilization (species specific recognition of egg and sperm, acrosome reactions, fast and slow block to polyspermy); oogenesis & gameto genesis. Cleavage (patterns, molecular mechanism of cleavage)

### UNIT - II

#### **Early embryonic Development:**

Gastrulation (frog, chick) Neurulation (Establishment of neural tube, Tissue architecture of CNS, cerebral organization, differentiation of neural tube, neurons and neural crest cells); Specification of cell fate and cellular basis of morphogenesis, Autonomous development, Regulative development, Syncytial development.

### UNIT - III

#### **Organogenesis:**

Mechanism of cellular differentiation – Ectoderm (CNS and Epidermis), Mesoderm (Chorda Mesoderm, paraxial, intermediate and lateral plate mesoderm) and Endoderm (digestive tube and its derivatives), Cell-cell communication, Development during organ formation: introduction and competence, paracrine and other factors (the inducer molecules), Signal transduction cascades. Birth defects -Malformations & Disruptions.

### UNIT - IV

#### **Gene expression during development:**

Establishment of body axes. Anterior-posterior polarity-role of maternal effector, segmentation and homeotic selector genes, Dorso-Ventral polarity. Differential gene expression during animal development, Differential gene transcription, Selective nuclear RNA processing and mRNA translation. Differential protein modification. Regeneration of organs.

#### **Suggested Reading Material:**

1. Scott F. Gilbert. Developmental Biology, Latest Edition, Sinauer Associates, Inc., Publishers Sunderland, Massachusetts, USA
2. L. Wolpert Rosa Beddington Thomas M. Jessell Peter Lawrence Elliot M. Meyerowitz and Jim Smith (2002) Principles of Development Lates Edition Oxford University Press.
3. JMW Slack (2005) Essential Developmental Biology Latest Edition Blackwell Publishing Australia.
4. Mac E. Hadley Endocrinology Sixth Edition Prentice hall International, Inc. Arizona (For Section 9).
5. Medical Implications of Developmental Biology

## **Z 303 METABOLIC CELL FUNCTIONS & REGULATION**

### **UNIT - I**

Thermodynamic principles and steady-state conditions of living organisms  
Organization and methods to study metabolism  
Degradation of glucose, palmitic acid, phenylalanine

### **UNIT - II**

Energy metabolism and high energy compounds  
Redox potentials  
Mitochondrial electron transport chain  
Oxidative phosphorylation  
Storage and utilization of biological energy  
Biosynthesis of Urea, Glucose, Glycogen, Oleic acid and prostaglandins

### **UNIT - III**

Nature of Enzymes  
Classification and nomenclature of enzymes  
Kinetic analysis of enzyme catalysed reactions  
Metabolic profile of adipose, neural, hepatic, and muscle tissues

### **UNIT - IV**

Metabolic Engineering  
Immobilized enzymes and their applications

### **Suggested Reading Material:**

1. Voet, D. and J.G. Voet. Biochemistry. J. Wiley & Sons
2. Foster, R.L. Nature of Enzymology
3. Lodish et. al. Molecular Cell Biology
4. Annual Reviews of Biochemistry
5. Garrett and Grisham. Biochemistry.

## Z 304 PRINCIPLES OF ECOLOGY

### UNIT - I

Introduction to Ecology, Environmental concepts, Ecosystem structure and function-Biotic and Abiotic environments. Habitat and Ecological Niche. Dynamics of ecosystem- energy flow, food chain, food web, Ecological pyramids. Concepts of primary productivity. Mineral cycling.

### UNIT - II

Population Ecology- Characteristics of population. Population growth. Growth models. Optimal yield. Life histories strategies(r and K Selection). Intraspecific and Interspecific interactions. Concept of metapopulation. Population Demography and life tables- mortality, natality, age structure, fecundity, net reproductive rate

### UNIT - III

Evolutionary ecology. Community ecology- Nature of communities. community structure and attributes. Community composition. Concept of Ecological succession. Patterns of biodiversity, Latitudinal and altitudinal gradients: Theory of Island biogeography. Biogeographic realms of the world. Biogeographic zones of India and faunal diversity. Hotspots the world & in India.

### UNIT - IV

Environmental stress- environment pollution. Major drivers of bio-diversity change. Biodiversity status, Monitoring and documentation. Biodiversity conservation-Threats, major approaches to management. IUCN classification of wild life. Indian case studies on conservation/management strategy. Concepts of sustainable development.

### Suggested Reading Material:

1. Begon, M., J.L. Harper and C.R. Townsend. Ecology, Individuals, Populations and Communities. Blackwell Science, Oxford, UK.
2. Koromondy, E.J. Concepts of ecology. Prentice Hall, New Delhi.
3. Clarke, G.L. Elements of Ecology, John Wiley & Sons, New York.
4. Odum, E.P. Fundamentals of Ecology. W.B. Saunders, Philadelphia.
5. Krebs, C.J. Ecology. Harper & Row, New York.
6. Chapman JL and Reiss MJ. 1995. Ecology Principles and Application. Cambridge University Press.
7. Trivedy RK, Goel and Trisa. 1997. Practical methods in Ecology & Environmental Science.
8. Agarwal KC. 1998. *Biodiversity*. India.
9. Peggy I. Fieldler and Perer M. Kareiva. 1997. *Conservation Biology*.
10. Prabodh K. Maiti and Paulami Maiti. 2011. *Biodiversity: Perception, Peril and Preservation*.
11. Saharia VV. 1982. *Wildlife in India*. Natraco Publishers, Dehradun.

### III SEMESTER PRACTICALS

#### **Z 305 Applied Zoology lab:**

1. Production of protease/amylase by batch fermentation.
2. Selective isolation of *Actinomyces* from soil samples
3. Microbial growth curve.
4. Production of alcohol by *S.cerevisiae* and its estimation.
5. Production of streptomycin by fermentation.
6. Production of citric acid by *A.niger*.
7. Production of red wine from grapes.
8. Determination of suspended solids in industrial effluents.
9. Removal of color of the industrial effluents by biological methods.
10. Reduction of pollution load in effluents by biological methods (laboratory models).

#### **Z 306 Developmental Biology Lab**

1. Estimation of shell calcium during the development of chick and its role
2. Estimation of phosphorous during the development of chick
3. Observation of spermatozoa in vertebrates
4. Effect of Iodine in the metamorphosis of frog.
5. Effects of Thyroxine in the metamorphosis of frog.
6. Preparation of sperm smear from goat testis
7. Observation of slides: Cleavage, Morula, Blastula, Gastrula
8. Neurulation slides: Neural plate, Neural fold, Neural tube.

#### **Z 307 Metabolic cell function and regulations lab:**

1. Enzyme kinetics
2. Dehydrogenase assay
3. Lactic acid estimation
4. Proteins, glucose and Lipid estimations
5. DNA, RNA estimation
6. Transaminases

#### **Z 308 Principles of Ecology Lab**

1. Ecosystem-structure and function-demonstration.
2. Populations interactions.
3. Local fauna- Identification. Conservation activities for any
4. Enumeration of Plankton.
5. Estimation of Population-Plant/Animal sps by quadrant method
6. Diversity indices- Abundance, dominance and Diversity
7. Creation of Life tables

**M.Sc. ZOOLOGY**  
**IV SEMESTER**

**Z 401 NEUROBIOLOGY & ANIMAL BEHAVIOUR**

**UNIT - I**

Introduction to Neurobiology: Organization of the Brain: Functional Anatomy of the brain. Systems neurobiology – Visual systems, Hearing systems. Neurons, astrocytes, oligodendroglia, Schwann cells, microglia, ependymal cells, neuroglial cell interaction.

**UNIT - II**

Neuron: Passive and membrane properties, information flow in neurons, compartments, spike initiation zone. Neuron – Excitability, conductivity, Membrane potentials (Resting & Action), Single neuron recording, Patch-clamp recording, Nerve Impulse, Refractory period, The Nernst equation and Goldman equation.

**UNIT - III**

Signaling and Channels: Ion and Voltage-gated Channels. Sodium, Potassium & Calcium channels structure and function.

Neural Communication: Synapses- Electrical and Chemical synapses, Nerve-muscle synapse and signaling, Neurotransmitters (synthesis, storage and function), post-synaptic action of neurotransmitters, neuro-transmitter gated ionic channels; Dale's principle drugs affecting their activities, ionotropic and metabotropic receptors. Synaptic Integration, Synaptic Plasticity.

**UNIT - IV**

Cognitive Neuroscience: Nerve cells and their network, Role of limbic System in cognition, Cognitive skills, Learning and memory- Conditioning, habituation, insight learning, association learning. Imprinting – case studies of animal models.

**Suggested Reading Material:**

1. Fundamental Neuroscience by Haines, Duane E., Churchill Livingstone, New York.
2. Principles of Neural Science by Kandel Eric, James H. Schwartz, and Thomas Jessel; 4th ed. Mc Graw-Hill.
3. Basic Neurochemistry: Molecular, Cellular and Medical Aspects, by George M.D. Siegel, R. Wayne Albers, Scott Brady, Donald M. D. Price; Seventh Edition; Elsevier Academic Press.
4. Foundations of Neurobiology by Fred Delcomyn, N.Y. Freeman.
5. The Neuron: Cell and Molecular Biology 3ed by Irwin B. Levitan, Leonard K. Kaczmarek, (2002), Oxford University Press.
6. Neuroscience (Book with CD-ROM) 3ed by Dale Purves, George J. Augustine, David Fitzpatrick, William C. Hall, Lawrence C. Katz, Anthony-Samuel LaMantia, James O. McNamara, S. Mark Williams (2004) Sinauer Assoc.,
7. Fundamental Neuroscience, 2ed by Larry R. Squire, Floyd E. Bloom, Susan K. McConnell, James L. Roberts (Editor), Nicholas C. Spitzer, Michael J. Zigmond (2002) Academic Press.
8. An Introduction to Animal Behaviour, 5th Edition by Aubrey Manning and Marian Stamp Dawkins.



## Z 402 ANIMAL CELL CULTURE & STEM CELL TECHNOLOGY

### UNIT - I

Introduction to cell and tissue culture, Components of cell culture: cell types and cell lines, different substrates, Preparation of cell lines: viral and chemical induction; maintenance of cell lines. Types of culture processes.

Cancer Biology: Genetic rearrangements in progenitor cells, oncogenes, tumor suppressor genes, cancer and the cell cycle, virus-induced cancer, metastasis, interaction of cancer cells with normal cells, apoptosis, therapeutic interventions of uncontrolled cell growth.

### UNIT - II

Hybridoma technology: methods of cell fusion, hybrid selection, cloning and *in vitro* & *in vivo* methods of hybridoma propagation, production and characterization of monoclonal antibodies and their applications. Vaccines: Conventional, peptide and recombinant vaccines. Production and characterization of recombinant chimeric & multimeric antibodies, immunoadhesins & immunotoxins and their uses, Principle of diagnostic kit development.

### UNIT - III

The biology of stem cells: Overview; types of stem cells-embryonic stem cells, fetal tissue stem cells, adult stem cells; human & animal cloning. Isolation and propagation of embryonic stem cells. Differentiation of adult stem cells, Stem cell plasticity: self renewal potential; differentiation versus stem cell renewal; transdifferentiation. Yamanaka factors, Induced pluripotent stem cells, *Ex- vivo* expansion of haemopoietic cells for the production of blood cells and their products.

### UNIT - IV

Stem cell assays and protocols: Isolation of defined stem cell populations; sources of progenitor cells, cytokine and chemotherapy approaches to mobilization of progenitor cells; flow cytometric techniques.

Clinical applications of stem cell therapy: neurodegenerative diseases, tissue systems failures-diabetes, cardiomyopathy, kidney failure, liver failure, hemophilia, lymphoma and leukemic malignancies requiring stem cell therapy.

### Suggested Reading Material:

1. Culture of animal cells; a manual of basic technique, 5th ed. Freshney, R. Ian. Wiley-Liss.
2. Handbook of stem cells Volume 1 and 2 Eds Robert Lanza and others Elsevier Academic Press.

## Z 403 AQUACULTURE

### UNIT - I

Aquaculture- History, General Principles. Types of culture systems and economics of different kinds of aquaculture and productivity of culture ponds. Biological characteristics of aquaculture species. Fish seed Resources and Transportation - Fish seed technology - natural collection, bundh breeding, induced breeding, cryopreservation of gametes. Transport of finfish and shellfish- transport of eggs, fry, fingerlings and adults. Induced breeding. Fish hatchery.

### UNIT - II

Construction of fish fresh water & brackish water farms. Pond preparation- and management.- Pre-stocking and post stocking. Integrated fish farming. Indian Major carp culture, catfishes, murrels and prawn culture. Ornamental fish culture

### UNIT - III

Principles of fish nutrition - nutritional requirements of commercially important finfish and shellfish, feed types, feeding techniques and Feed management, role of probiotics in nutrition. Shell fish hatchery construction and management., Role of genetics in aquaculture– gynogenesis, androgenesis, triploidy, tetraploidy, hybridization, sex reversal and breeding, production of transgenic fish, impact of GMOs on aquatic biodiversity *Chanos chanos*. *Lates calcarifer*. *Litopenaeus vannamei*.

### UNIT - IV

Water quantity management in aquaculture. Overview of fish diseases in fish and shell fish culture- common fish pathogens, routes of pathogen entry in fish, methods of colonization and spread of pathogens, immune - evasion mechanisms of fish pathogens.. General principles of Molluscan culture. Pearl Oyster culture. Seaweeds culture. Environmental impact of aquaculture- aquacultural wastes and future developments in waste minimization, environmental consequences of hyper-nutrication.

### Suggested Reading Material:

1. Pillay, T.V.R. 1990. Aquaculture – Principles and Practices. Fishing News Books Survey, U.K.
2. Jhingran, V.G. 1993. Fish and fisheries of India. Hindustan Publishing Corporation (India), New Delhi.
3. Ravishankar Piska, 1999. Fisheries and Aquaculture. Lahari Publications, Hyderabad.
4. Santanam, R., Ramanathan, N. and Jegatheesan, G. 1990. Coastal Aquaculture in India. CBS Publishers & Distributors, Delhi.
5. Bardach, J.E., Ryther, J.H. and McLarney, W.O. 1972. Aquaculture. John Wiley & Sons Inc., USA.
6. Ghosh, S., Palanisamy, K. and Pathak, S.C. 1994. Shrimp and Freshwater Hatchery Public Relations Division, National Bank for Agriculture and Rural Development, Bombay.
7. Fishponds in Farming Systems, Zijpp, V. D., Verreth, J. A. J., Tri, L. Q., van Mensvoort, M. E. F., Bosma, R. H., and Beveridge, M. C. M., Wageningen Academic Publishers, Netherlands
8. Aquaculture and Fisheries Biotechnology Genetic Approaches, Dunham, R. A., CABI Publishing, USA

## Z 404 ANIMAL BIOTECHNOLOGY & BIO-ETHICS

### UNIT- I

Introduction to Animal Biotechnology, Recombinant DNA technology: Restriction endonucleases, Restriction maps, isolation of gene fragments using restriction endonucleases and mechanical shearing; Cloning vectors - Isolation and properties of plasmids, bacteriophage cosmids, Ti plasmid (binary vector), expression vectors, viral vectors, YAC, BAC, phagemids and vectors used for cloning in mammalian cells, Hosts - Prokaryotic: *E.coli*, *B.subtilis*, Eukaryotic: Yeast and mammalian cell lines; Ligation of fragments

### UNIT - II

Gene transfer techniques: Biological and artificial delivery system, Cloning strategies, shot gun experiments, isolation of poly mRNA, synthesis of cDNA, cDNA cloning in bacteria; Genomic and cDNA libraries, Identification of recombinants - structural and functional analysis of recombinants; Design and preparation of DNA and RNA probes for hybridization, Southern and Northern blotting.

### UNIT - III

DNA sequencing methods: Maxam and Gilbert's chemical and Sanger's chain termination methods, automated DNA sequencing, Base calling and sequencing accuracy. Introduction to next generation sequencing (NGS). DNA fingerprinting.

PCR amplification and diagnosis - Applications in forensic medicine. Genetic diseases. Gene therapy- Types and use of rDNA constructs for gene therapy.

### UNIT - IV

Bioethics: Introduction – causes of unethical acts, ignorance of laws, policies and procedures, recognition, friendship, personal gains. Professional ethics – professional conduct. Ethical decision making, ethical dilemmas. Teaching ethical values to scientists, good laboratory practices, good manufacturing practices, laboratory accreditation.

Socio-economic and legal impacts of biotechnology, national and international guidelines, experimental protocols approval, levels of containment.

### Suggested Reading Material:

1. Principles of Gene manipulation: An Introduction to genetic Engineering. R.V.Old and S.B.Primrose (Blackwell Scientific Publications).
2. Biotechnology by B.D.Singh (Kalyani).
3. Molecular Biology and Biotechnology by Meyers, RA, A comprehensive Desk reference (VCH Publishers).
4. Biotechnology by U. Satyanarayana (Books & Allied (P) Ltd).
5. Bioethics and Biosafety in Biotechnology by V. Sree Krishna, New Age International Publishers.

## IV SEMESTER PRACTICALS

### **Z 405 Neurobiology & Animal Behaviour lab:**

1. An introduction to animal behaviour – Animal Psychology – Classification of behavioural patterns
2. Perception of the environment – Examples
3. communication – Examples from invertebrates and vertebrates (Terrestrial, Aerial, Aquatic habitats)
4. Ecological aspects – Food selection, optimal foraging, prey and predator, Host-Parasite relations
5. Social behaviour – Aggregations – Examples from fishes, birds and mammals, social organization - insects
6. Reproductive behaviour – mating systems, sexual selection, parental care
7. Biological rhythms – examples – migration of fish, turtle and bird.

### **Z 406 Animal Cell Culture & Stem Cell Technology lab:**

1. Preparation of animal cell culture media
2. Preparation of single cell suspension from spleen and thymus
3. Viable cell counting.
4. Primary culture demonstration
5. Sub-culture preparations
6. Cell preparation for storage.
7. Cell preparation for feeding.

### **Z 407 Aquaculture lab:**

1. Spotters: cultivable species of finfish, shellfish and ornamental based on the theory
2. Analysis of water: Turbidity, pH, Dissolved oxygen, Alkalinity etc.
3. Primary productivity, Estimation by Light and Dark bottle method
4. Dissecting out the pituitary gland and preparing the extract
5. Identification of types of feeds
6. Feed analysis-Biochemical constituents
7. Visits to aquaculture farms, finfish and shellfish hatcheries

### **Z 408 Animal Biotechnology and Bio-ethics Lab:**

1. Isolation of genomic DNA
2. Agarose gel electrophoresis of genomic DNA.
3. Purification of bovine serum IgG by ammonium sulphate precipitation
4. Western Blotting of proteins.
5. Southern Blotting (Demonstration)
6. PCR diagnosis of white spot syndrome virus, *monodon* baculovirus, haemotopoetic necrosis virus - Demonstration
7. Intellectual property and India: comprehensive e-filing patents, Trademarks.
8. On line patent search.
9. Online patent register and application status.
10. WIPO online database search

**ADIKAVI NANNAYA UNIVERSITY, RAJAMAHENDRAVARAM**

**M.Sc Zoology - I Semester**

**Model Question Paper: Paper - I**

**A/Z 101 Tools and Techniques for Biology**

**Time: 3hours**

**Max. Marks: 75**

**Answer ALL questions.  
All questions carry equal marks**

**Section-A**

**4X15=60**

1. a) What is an assay? Explain different types of assays.  
(OR)  
b) Write the principle and types of microscopy and elaborate on dark field microscopy.
  
2. a) Describe the principle and applications of centrifuges with an emphasis on ultracentrifuge.  
(OR)  
b) Describe various types of chromatographic techniques to separate molecules.
  
3. a) Describe the principle and applications of spectrophotometer.  
(OR)  
b) What is autoradiography? Give an account on its biological applications.
  
4. a) Describe the process of inoculation and growth monitoring.  
(OR)  
b) Explain in detail about microbial assays.

**Section-B**

**5X3=15**

5. Answer any **FIVE** of the following:
  - a) pH meter.
  - b) Biochemical mutants and their uses.
  - c) TLC.
  - d) Spectrofluorimetry.
  - e) Density gradient centrifugation.
  - f) Treatment of substrate surfaces.
  - g) Oxygen electrode.
  - h) Radio active counter.

**ADIKAVI NANNAYA UNIVERSITY, RAJAMAHENDRAVARAM**  
**M.Sc Zoology - I Semester**  
**Model Question Paper: Paper - II**  
**A/Z 102 Biosystematics, Biodiversity & Evolution**

**Time: 3hours**

**Max. Marks: 75**

**Answer ALL questions.**  
**All questions carry equal marks**

**Section-A**

4X15=60

1. a) Define Biosystematics. Explain in detail the importance and applications of Biosystematics  
(OR)  
b) Discuss about the different taxonomic procedures.
2. a) Discuss in detail about the origin of basic biological molecules.  
(OR)  
b) Explain about the evolution of eukaryotic genome
3. a) What is the three domain concept of living kingdom. Discuss  
(OR)  
b) What is Speciation. Explain the mechanism involved in speciation.
4. a) Discuss in detail about the theories of Organic Evolution.  
(OR)  
b) What is Hardy Weinberg Law. Discuss.

**Section-B**

5X3=15

5. Answer any **FIVE** of the following:
  - a) Chemotaxonomy.
  - b) ICZN.
  - c) Molecular Clocks.
  - d) Eras.
  - e) Subspecies.
  - f) Hierarchy of categories.
  - g) Punctuated equilibrium.
  - h) Gene pool.

**ADIKAVI NANNAYA UNIVERSITY, RAJAMAHENDRAVARAM**  
**M.Sc Zoology - I Semester**  
**Model Question Paper: Paper - III**  
**A/Z 103 Biomolecules**

**Time: 3hours**

**Max. Marks: 75**

**Answer ALL questions.**  
**All questions carry equal marks**

**Section-A**

4X15=60

1. a) Describe the structure, classification and properties of amino acids.  
(OR)  
b) Explain about structural characterization of proteins.
  
2. a) Write about the classification, structure, properties and functions of monosaccharides.  
(OR)  
b) Explain about polysaccharides and their occurrence in nature.
  
3. a) Discuss about the classification, structures, properties and biological functions of fatty acids.  
(OR)  
b) Explain about phospholipids, sphingolipids, prostaglandins, and steroids with their biological role.
  
4. a) Explain about the structure, types and physicochemical properties of Nucleic acids.  
(OR)  
b) Write in detail about RNA and its functions.

**Section-B**

5X3=15

5. Answer any **FIVE** of the following:
  - a) Peptide bond.
  - b) Glycoproteins.
  - c) fatty acids.
  - d) Chitin.
  - e) Ramachandran plot.
  - f) Leukotrienes.
  - g) mRNA.
  - h) Denaturation of DNA.

**ADIKAVI NANNAYA UNIVERSITY, RAJAMAHENDRAVARAM**

**M.Sc Zoology - I Semester**

**Model Question Paper: Paper - IV**

**A/Z 104 Molecular Cell Biology**

**Time: 3hours**

**Max. Marks: 75**

**Answer ALL questions.  
All questions carry equal marks**

**Section-A**

**4X15=60**

1. a) Describe in detail about the transport across the cell membrane.

(OR)

b) Explain the transport of macromolecules across the epithelial layer.

2. a) Explain the role of cytoskeletal elements in defining the structure of a cell.

(OR)

b) Enumerate the role of cytoskeletal elements in mitosis.

3. a) Write in detail about cell adhesion and communication mechanisms.

(OR)

b) Elaborate on the second messenger system in cell signaling.

4. a) Cyclins and cyclin dependent kinases regulate cell cycle, Justify.

(OR)

b) Describe various post-translational mechanisms in protein synthesis.

**Section-B**

**5X3=15**

5. Answer any **FIVE** of the following

a) Membrane potential.

b) Cilia and flagella.

c) Integrins and collagen.

d) Chromosomal organization of genes.

e) Mobile DNA.

f) Symporters and antiports.

g) Microtubules.

h) Apoptosis.



**ADIKAVI NANNAYA UNIVERSITY, RAJAMAHENDRAVARAM**  
**M.Sc Zoology - II Semester**  
**Model Question Paper: Paper - I**  
**A/Z 201 Biostatistics and Bio-informatics**

**Time: 3hours**

**Max. Marks: 75**

**Answer ALL questions.**  
**All questions carry equal marks**

**Section-A**

4X15=60

1. a) What is Sampling. Discuss  
(OR)  
b) Discuss in detail about the Measures of Central tendency.
2. a) Explain in detail about the bivariate analysis.  
(OR)  
b) What is test of significance. Discuss in detail.
3. a) Describe about the Basic components of the Computer.  
(OR)  
b) Explain the use of MS excel in for data presentation.
4. a) What are biological databases? Explain.  
(OR)  
b. Discuss in detail about sequence alignments.

**Section-B**

5X3=15

5. Answer any **FIVE** of the following
  - a) Frequency distribution.
  - b) Ogive.
  - c) Poisson distribution.
  - d) Chisquare test.
  - e) MS word.
  - f) Power point.
  - g) Genomics.
  - h) Phylogenetic analysis.

**ADIKAVI NANNAYA UNIVERSITY, RAJAHMUNDRY**  
**M.Sc Zoology - II Semester**  
**Model Question Paper: Paper-II**  
**A/Z 202 Animal Physiology**

**Time: 3hours**

**Max. Marks: 75**

**Answer ALL questions.**  
**All questions carry equal marks**

**Section-A**

4X15=60

1. a) Write briefly molecular structure and properties of muscle, Add note on sliding filament theory.  
(OR)  
b) Write about haemopoiesis, Haemoglobin, and haemostasis. Add note on factors affecting blood coagulation.
2. a) Write about osmoregulation in aquatic Environments.  
(OR)  
b) Write about response to biotic and abiotic factors.
3. a) Write about the comparative physiology of excretion, Urine formation, Urine concentration, and waste elimination.  
(OR)  
b) Write about comparative anatomy of heart structure, myogenic heart. Add a note on blood pressure.
4. a) Write about photoreceptors, Auditory, Mechanoreceptors.  
(OR)  
b) Explain fresh water and terrestrial environment.

**Section-B**

5X3=15

5. Answer any **FIVE** of the following:
  - a) Synaptic transmission & Neurotransmitters.
  - b) Neural control of muscle tone and posture.
  - c) Yoga and meditation.
  - d) Chemoreceptor.
  - e) Acclimatization.
  - f) Micturition.
  - g) BMR.
  - h) ECG.

**ADIKAVI NANNAYA UNIVERSITY, RAJAMAHENDRAVARAM**

**M.Sc Zoology - II Semester**

**Model Question Paper: Paper - III**

**A/Z 203 Immunology**

**Time: 3hours**

**Max. Marks: 75**

**Answer ALL questions.  
All questions carry equal marks**

**Section-A**

**4X15=60**

1. a) What is innate immunity? Describe various innate immune mechanisms.  
(OR)  
b) Describe the structure and functions of various types of immunoglobulins.
  
2. a) Write an essay on antigen-antibody interactions.  
(OR)  
b) What are the cells involved in immune response? Describe their role.
  
3. a) Elucidate the mechanisms of antibody response to antigens.  
(OR)  
b) Write about Classical and alternative activation of complement.
  
4. a) What is immune tolerance? Elucidate the mechanisms of tolerance in T and B cells.  
(OR)  
b) Write an essay on immunological tests used in molecular and diagnostic laboratories.

**Section-B**

**5X3=15**

5. Answer any **FIVE** of the following:
  - a) Acquired immunity.
  - b) Haptens.
  - c) Lymphocyte traffic.
  - d) Antigen presenting cells.
  - e) Cytotoxic T-cells.
  - f) Antigen receptors.
  - g) ELISA.
  - h) Thymic hormones.

**ADIKAVI NANNAYA UNIVERSITY, RAJAMAHENDRAVARAM**  
**M.Sc Zoology - II Semester**  
**Model Question Paper: Paper - IV**  
**A/Z 204 Molecular Biology**

**Time: 3hours**

**Max. Marks: 75**

**Answer ALL questions.**  
**All questions carry equal marks**

**Section-A**

4X15=60

1. a) Explain the prokaryotic and eukaryotic DNA replication.  
(OR)  
b) Explain the mechanics of DNA replication.
2. a) Explain the post transcription in prokaryote and eukaryotic transcription.  
(OR)  
b) Explain the post transcriptional modifications in RNA.
3. a) Explain the mechanisms of prokaryotic and eukaryotic translation.  
(OR)  
b) Explain the molecular mechanism of the antisense molecules and add a note on inhibition of splicing.
4. a) Write about gene targeting and DNA repair.  
(OR)  
b) Explain the types of mapping and molecular mapping of genome.

**Section-B**

5X3=15

5. Answer any **FIVE** of the following:
  - a) Enzymes involved in DNA replication.
  - b) RNA polymerases.
  - c) Genetic code.
  - d) FISH.
  - e) Necessary proteins involved in DNA replication.
  - f) Genetic map.
  - g) Cap formation in post-translational modifications.
  - h) Structure of DNA.

**ADIKAVI NANNAYA UNIVERSITY, RAJAMAHENDRAVARAM**

**M.Sc Zoology - III Semester**

**Model Question Paper: Paper - I**

**Z 301 Applied Zoology**

**Time: 3hours**

**Max. Marks: 75**

**Answer ALL questions.  
All questions carry equal marks**

**Section-A**

**4X15=60**

1. a) What are fermenters? Write about principle and types of fermenters.  
(OR)  
b) Explain in detail about the industrial production of pencillin and riboflavin.
2. a) Describe about structure of live-stock breeding in poultry.  
(OR)  
b) Explain artificial insemination technique.
3. a) Elucidate on breeding of animals through artificial insemination.  
(OR)  
b) Describe the production of transgenic animals and their applications in health and disease.
4. a) Explain the mechanism of recovery of metals and acid mines from drainage using bioresources.  
(OR)  
b) Discuss in detail on the need and usage of biopesticides in agricultural production.

**Section-B**

**5X3=15**

5. Answer any **FIVE** of the following.

- a) Germplasm bank.
- b) Molecular cloning.
- c) Bioremediation.
- d) Single cell protein.
- e) Recombinant vector antigens.
- f) Somatic cell nuclear transfer.
- g) Anabaena.
- h) Marker-assisted technology.

**ADIKAVI NANNAYA UNIVERSITY, RAJAMAHENDRAVARAM**

**M.Sc Zoology - III Semester**

**Model Question Paper: Paper - II**

**Z 302 Developmental Biology**

**Time: 3hours**

**Max. Marks: 75**

**Answer ALL questions.  
All questions carry equal marks**

**Section-A**

**4X15=60**

1. a) Describe in detail about the process of fertilization.  
(OR)  
b) Write an account on molecular mechanism of cleavage and cleavage patterns.
  
2. a) Give a detailed account on chick gastrulation.  
(OR)  
b) What is neurulation .Explain the process of neurulation with an example.
  
3. a) Explain the mechanism of cellular differentiation of ectoderm into CNS & Epidermis.  
(OR)  
b) How does cell to cell communication help in organ formation during development?
  
4. a) How does differential gene expression occurs during animal development.  
(OR)  
b) Write about selective nuclear RNA processing and mRNA translation.

**Section-B**

**5X3=15**

5. Answer any **FIVE** of the following:
  - a) Blocking of polyspermy.
  - b) Regulative development.
  - c) Endoderm derivatives.
  - d) Homeotic selector genes.
  - e) Structure of sperm.
  - f) Autonomous development.
  - g) Signal transduction cascades.
  - h) Regeneration of organs.

**ADIKAVI NANNAYA UNIVERSITY, RAJAMAHENDRAVARAM**

**M.Sc Zoology - III Semester**

**Model Question Paper: Paper - III**

**Z 303 Principles of Ecology**

**Time: 3hours**

**Max. Marks: 75**

**Answer ALL questions.  
All questions carry equal marks**

**Section-A**

**4X15=60**

1. a) Write in detail about the abiotic component of the ecosystem.  
(OR)  
b) Explain the Concept of Primary Productivity.
2. a) Discuss about the Population growth.  
(OR)  
b) Explain about the different types of species interactions.
3. a) What is an Ecological Community. Explain in detail about the structure and form of the Community.  
(OR)  
b) Discuss about the biogeographic realms of the world.
4. a) Discuss in detail about the major drivers responsible for environmental stress.  
(OR)  
b) What is biodiversity conservation? Discuss.

**Section-B**

**5X3=15**

5. Answer any **FIVE** of the following:
  - a) Food chain.
  - b) Ecological Pyramids.
  - c) Metapopulation.
  - d) Optimal yield.
  - e) Ecological Succession.
  - f) Hotspots.
  - g) Sustainable development.
  - h) IUCN.

**ADIKAVI NANNAYA UNIVERSITY, RAJAMAHENDRAVARAM**  
**M.Sc Zoology - III Semester**  
**Model Question Paper: Paper-IV**  
**Z 304 Metabolic Cell Function and Regulation**

**Time: 3 hours**

**Max. Marks: 75**

**Answer ALL questions.**  
**All questions carry equal marks**

**Section-A**

4X15=60

1. a) Describe the thermodynamic principles suitable for living organisms.  
(OR)  
b) Write notes on degradation of glucose.
2. a) Explain the electron transport chain in mitochondria.  
(OR)  
b) Explain the biosynthesis of prostaglandins.
3. a) Write an account on classification and nomenclature of enzymes.  
(OR)  
b) Discuss on the metabolic profile of neural tissue.
4. a) Explain the process of immobilization of enzymes.  
(OR)  
b) What is metabolic engineering? Elaborate.

**Section-B**

5X3=15

5. Answer any **FIVE** of the following:
  - a) Methods to study metabolism.
  - b) Oxidative phosphorylation.
  - c) Kinetic analysis of enzymes.
  - d) Metabolic profile of adipose.
  - e) Degradation of palmitic acid.
  - f) Storage of biological energy.
  - g) Metabolic profile of tissue.
  - h) Applications of immobilized enzymes.



**ADIKAVI NANNAYA UNIVERSITY, RAJAMAHENDRAVARAM**  
**M.Sc Zoology - IV Semester**  
**Model Question Paper: Paper-I**  
**Z 401 Neurobiology and Animal Behaviour**

**Time: 3hours**

**Max. Marks: 75**

**Answer ALL questions.**  
**All questions carry equal marks**

**Section-A**

4X15=60

1. a) Describe in detail the flow of information in neurons.  
(OR)  
b) Derive Nernst equation.
2. a) What is Action potential. Explain the propagation of action potential across the neuron.  
(OR)  
b) Discuss the types of channels involved in signaling.
3. a) Write an account on Catecholamine synthesis, release and uptake.  
(OR)  
b) Write an account on organization of the brain.
4. a) Discuss the behavior in insects with examples.  
(OR)  
b) What are cognitive skills. Explain different types of learning with examples.

**Section-B**

5X3=15

5. Answer any **FIVE** of the following:
  - a) Neuroglial cell interaction.
  - b) Metabotropic receptors.
  - c) Cerebellum.
  - d) Imprinting.
  - e) Structure of neuron.
  - f) Sodium channel.
  - g) Temporal lobe.
  - h) Memory.

**ADIKAVI NANNAYA UNIVERSITY, RAJAMAHENDRAVARAM**  
**M.Sc Zoology - IV Semester**  
**Model Question Paper: Paper-II**  
**Z 402 Animal Cell Culture & Stem Cell Technology**

**Time: 3 hours**

**Max. Marks: 75**

**Answer ALL questions.**  
**All questions carry equal marks**

**Section-A**

4X15=60

1. a) Discuss the Scope and Importance of biotechnology.  
(OR)  
b) Explain Recombinant DNA and gene cloning technology.
2. a) Write about polymerase chain reaction.  
(OR)  
b) Discuss the application of PCR in biotechnology and genetic engineering.
3. a) Explain the laboratory facilities of culture media in animal cell and tissue culture.  
(OR)  
b) Discuss biotechnology in Medicine.
4. a) Explain pollution control of environment and energy conservation.  
(OR)  
b) Explain in detail IPR and IPP.

**Section-B**

5X3=15

5. Answer any **FIVE** of the following:
  - a) Gene libraries.
  - b) Basic PCR and its modifications.
  - c) Cell lines.
  - d) Organ culture.
  - e) Biotechnology and biodiversity.
  - f) Genetic counseling.
  - g) Vectors.
  - h) Expression vectors.

**ADIKAVI NANNAYA UNIVERSITY, RAJAMAHENDRAVARAM**  
**M.Sc Zoology - IV Semester**  
**Model Question Paper: Paper-III**  
**Z 403 Aquaculture**

**Time: 3hours**

**Max. Marks: 75**

**Answer ALL questions.**  
**All questions carry equal marks**

**Section-A**

4X15=60

1. a) Explain the criteria involved for the construction of fish farms.  
(OR)  
b) Write about the preparation and management of different types of ponds in fish farms.
2. a) What are the different fish seed resources? Add a note on their transportation.  
(OR)  
b) Discuss about carp culture.
3. a) Discuss about fish nutrition.  
(OR)  
b) Explain crab culture.
4. a) Discuss about the shrimp hatchery construction and its management.  
(OR)  
b) Explain the water quality management in brackish water farms.

**Section-B**

5X3=15

5. Answer any **FIVE** of the following:
  - a) Biological criteria for selection of aquaculture species.
  - b) Integrated fish farming.
  - c) Milk fish culture.
  - d) Feed management.
  - e) Pearl oyster culture.
  - f) Preparation and management of nursery ponds.
  - g) Composite Fish Culture.
  - h) Cage culture and pen culture.

**ADIKAVI NANNAYA UNIVERSITY, RAJAMAHENDRAVARAM**  
**M.Sc Zoology - IV Semester**  
**Model Question Paper: Paper-IV**  
**Z 404 Animal Biotechnology & Bio-ethics**

**Time: 3hours**

**Max. Marks: 75**

**Answer ALL questions.**  
**All questions carry equal marks**

**Section-A**

4X15=60

1. a) Write about the tools used in rDNA technology with examples.  
(OR)  
b) Describe different types of vectors used for cloning in mammalian cells.
2. a) What is gene transfer? Write the mechanism of gene delivery systems.  
(OR)  
b) What is hybridization? Explain the design and preparation of probes used for hybridization.
3. a) Enumerate the methods of DNA sequencing and add a note on next generation sequencing.  
(OR)  
b) Discuss the role of DNA finger printing in forensic science.
4. a) Define bioethics. Discuss the need to follow the policies and laws in scientific field.  
(OR)  
b) Write an account on good laboratory practices.

**Section-B**

5X3=15

5. Answer any **FIVE** of the following:
  - a) Mechanical shearing.
  - b) cDNA library.
  - c) Automated DNA sequencing.
  - d) Un-ethical acts.
  - e) Ti plasmid.
  - f) Northern blotting.
  - g) Gene therapy.
  - h) Laboratory accreditation.