

**DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY,
CHHATRAPATI SAMBHAJINAGAR.**



CIRCULAR NO.SU/M.Sc/College./NEP/95/2024

It is hereby inform to all concerned that, the Revised syllabi prepared by the Board of Studies/ Ad-hoc Boards & recommended by the Dean, Faculty of Science & Technology, **Academic Council at its meeting held on 08 April 2024 has accepted** the following Syllabi under the Faculty of Science & Technology **as per Norms of National Education Policy -2020** run at the Affiliated Colleges, Dr.Babasaheb Ambedkar Marathwada University as appended herewith.

Sr.No.	Courses	Semester
1.	M.Sc.Zoology	IIIrd & IVth semester
2.	M.Sc. Biotechnology	IIIrd & IVth semester
3.	M.Sc.Bioinformatics	IIIrd & IVth semester
4.	M.A./M.Sc.Mathematics	IIIrd & IVth semester

This is effective from the Academic Year 2024-25 and onwards.

All concerned are requested to note the contents of this circular and bring the notice to the students, teachers and staff for their information and necessary action.

University Campus,
Aurangabad-431 004.
REF.NO.SU/2024/26472-80
Date:- 20.05.2024

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**Deputy Registrar,
Academic Section**

Copy forwarded with compliments to :-

- 1] **The Principal of all concerned Colleges,**
Dr. Babasaheb Ambedkar Marathwada University,
- 2] **The Director, University Network & Information Centre, UNIC, with a request to upload this Circular on University Website.**

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- 1] **The Director, Board of Examinations & Evaluation,** Dr.Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar.
- 2] The Section Officer,[M.Sc.Unit] Examination Branch, Dr.Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar.
- 3] The Programmer [Computer Unit-1] Examinations, Dr.Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar.
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DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY, CHHATRPATI SAMBAHAJINAGAR.



FACULTY OF SCIENCE & TECHNOLOGY

2 Years/1 Year P.G. Programme

Course Structure

According to NEP from 2023 onward

Subject: Zoology

Course structure for M.Sc. IInd year

For PG departments of affiliated colleges.
(Effective from 2024-25)

Page 1 to 38.

Credit distribution structure for Two Years with Multiple Entry and Exit options –

Class: M.Sc. Second Year Semester: IIIrd Semester

Subject: Zoology

Theory + Practical

Course type	Course Code	Teaching Scheme (Hrs./ week)		Credits Assigned		Total Credits
		Theory	Practical	Theory	Practical	
Major Mandatory DSC Core Course	ZOO/MJ/600 Developmental Biology	4	-	3	-	14
	ZOO/MJ/601 Biophysics	4	-	3		
	ZOO/MJ/602 Applied Biotechnology I	4		3		
	ZOO/MJ/603 Practical based on-ZOO/MJ/600		3	-	1	
	ZOO/MJ/604 Practical based on-ZOO/MJ/601	-	3	-	1	
	ZOO/MJ/605 Practical based on ZOO/MJ/602	-	3	-	1	
	ZOO/MJ/606 Advanced skill	-	4	-	2	
						Credits-14
DSE (any one from pool)	ZOO/DSE/607 Applied parasitology I	3	-	3	-	4
	ZOO/DSE/608 Animal physiology I	3	-	3		
	ZOO/DSE/609 Molecular biology I	3	-	3		
	ZOO/DSE/610 Fishery science I	3	-	3		
	ZOO/DSE/611 Practical based on Applied parasitology I	-	3	-	1	
	ZOO/DSE/612 Practical based on Animal physiology I	-	3	-	1	
	ZOO/DSE/613 Practical based on Molecular biology I	-	3	-	1	
	ZOO/DSE/614 practical based on Fishery science I	-	3	-	1	
						Credits -04
RP	ZOO/RP/649- RP1	4	-	4	-	Credits-04
						Total Credits 22

Class: M.Sc. Second Year , Semester: IVth
Semester Subject: -Zoology Theory+ Practical

Course type	Course Code	Teaching Scheme (Hrs./ week)		Credits Assigned		Total Credits
		Theory	Practical	Theory	Practical	
Major Mandatory DSC	ZOO/MJ/650 Evolution and behaviour	4	-	3	-	12
	ZOO/MJ/651 General and comparative physiology	4	-	3	-	
	ZOO/MJ/652 Applied biotechnology II	4	-	3	-	
	ZOO/MJ/653 Practical based on Evolution and behaviour	-	3	-	1	
	ZOO/MJ/654 Practical based on General and comparative physiology	-	3	-	1	
	ZOO/MJ/655 Practical based Animal biotech.	-	3	-	1	
DSE (any one)	ZOO/DSE/656 Applied parasitology II	4	-	3		04
	ZOO/MJ/657 Animal physiology II	4		3		
	ZOO/MJ/658 Molecular biology II	4	-	3	-	
	ZOO/MJ/659 Fishery science II	4	-	3	-	
	ZOO/MJ/660 Practical based on Applied parasitology II	-	3	-	1	
	ZOO/MJ/661 Practical based on Animal physiology II	-	3	-	1	
	ZOO/MJ/662 Practical based on Molecular biology II	-	3	-	1	
	ZOO/MJ/663 Practical based on Fishery science II	-	3	-	1	
RP	ZOO/RP/699- RP2	6	-	6	-	Credits-6
		12	20	12	10	Total Credits -22

M. Sc. Zoology-second Year, Semester – III- Syllabus-
Theory Paper Code: ZooMJ 600
Title of the Paper – Developmental Biology
Major Mandatory DSC
Credits: 03 , Contact Hours: 45

Course objectives:

1. To study the structure and function of the basic unit of living organisms.
2. To study steps in animal development.
3. To determine the modern trends and tools, techniques in Animal embryology and Development.

Course Outcome:

After learning the development of life from cell to multicellularity complex and coordinated systems in organisms the students can apply this knowledge for research, and education, to solve the problems related to development in animals through research.

Unit I.

Gametogenesis, Production of gametes- Spermatogenesis in mammals, structure of sperm, Oogenesis in mammals, Structure of egg
Semen formation, Capacitation, Cell surface molecules in sperm-egg recognition in animals; .
Prevention to polyspermy (Fast block and slow block)
Acrosome reaction.
Fertilization Activation of Egg (Molecular mechanism).
Zygote formation in animals and composition and early development

Unit II

Type of eggs, Cleavage and patterns of embryonic cleavage.
Blastula formation and fate map of blastula.
Gastrulation and formation of 3 germ layers in animals (Ex. Frog and Chick)
Extra embryonic membrane formation.

Unit III

Basic concepts of animal development:
Potency. Commitment. Specification.. Induction.. Competence.
Determination and differentiation Morphogenetic gradients.
Cell fate and cell lineages..
Stem cells. Imprinting; mutants and transgenics in analysis of development.

Unit IV

Morphogenesis and organogenesis in animals:
Cell aggregation and differentiation in *Dictyostelium*;
Axes and pattern formation in *Drosophila*, Segmentation genes, Homeotic genes
Nuclear transplantation and cloning in mammals..
The concept of totipotency embryonic stem cells.
Differentiation of neurons,

Unit V

Post embryonic development- . Larval formation, .
Metamorphosis; .
Environmental regulation of normal development;
Sex determination.

References:

1. Developmental Biology by Gilbert Scott
2. Molecular biology of the cell By Albert et al
3. Molecular biology of the Gene by Watson et al
4. Principle of Development by Wolpert
5. Genes VIII/ IX By Benjamin Lewin
6. Developmental Biology by Balinsky
7. Developmental Biology by Berril
8. Developmental Biology by Waddington
9. Chordate Embryology: Verma and Agarwal.
10. Readings are also assigned from journals and from Internet resources such as Medline([Http://www.ncbi.nlm.nih.gov/entrez/quey.fcgi](http://www.ncbi.nlm.nih.gov/entrez/quey.fcgi)) and bio Med Net (<http://www.bmn.com/>) Wikipedia etc.

Paper No. ZOO/MJ/601
Title of the Paper – Biophysics
credits-3

Contact Hours: 45

Course objectives:

To understand universal law as applied to biological system.

Better understanding to f the concept from physical laws and application

To understand the various physical mechanisms happening in a biological system.

Learning Outcome.

The student will learn the application and concept of the physics in biological processes.

UNIT 1: Diffusion and Osmosis

Diffusion Kinetics of diffusion, Fick's law of diffusion and diffusion coefficient, Biological significance in animals and plants. Electrochemical gradients, capacity and resistance, Stokes- Einstein Equation and Graham's Law, Facilitated diffusion, Gibbs- Donnan Equilibrium.

Plasma membrane:-Internal composition, cell penetration, permeability of cell membrane, permeability coefficient.

Osmosis-Osmotic concentration and osmotic pressure, Van't Hoff's Laws.

Biological significance of osmosis and animal and plants,

UNIT II: Biophysics cell Membrane

Physicochemical properties of cell membrane, conformational properties of cell membranes, Membrane transport, endocytosis, exocytosis, nutrient transport across membranes, porins, facilitated diffusion, porter molecules, Facilitated transport:- Symport, antiport, uniport, anion porter, glucose porter, Active transport: Proton pumps, Na K' pumps and Cat pumps, ionic channels. Functions of cell membrane, Artificial membranes.

UNIT III: Bioenergetics

Thermodynamics -Laws of thermodynamics, Entropy, Enthalpy, Free energy, Reversible thermodynamics, and irreversible thermodynamics; System open, closed, and isolated Photo-bioenergetics. Photosynthesis light and dark reactions, redox couple and redox potential. Chemo-bioenergetics; electron transport and oxidative phosphorylation, Chemiosmotic theory and binding changes mechanism of ATP synthesis.

UNIT IV: Biomechanics and Neurophysics

Striated muscle- contractile proteins, Mechanical properties of muscle, contraction mechanisms, role of calcium ions, Biomechanics of the cardiovascular system activity of during the heart beat, Electrocardiography. Blood pressure, electrical Nervous system-synapse, Physics of membrane potential bioelectric potential: Diffusion potential, membrane potential- muscle and nerve, voltage clamp, Sensory mechanism- The eye- visual receptor, electrical activity and visual generator potentials, Neural aspects of vision, Visual communication and bio luminance.

Hearing Physical aspects, the ear,, elementary acoustic, theories of hearing, Signal transduction-mode of transport, signal transduction in the cells.

UNIT V: Radiation Biophysics

Ionizing radiations, units of radioactivity, exposure and dose.

Interaction of radiation with matter: Photoelectric effect, ion pair production, absorption and scattering of electrons. Biological effects of radiations; effect on nucleic acids, proteins, enzymes, and carbohydrate

cellular effects, of radiations, somatic and genetics, Nuclear medicine; Internally administered radioisotopes, radioiodine in thyroid function analysis, Renal, liver, and lung function analysis.

Applications of radioactive tracers, Radiations protection and therapy.

REFERENCES

1. Ackerman, E (1962) Biophysical Science. Prentice Hall Inc. NJ, USA
2. Alonso, A and Amondo, JLR(2006) Advanced Techniques in Biophysics. Springer, UK 3. Arora, MP (2007) Biophysics. Himalayan Publishing House, New Delhi.
4. Baker, EJ and Silverton RE(1978) Introduction to Medical Laboratory Technology, ELBS, London, UK
5. Das, D (1991) Biophysics and Biophysical chemistry, Academic Publishers, Calcutta.
6. Edward,A.L. (1997) Radiation Biophysics Academic Press, NY, USA.
7. Emster, L. (Ed.). (1985), Bioenergetics. Elsevier, New York, USA.
8. Ghatak K.I. (2011). Techniques and Methods in Biology. PHI Learning Pvt. Ltd. New Delhi
9. Gupta A. 2009. Instrumentation and Bio-Analytical Techniques. Pragati Prakashan, Meerut.
10. Hoope, W. et.al. 1983. Biophysics. Springer Verlag. Berlin.
11. Lehninger, A.L. 1971. Bioenergetics. W.A. Benjamin, London, UK.
12. Narayanan, P.2000. Essentials of Biophysics. New Age International (P) Ltd. Publishers New Delhi.
13. Pearse, A.G.E. 1980. Histochemistry, Vol. I & Vol. II. Churchill Livingstone, NY, USA.
14. Pradeep T. 2007. NANO The Essentials. Understanding Nanoscience and Nanotechnology. Tata McGraw Hill Education Pvt. Ltd., New Delhi.
15. Roy, R.N. 1996. A Textbook of Biophysics. New Central Book Agency (P) Ltd. Calcutta
16. Sandhu, G.S. 1990. Research Techniques in Biological Sciences. Anmol Publications, New Delhi
17. Srivastava, P.K. 2006. Elementary Biophysics. An Introduction. Narosa Publishing House, New Delhi.
18. Varghese, T. and Balakrishna, K.M. 2012. Nanotechnology-An Introduction to Synthesis, Properties and Applications of Nanomaterials. Atlantic Publishers and Distributors. (P) Ltd. New Delhi
19. Weesner, F.M. 1960. General Zoological Microtechniques. The Williams & Wilkins Co., Baltimore, USA

Paper No .ZOO/MJ/602
Title of the Paper - Applied Biotechnology I
credits-3
Contact Hours: 45

Learning Objectives:

1. To create interest in technological advancements in biological sciences and its application to mankind
2. To familiarize the students with different diagnostic techniques with applications,
3. To develop critical thinking about emerging techniques of biology, including nano biotechnology and marine biotechnology.

Learning Outcomes:

By the end of the course students will be able to

1. Understand the applications of Biotechnology in Agriculture and waste-recycling
2. State principles and applications of various diagnostic techniques.

Unit I: Biotechnology in Agriculture and waste recycling

Waste management: Definition, Solid waste suitable for composting,

Methods of composting: Vermi composting Mineralization process in composting,

Biochemistry of composting, factor involved.

The infrastructure required-maturity parameters, value-added application methods.

Unit II: Biotechnology in Diagnosis and Molecular diagnosis

Introduction to molecular diagnosis, significance, scope rise of diagnostic industry, Biomarkers in disease diagnostics, Role of markers in disease diagnosis with examples.

Immunodiagnostic techniques: DNA reporter, Fluorogenic reporters, electro-chemiluminescent tags. and label-free immunoassays. PCR in molecular diagnosis, cellular and fundamental genomics in diagnostics.

Principles, techniques and application of Protein Sequencing,

DNA Sequencing,

CRISPR-CAS technology.

Family Genetic Inheritance for identifying rare and common genetic variants NGS platforms Illumina, ion Torrent, complete Genomics technology, Third generation sequencing (3GS); Pac bio Single Molecule Real Time (SMRT) sequencing and Oxford Nanopore Technologies (ONT) Heliocose Single molecule sequencing, Complete genome Advanced sequencing.

Unit III: Marine Biotechnology

Significance, Marine-derived pharmaceuticals, Marine bioresources. Secondary metabolites, Marine action-bacterial metabolites and their pharmacological potential, Barophilic organisms and their applications, Seaweeds for removal of metal pollutants. Green fluorescence proteins. Red fluorescence proteins, characteristics, and applications.

Unit IV: Nanobiotechnology

Introduction: What is nanotechnology and nanobiotechnology, principles of nanoparticle synthesis using living organisms and characterization.

Different morphological forms of nanoparticles. (Nanospheres, Nano-capsules, Dendrimers).

Applications of nanomaterials in drug delivery.

Importance of nanomedicine.

Unit V: Transgenic Animals

Transgenic mouse, Creation of gene knockout mice.

Transgenic livestock: Non-Breeding Strategies: Milk production, Growth and meat production.

Breeding Strategies embryonic transfer. Sex selection, embryo cloning. Gene transfer in animals.

Genetic engineered vaccine used with live stock, Animal Pharming. Genetic engineering in animals by nuclear transfer, Transgenic sheep, Transgenic poultry, and genetically altered fish.

References

1. Satyanarayana, (2010): Biotechnology, Books and Allied (P) lid, Kolkata 2. Rastogi, Sel (2009): Biotechnology, Principle and Applications. Narona Publishing House, Mumbai.
3. Patnaik, HK, Kara, TC, Gosh, SN, Dalaj. AK (2012) Text book of Biotechnology. Tata McGraw Hill Education Private Limited.
4. Chanarayappa (2006): Molecular Biotechnology Principles and Practices, University Press
- 5 Experimental biotechnology, P.M. Philopose, Dominant publishers and distributors, New Delhi.
- 6 Biotechnology by Trehan.
- 7 Helen Kreuzer & Adrienne Massey Biology and Biotechnology: Science, Applications and Issues.. ASM Press, Washington DC. 2005
- 8 Handbook of Molecular and Cellular Methods in Biology and Medicine. Second Edition, 2004. Edited by Leland J. Cseke, Peter B. Kaufman, Gopi K. Podila, Chung- Jui Tsai. CRC Press, Boca Raton, London, New York, Washington DC.
- 9 Joseph Sambrook & David W. Russell Molecular Cloning : A Laboratory Manual. Third Edition, 2001. Volumes I, II & III.. Cold Spring Harbor Laboratory Press, New York.
- 10 PCR Protocols : A Guide to Methods and Applications. Edited by Michael A. Innis, David H. Gelfand, John J. Sninsky, Thomas J. White. Academic Press, Inc. 1990.
- 11 Principles of Gene Manipulation and Genomics. Seventh Edition, 2006. S. B. Primrose & R. M. Twyman. Blackwell Publishing
12. Molecular Biology of the Cell. 4th Edition, 2002. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts & Peter Walter. Garland Science, Taylor Francis Group.
13. Analysis of Genes and Genomics. Richard J. Reece. John Wiley & Sons Ltd. (2004)
- 14 From Genes to Clones : Introduction to Gene Technology. Ernst-L. Winnacker Panima Publishing Corporation, New Delhi/Bangalore.
- 15 Molecular Biotechnology. Third Edition, 2002. Glick & Pasternak. ASM Press.
16. Concepts in Biotechnology. Edited by D. Balasubramanian, K. Dharmalingam, C. F. A. Bryce, J. Green & K. Jayaraman. University Press.

Practical Papers- Credits: 01 Marks: 50

Practical Paper No. ZOO/MJ/603 Practical based on- ZOO/MJ/600 Developmental Biology

1. Microscopic study of structure of sperms.
2. Study of semen for sperm motility and abnormalities.
3. Micro techniques for histology and histo-chemistry of tissue preparation.
4. Study of developmental stages in fertilized egg of hen (Various Hrs. stages of Embryonic Development) and demonstration of organogenesis in chick embryo.
5. Study of regeneration in earthworms and cultivable fishes.
6. Preparation and submission of five slides of cells isolated from different organs of Invertebrate and vertebrate animals.
7. Techniques of cryopreservation of Ova and sperms in fish/Cattle.
8. Computer simulated experiments in animal embryology and cell biology

Practical Paper No. ZOO/MJ/604 Practical based on- ZOO/MJ/601 Biophysics

1. To study the ECG cycle for signals and the corresponding cardiac functions.
2. To study the measurement of blood pressure
3. To study the phenomenon of cyclosis by ingestion of dye in Paramecium
4. To study the osmotic relation in animals
5. To study the osmotic hemolysis of erythrocytes in different concentrations of salt solutions
6. To study the muscle excitation by using the Kymograph apparatus
7. To study the effect of calcium ions on the heartbeat of a rat/ crab by using a kymograph.
8. Demonstration of background count of radiation by Geiger Muller counter.
9. Cell fractionation and Differential Centrifugation to isolate mitochondria and nuclei
10. Study of membrane fluidity,
11. Study of diffusion of biomolecules/ions (Flick's law),
12. To study membrane potential using fluorescence spectroscopy.
13. Passage of molecule through dialysis membrane and demonstration of Donnan membrane equilibrium.
14. Preparation of liposome
15. To analyze erythrocyte membrane lipid/proteins by TLC/SDS-PAGE
16. To study spectrophotometric assay of Hill reaction and estimation of Chlorophyll.

Practical Paper No. ZOO/MJ/605 Practical based on ZOO/MJ/602 Applied Biotechnology I

- 1 Process the data using suitable computer software for calculating mean, median, and mode.
2. Calculation of average, variance, frequency distribution, standard deviation.
- 3 Making of graphs using Computer
4. Calculation of t test, (Unpaired and Paired
5. Calculation of ANOV
6. Calculation of Chi square test.
7. Techniques for isolation of pure cultures. 8. Gram stain for differentiation of bacteria
9. Nutritional requirements: Media for the routine cultivation of Bacteria.
- 10 Determination of growth curve of bacteria.
- 11 Methylene blue reductase test
12. Standard qualitative analysis of water: Confirmed test of bacteria.
13. Isolation colony characterization and Gram characteristics of bacteria from fermented food.(curd/idli batter/ dhokla batter)
14. Testing of food adulteration (milk/milk products/haldi or any food sample)
15. Determination of moisture in food sample. /Determination of ash in food sample
16. Antibiotic Potency test-Plate diffusion method (Minimum Inhibitory Concentration)

17. Visit to Food/ Pharmaceutical industry

ZOO/MJ/606
Advanced skill

Credits 4 ,Marks 10

Elective Course
ZOO/DSE/607
Applied parasitology I
Credits-3
Contact Hours: 45

Learning Objectives:

1. To understand the basic and general concepts of Parasitology.
2. To study major types of parasites of medical and veterinary importance.
3. To develop understanding of food and water borne diseases

Learning Outcomes

By the end of the course students will be able to:

1. Enlist types of parasites and hosts along with their relationship,
2. State the advantages and disadvantages of parasite in life.
3. Explain Inter-specific biological relationships.

Unit I: Introduction to Parasitology

1. Scope and historical landmarks in Parasitology. Inter-specific biological relationships phoresis, symbiosis, commensalism and parasitism.
2. Parasitism- Definition and concept, Origin and evolution of parasites, Adaptation in parasites. Advantages and disadvantages in parasitic life Adaptations for transmission: parasitic reproduction, behavioral adaptation, Epidemiology of parasites.
3. Types of hosts definitive and intermediate, primary secondary specific host, paratenic, carrier, Susceptible, Resistant, accidental, Vectors parasites

Unit II: Systematics and taxonomy

1. Basic principles and nomenclature aspects of parasites
2. Types of Parasites.
3. Types of hosts- Definitive and intermediate, primary secondary specific host, Paratenic, Carrier, Susceptible, Resistant, Accidental, Vectors etc
4. Major taxa of parasites of medical & veterinary importance.
5. Factors influencing Parasitism; Influence of season, host age and other phonological factor on parasitic population (prevalence, intensity etc),.

Unit III: Habitat and Environment

1. Habitat and environment of different parasites. Host parasite system. Host reaction to parasites. Pathogenicity of Endo and Ectoparasites.
2. General control of ecto and endoparasites, chemical. biological, physical, mechanical, cultural and legislative.
3. Economic importance of parasites, direct or indirect effect on human, animal, farm animals and Agriculture, poultry and fisheries pathogenicity.
4. Host as an environment, parasites ecological niche, infectious site, Parasitic populations: Quantitative descriptors Macro and micro parasites, trophic relationships, Host-switching or host capture, phylo-geography

Unit-IV

1. General organization of the parasitic Protozoa occurring in urinogenital tract and blood.
i) *Trichomonas vaginalis* ii) *Tritrichomonas foetus* iii) *Trypanosoma* iv) *Leshmania donovani*
- 2) Medically and veterinary important Parasitic Cestodes and trematode

i. General organization, life-cycle, pathology, laboratory diagnosis, control and prevention of diseases caused by *Clonorchis sinensis*, *Paragonimus westermani*, *Diphyllbothrium latum*, *Dipylidium*

caninum, *Moniezia expansa* and *Hymenolepis nana*.

ii. Parasitic diseases of: Alimentary canal: GI tract, Nervous system and tissue
Clonorchiasis, Fasciolopsias, Echinococcosis, Taeniasis, Human Schistosomiasis

UNIT V: Immunology, Biochemistry and pathology

Overview of innate and acquired immunity, immune response and complement. Parasites in immunized hosts.

Immunity to helminths and parasitic protozoa. tissue damage by immunological mechanisms;

Autoimmunity, Antibody-antigen interactions. Immunological applications in parasitology;

Immuno-therapy and immuno-control in parasitic infections,

Hypersensitivity and allergic reactions in parasitic infections inflammation.

Energy metabolism in parasitic protozoa and helminth, lipid metabolism, metabolism of nitrogenous compound, Amino acid metabolism.

References

1. Infectious Disease Epidemiology: theory and practice. 2nd edition. Nelson & Williams (Eds.). 2007.
2. A good additional online text: Global Burden of Disease and Risk Factors. Disease Control Priorities Project. It is available at: <http://www.ncbi.nlm.nih.gov/books/bv.fcgi?rid=gbd.TOC&depth-2>
3. Medical Parasitology by Markell, Voge and John, 8th ed. W.B. Saunders Co. 4. Reingold, A.L. Outbreak Investigations - A Perspective. Emerging Infectious Diseases 1998: 4(1): 21-27.
5. Modern Parasitology Ed FEG Cox, Blackwell Science
6. Foundations of parasitology (2009): GD Schmidt and LS Roberts. McGraw Hill Higher Education.

ZOO/DSE/608
Animal physiology I
Credits-3
Contact Hours: 45

Learning Objectives:

To understand the basic physiological processes in invertebrates and their use in medical, Non medical and veterinary sciences.

Learning Outcomes:

By the end of the course students will be able to

1. Explain osmoregulation and hormonal regulation in various invertebrates.
2. Describe physiological processes like digestion, respiration, excretion and reproduction in invertebrates.

Unit I: Crustacea

1. Osmotic and ionic regulation, mechanism of regulation, hormonal control of osmoregulation
2. Structure and functions of heart: Significance of pericardial organs in heartbeat, blood Sugars in crustacean and its hormonal control.
3. Types of reproduction, genetic sex determination, sex reversal, factor affecting reproduction , hormonal control of reproduction.

Unit II: Insecta

1. Nutrition and choice of food, functional morphology of alimentary canal and associated glands, role of digestive enzymes.
2. Functional morphology of respiratory organs in insects, physiology and factors affecting respiration.
3. Structure and functions of photoreceptors, mechano-receptors and chemoreceptors mechanism of reception.
4. Gametogenesis and factors affecting reproduction, hormonal control of reproduction.
5. Types of metamorphosis in insects and hormonal regulation of metamorphosis.

Unit III: Annelid

1. Digestive system, transport of food through alimentary canal, regulation of digestion.
2. Types of reproduction, sexual development and maturation, factors affecting reproduction.
3. Growth and regeneration in polychaeta and its hormonal regulation.

Unit IV: Mollusca

1. Osmotic equilibrium, osmotic and ionic regulation in freshwater and Marine forms.
2. Respiratory organs, structural properties and functions of respiratory pigments.
3. Nitrogenous end products, urine formation and excretion
4. Reproduction pattern (Gonochorium, Hermaphroditism, self-fertilization, parthenogenesis).
5. Factors influencing reproduction, formation control of reproduction, sex reversal.

Unit V: Echinodermata

1. Coelomic fluids and coelomocytes.
2. Respiratory organs, role of perivisceral coelomic fluid in respiration, factors affecting respiration. in echinoderms.
3. Types of reproduction, breeding behavior, factors influencing reproduction, regeneration in echinoderms.

Reference Books:

1. Comparative animal physiology by Prosser C.L
2. General and comparative physiology by Florey W.
3. General and comparative physiology by Hoar W.B.
- 4 . Animal physiology by Neilsen K.S. 5 . Cell Biology by Ambrose and Fastly.
6. Principle of animal physiology by Wilson J.A. 7. Neural and integrative physiology by Prosser C.
8. Animal physiology by Gordon G.S.
9. Modern physiology by Strang F.

Molecular Biology 1(Paper No. 700-312) 4 Credits: Total 60 Hours: 4 Hours/Week

Learning Objectives:

10. To impart knowledge in evolving biological science at a molecular level. To impart an understanding of the fundamental procesa governing life and information flow

ZOO/DSE/609
Molecular biology I
Credits-3
Contact Hours: 45

Learning Objectives:

1. To impart knowledge in evolving biological science at a molecular level.
2. To impart an understanding of the fundamental process governing life and information flow.
3. To inculcate interest in research molecular biology and creating a human resource for this region.

Learning Outcomes:

By the end of the course students will be able to

1. Explain chemical components of nucleic acids, structure of DNA, structure and types of RNA
2. Have a proper understanding of prokaryotic and eukaryotic replication.
3. Understand DNA damage and various genetic disorders.

Unit I:

1. Introduction to Molecular biology; History of DNA discovery, Griffith and Avery Oswald. Nucleic acids, DNA structure and function Rosalind Franklin and Maurice Wilkins experiment. Watson and Crick double-stranded DNA helix, Central dogma of Molecular biology.
2. DNA structure: Size and Fragility, Recognition pattern in the major and minor grooves, DNA binding. Denaturation and Renaturation, Helicase, SS DNA proteins, Topoisomeres and Topoisomerase, Non-B-DNA confirmation, RNA structures, RNA world hypothesis.

Unit II:

1. Chromosome structure, Bacterial chromatin, Karyotype, Nucleosome, The 30nm fiber. The scaffold model, The centromere, Telomere.
2. DNA metabolism: DNA Replication in bacteria: General features. The initiation phase. The elongation phase, The termination phase, Regulation,
3. DNA replication in eukaryotes and Archaea. SV DNA replication, Eukaryotic DNA replication, Eukaryotic replication initiation, Elongation and replication problem, Replication coupled chromatin synthesis, DNA replication in Archaea.

Unit III: DNA Damage

1. Radiation damage, DNA instability in water, Oxidative damage, Alkylation damage by monoadduct formation, Chemical crosslinking agents, Mutagen and carcinogen detection.
2. DNA repairs: Direct reversal of damage, Base excision repair, nucleotide excision repair, mismatch repair, the SOS repair and translation DNA synthesis

Unit IV: Recombination

Homologous recombination, clues from bacteriophage, models of homologous recombination. Homologous recombination model initiation by double-strand break, Homologous recombination proteins from bacteria and eukaryotes, Meiotic recombination, Meiotic recombination to make gene knockout, site-specific recombination.

Unit V: Transposons and other mobile elements Transposition, Conservative site-specific recombination, Target primed reverse transcription.

Reference Books:

1. Molecular Biology of gene, 5th edition (2004), James D. Watson, Tania Baker, Stephen P. Bell Alexander Ciann, Michael Levine, Richard Lodwick, Publisher Pearson Education, Inc, and Dorling Kindersley Publishing Inc.
2. Molecular Biology, 4th edition (2007), Weaver R., Publisher-McGraw Hill Science,
3. Molecular Biology of Cell, 4th Edition (2004), Bruce Alberta, Dennis Bray, Julian Lewis.

Martin Raff, Keith Roberts and James D. Publisher: Garland Publishing.

4. Essential Cell Biology, 2nd edition (2003), Bruce Alberts, Dennis Bray. Karen Hopkin. Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter, Publisher: Garland Publishing. 5. Fundamentals of Molecular Biology, (2009), Pal J.K. and Saroj Ghaskadbi, Publisher: Oxford University Press. 6. Genes X, (2010), Benjamin Lewin, Publishers-Jones and Barlett Inc.

ZOO/MJ/610
Fishery science I
Credits-3
Contact Hours: 45

Learning Objectives:

1. To develop the scientific outlook and awareness in Inland water bodies and its great potential for fish and fish seed production.
2. To familiarize the students with phylogeny of fish.
3. Application of the fishery science for the biological productivity of inland waters.
4. The commercial fish species exploitation by sharing ecological niches.

Learning Outcomes:

By the end of the course students will be able

1. Identify the fish from both, marine and fresh water.
2. Explain characters, classification and techniques related to fish.
3. Develop knowledge about fisheries, conventional and non-conventional fishing methods.

Unit I:

General Characters and classification of fresh and marine water fish, Identification of larval stages of major carps, Identification of fish up to species level, General characters of bony and cartilaginous fish and phylogeny of fish.

Unit II:

Aquatic ecosystems, Fresh, brackish and marine water ecosystems, Productivity of ponds and its nutrient circulations, Identification of plankton, nekton and benthos, Role of plankton in fish culture.

Unit III:

Culture techniques of major carps, Breeding techniques, Induced breeding bundh breeding, breeding in happa, Types of fish culture-Cage culture, Pen culture, Monoculture, Polyculture, Types of hatcheries. hatching happa, Chinese hatchery, Maintenance and management of hatcheries. Hybridization

Unit IV:

Types of fish-ponds in fresh water fish culture, Layout and construction of ponds. Fertilization and management of various ponds. Fish diseases and their control measures. Setting up of home aquarium and maintenance of aquarium fish.

Unit V

Major fisheries in India and fishing methods. Important Inland, cold water, Brackish, estuarine and marine fisheries of India. Conventional and non-conventional fishing methods.

Reference books

1. Pillay.T.V.R.& M.A. Dill.- Advances in Aquaculture. Fishing News (Books)Ltd., England. 1979
2. Stickney, R.R. -Principles of Warm water Aquaculture. John Wiley & Sons Inc.. 1970
3. Boyd, C.E. -Water Quality Management for Pond Fish Culture. Elsevier Scientific Publishing Company, 1982.
4. Jhingran, V.G. -Fish and Fisheries of India. Hindustan Publishing Corporation India 82 5. Bardach, et. al. -Aquaculture The Farming and Huslanoday of Freshwater and Ma Organisms. John Wiley & Sons, NY, 1972.
6. Chondar, C.L., Hypophysation of Indian major carps. Satish Book Enterprise.Agru, 1980, 7.
- Santhanam, R. et. al. A Manual of Freshwater Aquaculture. Oxford & IBH Publishing Co. Pvt. Ltd., 1987
8. Cheng, T.C. -The Biology of Animal Parasites, Saunders, Philadelphia, 1964

9. Ribelin, W.E. & G. Migaki- The Pathology of Fishes. The Univ. of Wisconsin Press Ltd., Great Russel st., London, 1975.
10. Schaperclaus- Fish Diseases. Vol. 1 & II. Douglas P Anderson-Text Book of Fish Immunology
11. Karunasagar, I. -Aquaculture and Biotechnology. Oxford-1311 Publishers, New Delhi Govindan, T.K. -Fish Processing Technology, Oxford-IBH, 1985.
12. Shang, Y.C. -Aquaculture Economic Analysis-An Introduction, 1990.
13. Nikolsky, G.V. Ecology of Fishes. Academic Press, NY, 1963,
14. Howar, W.S. & D.J. Randal- Fish Physiology, Vols. 1-4, Academic Press, NY, 1970. Carl, B.E. Biology of Fishes- Saunders, 1979.
15. Day, F. -The fishes of India.

ZOO/DSE/611 Practical based on ZOO/DSE/607 Applied parasitology I

1. Study of different types of animal associations with suitable examples
2. Study of different types of parasites, vectors etc.
3. Collection, preservation, mounting and identification of helminth parasites from locally available hosts.
4. Study of different/important ecto/endoparasites of poultry, fish, animal and human.
5. Study of hemoflagellates from vertebrate blood
6. Preparation of blood smear, staining and identification of Haemosporina.
7. Study of different mosquito vectors of protozoan parasites.
8. Submission of permanent slides at the time of examination.

ZOO/DSE/612 Practical based on ZOO/DSE/608 Animal physiology I

1. Effect of salinity on blood chloride content of crab.
2. Effect of temperature on Heartbeat. Q10 measurements in bivalve/crabs.
3. Estimation of glycogen from hepatopancreas and gonads of bivalve/crabs.
4. Estimation of protein from hepatopancreas and gonads of bivalve/crabs.
5. Estimation of lipid from hepatopancreas and gonads of bivalve/crabs
6. Estimation of cholesterol from hepatopancreas and gonads of bivalve/crabs
7. Oxygen consumption in relation to sex and size/temperature of bivalve/leech/crabs.
8. Acid phosphatase activity in hepatopancreas of crab/bivalve.
9. Alkaline phosphatase activity in hepatopancreas of crab/bivalve.
10. Estimation of ascorbic acid from hepatopancreas and gonad of crab/bivalve.
11. Chromatophores in crustaceans and effect of background on color change.

ZOO/DSE/613 Practical based on ZOO/DSE/609 Molecular Biology-I

1. Extraction of genomic DNA from plant/bacterial/yeast/tissue/whole blood..
2. Determination of Molecular size of DNA.
3. Restriction digestion of DNA.
4. Determination of molecular weight of different DNA fragments by running a standard marker on agarose gel electrophoresis.
5. Demonstration of plastids in the gel by gel electrophoresis.
6. To isolate and clearing of the DNA fragment of interest from the agarose gel.
7. To perform transformation of DNA into bacterial cells.
8. To separate immunological proteins (alpha, beta and gamma) from serum by Sodium dodecyl sulfate polyacrylamide gel electrophoresis (SDS-PAGE).

ZOO/DSE/614 Practical based on ZOO/DSE/610 Fishery Science-1

1. Identification of fish up to species level with suitable examples from each class.
2. Analysis of water: Turbidity, pH, dissolved oxygen, carbon dioxide, alkalinity, chlorinity.
3. Identification of plankton, nekton and benthos.
4. Fishing crafts and gears, hatching happa.
5. Identification fish parasites.
6. Identification of fish food (at least twenty)
7. Visit to fish breeding centre.

ZOO/RP/649- RP1

Credits-4

Class: M.Sc. Second Year , Semester: IVth
Semester Subject: -Zoology Theory+ Practical

Course type	Course Code	Teaching Scheme (Hrs./ week)		Credits Assigned		Total Credits
		Theory	Practical	Theory	Practical	
Major Mandatory DSC	ZOO/MJ/650 Evolution and behaviour	4	-	3	-	12
	ZOO/MJ/651 General and comparative physiology	4	-	3	-	
	ZOO/MJ/652 Applied biotechnology II	4	-	3	-	
	ZOO/MJ/653 Practical based on Evolution and behaviour	-	3	-	1	
	ZOO/MJ/654 Practical based on General and comparative physiology	-	3	-	1	
	ZOO/MJ/655 Practical based Animal biotech.	-	3	-	1	
DSE (any one)	ZOO/DSE/656 Applied parasitology II	4	-	3		04
	ZOO/MJ/657 Animal physiology II	4		3		
	ZOO/MJ/658 Molecular biology II	4	-	3	-	
	ZOO/MJ/659 Fishery science II	4	-	3	-	
	ZOO/MJ/660 Practical based on Applied parasitology II	-	3	-	1	
	ZOO/MJ/661 Practical based on Animal physiology II	-	3	-	1	
	ZOO/MJ/662 Practical based on Molecular biology II	-	3	-	1	
	ZOO/MJ/663 Practical based on Fishery science II	-	3	-	1	
RP	ZOO/RP/699- RP2	6	-	6	-	Credits-6
		12	20	12	10	Total Credits -22

M. Sc. Zoology-second Year, Semester – IV- Syllabus-
Theory Paper Code: Zoo MJ 650
Title of the Paper – Evolution and Animal Behavior:
Major Mandatory DSC
Credits-3
Contact Hours: 45

Learning Objectives:

1. To study the origin of various animal groups.
2. To study the mechanism involved in evolution,
3. To study the significance and pattern of evolution.
4. To study the behavioral mechanisms.

Learning Outcomes: By the end of the course students will be able to:

1. Explain various theories of evolution.
2. Describe the origin of biomolecules and their metabolism.
3. State the evolutionary time scale and evolution of organisms.

Unit I

1. Concept of evolution and development of idea of evolution, Geological time scale.
2. Lamarckism and Darwinism,
3. New concepts regarding Lamarckism and Darwinism.
4. Hardy-Weinberg law of genetic equilibrium, Destabilizing forces (i) Natural selection (ii) Mutation (iii) isolation and its role in species formation (iv) genetic drift (v) Migration (vi) Melotic drive

Unit II

1. Molecular population genetics, patterns of change in nucleotides and amino acid sequences, Ecological significance of molecular variations, Emergence of Non-Darwinian hypothesis.
2. Genetic of quantitative traits in population, Genotype-environment interaction, inbreeding depression and heterosis, Molecular analysis of quantitative traits, phenotypic plasticity.
3. Genetics and speciation, Morphological species concept, biological concept, Nominalistic species Concept, Phylogenetic species concept
4. Patterns and mechanism of reproductive isolation, models of speciation (Allopatric, Sympatric, Parapatric).

Unit III

1. Molecular evolution: Genetic evolution, Evolution of gene families, Molecular drive. Assessment of molecular variation, origin of higher categories: Micro and macroevolution.
2. Characteristics of evolution, Extinction, replacement, irreversibility of specialization, etc.
3. Adaptive radiations, occupation of new environment and niche, mimicry and coloration, relevance of adaptive radiation in light of new discoveries.

Unit IV

1. Introduction to animal behavior, definition, concept of ethology, scope and limitations Orientation, classification of various types of taxis and kinesis.
2. Social behavior in primates (a) Primate societies (b) Social sounds, olfactory, tactile, visual, vocal and acoustic (c) Status: Dominance and hierarchy, territorial behavior, courtship and mating, aggregation

Unit V

1. Reproductive behavior in fish (Stickle back or any other fish).
2. Behavior in insects, courtship behavior in Drosophila, Social behavior, Communications Concealment

- behavior, Pheromones in behavior, genetics and human behavior.
3. Learning. Habituation, conditioned reflex: Trial and error, Latent learning, learning and discrimination, imprinting, neural mechanism of learning.
 4. Instinctive behavior: concept, Phylogenetic descent, and physiology
 5. Methods of studying behavior: Brain lesions, electrical stimulation, drug administration.

Reference Books:

1. Varma and Agrawal-Genetics and Evolution
2. Dobzhansky. Th.. Genetics and Origin of Species. 3rd Ed. Columbia Univ. Press.
3. 4. Dobzhansky. Th., F.J. Ayala, G... Stebbins and J.M. Valentine. Futuyama, D.J. Evolution. Surjeet Publication, Delhi.
5. Jha, A.P. Genes and Evolution. John Wiley Publication, New Delhi.
- Savage J.M Evolution, Amerind Publishing Co. New Delhi.
7. Varma and Agrawal - Evolution
8. Animal behavior and Evolutionary Approach by Alcock
9. Perspectives in animal behavior Goodenough, Wiley 1993
10. An introduction to animal behavior 5"ed. Cambridge Univ Press. By Manning
11. Animal Behaviour – Mechanism, Ecology, Evolution by Drickamer, Vessey, Jakob
12. Animal Behaviour – Its development, Ecology and Evolution by Robert A Wallace. Goodyear Publishing Company
13. Animal Behaviour by David McFarland. Pitman Publishing Ltd
14. Textbook of Animal behaviour by F.B.Mandal. PHI
15. Behaviour by M. Dockety and M Reiss. Cambridge University press.
16. Introduction to Animal Behaviour by Manning and Dawkins. Cambridge Univ. Press

ZOO/MJ/651
General and comparative physiology
credits-3
Contact Hours: 45

Learning Objectives:

1. To study the physiological processes in detail for medical, non-medical and veterinary science Purposes.
2. To gain knowledge about various biological systems.

Learning Outcomes: By the end of the course students will be able to:

1. Explain various biological systems and their regulation in detail.
2. Describe the origin of biomolecules and their metabolism.

Unit I: Energy sources and their Distribution:

1. Anaerobic stages in Terrestrial evolution, Origin of aerobic world (Photosynthesis) and animal and its environment.
2. Regulatory mechanisms: Factors at enzyme activity, at organ system level, Autonomic nervous system, endocrine system, coordinated regulations
3. Digestive mechanisms: collection of food, Digestion, Absorption, Correlation of digestive activities, energy balance, BMR. Nutritive requirement and related disorders(ex. obesity)

Unit II: Exchange of gases, cardiovascular system and excretory system.

1. Integumentary, Bronchial respiration, Aquatic to aerial breathing (Lungs. Trachea and Respiratory mechanisms).
2. Transporting of oxygen, Cos. Regulation of fluid volume,
3. Phagocytosis, the reticulo- endothelial system, coagulation of blood, energy-producing reactions and energy utilizing reactions, Comparative physiology of excretion, kidney, nitrogenous waste in mammals, and in animals, formation of urine, urine concentration, waste elimination, regulation of water balance, electrolyte balance and acid base balance.
3. Competitive anatomy of heart structure, myogenic heart, specialized tissue, neural and chemical regulation of all above.

Unit III: Environmental reactions:

1. Temperature and rates of biological activities, Temperature compensation in poikilotherms and homeotherms.
2. Water and electrolyte problems of terrestrial living. Regulatory mechanisms. Oxygen as limiting factor in the environment, effect of environment on oxygen demand, effect of hydrostatic pressure, buoyancy and biological clocks.
3. Comfort zone. Body temperature Physical, chemical. neural, acclimatization and Acclimation.

Unit IV: Various interactions and Animal activities:

1. Molecular basis of cellular irritability and pain, Chemoreception. Mechanoreception. Temperature receptors, Mechanism producing movement, amoeboid movement, electric organ, Luminescent organs, Pigment cells, Interneural transmission, Integrative systems of neurons; physiology of behavior.
2. Neurons, Gross neuroanatomy of the brain and spinal cord, central and peripheral nervous system ,neural control of muscles, bone and posture.

Unit V: Reproduction and Development:

Reproductive mechanisms, Invertebrate hormones of reproduction, Vertebrate control,

regeneration, metamorphosis, Arthropod growth and metamorphosis,
Growth, molting and metamorphosis in the vertebrates.

Reference Books:

1. Comparative Animal Physiology by Prosser C.L...
2. General and Comparative Physiology by Floren W.A
3. General and Comparative Physiology by Hoar W. B.
4. Animal Physiology by Neilsen K.S.
5. Principles of Animal Physiology by Wilson J.A.
6. Animal Physiology by Gordon G.L...
7. Modern Physiology by Strang F.L
8. Animal Physiology by Mohan and Arora

ZOO/MJ/652
Applied Biotechnology II
credits-3
Contact Hours: 45

Learning Objectives:

1. To create interest in Biotechnology.
2. To familiarize the students with different diagnostic techniques with applications.
3. To develop critical thinking about emerging techniques of biology, including nano-biotechnology and marine biotechnology

Learning Outcomes: By the end of the course students will be able to:

1. Explain biofuels, biotransformation of reclaimant metabolites and green technologies.
2. Describe principles and applications of DNA finger printing, human genome project etc.
3. Understand stem cells, policies, storage and applications.

Unit I: Biotechnology in environment:

1. Generation of plant origin alternative fuels First-generation biofuels: Bio-alcohol (Corn, Sugarcane), Syngas, Biodiesel, Biogas; Second- generation biofuels: Cellulose biofuels, biohydrogen, bioethanol, Third-generation biofuels: Algae
2. Biotransformation of reclaimant Metabolite (with examples), the ecological impact of microbes. Green technology: Definition, concept and implication, the role of green technologies towards Sustainable development.

Unit II: Biotechnology in Human Welfare

1. Application to forensic science: Principle of DNA fingerprinting, application of DNA profiling in forensic medicine for solving crimes and paternity disputes. Genetically modified crops and food; Health concerns, Human genome project: Its implication in health and diseases. GUARDIAN: Genomics for precision medicine in India.
2. NGS Strategies for Family based Genetic analysis Family based Genome Wide Association Studies (GWAS), advantages and disadvantages. Target specific sequencing- Panel gene sequencing: Whole Exome Sequencing (WES), Whole Genome Sequencing; Linkage analyses in Era of NGS.

Unit III: Bioinformatics Pipelines for Variants:

General variants calling workflow using WS and WGS data, Specialized Pipelines for family Based Variants analysis: Genetic resources for variant analysis, classification of Genetic variants. Cloud based bioinformatics services for Analysis of Genomic Data Selecting Bioinformatics Strategies; Common sequencing errors a with NGS Analysis. regulating Challenges in Analysis of NGS.

Unit IV: Systems, synthetic biology and stem cell technology in biotechnology. Introduction to system biology; principles of system biology, modeling in systems biology. applications of system biology in biotechnology, Introduction to synthetic biology, principle and applications and scope of synthetic biology for the production of bioactive metabolite. Introduction, what is a stem cell, types, Therapeutic applications of stem cells in human degenerative diseases (Examples). Stem cell policies and ethics, cord blood banking, and long-term storage of stem cells.

Unit V: Pharmaceutical biotechnology

Introduction, Use of Microbes in pharmaceutical industries, Microbial Drug Discovery, Screening at molecular level, Construction and design strategies. Rational drug discovery, Preclinical and clinical trials. Estimation of toxicity: LD 50 and ED 50.

References

1. Satyanarayana, J (2010): Biotechnology, Books and Allied (P) ltd, Kolkata
 2. Rastogi, Se(2009): Biotechnology. Principle and Applications, Narosa Publishing House. Mumbai.
 3. Patnaik, B.K, Kara, TC, Gosh, SN, Dalai, AK (2012) Text book of Biotechnology. Tata McGraw Hill Education Private Limited.
 4. Chanarayappa (2006): Molecular Biotechnology Principles and Practices, University Press Pvt limited. Hyderabad
 5. Frontier in Genetics-Reviews
 6. Primrose. S.B., Twyman R.M. (2014) Principles of Gene Manipulation and Genomics, 7th Edition, Blackwell Science Limited.
 - 7 Primrose .S.B (1994) Molecular Biotechnology., Blackwell Scientific Publishers, Oxford.
 - 8 Alberts. B., Johnson. A.D., Lewis. J., Morgan. D (2014) Molecular Biology of the Cell.
 - 9 Brown, T. A. (2006). Genomes (3rd ed.). New York: Garland Science Pub.
 - 10 Old, R. W., Primrose, S. B., & Twyman, R. M. (2001). Principles of Gene Manipulation: an Introduction to Genetic Engineering. Oxford: Blackwell Scientific Publications.
- Reference Books
- 11 Micklos D.A., Freyar G.A. (1990) DNA Science – A first course in rDNA technology, Cold Spring Harbor laboratory Press, New York.
 - 12 Glick. B.J., Pasternak j. J., Patten C.L (2010) Molecular Biotechnology: Principles and Applications of Recombinant DNA.
 - 13 Das H. K (2004) Textbook of Biotechnology 4 ed., Wiley India.
 - 14 Brown T. A. (2016) Gene Cloning and DNA Analysis. An Introduction, 7th Edition Blackwell Scientific Publications.
 - 15 Theiman W.J., Palladino. M.A., (2014) Introduction to Biotechnology, 3rd Edition.
 - 16 Cooper G. M., & Hausman R. E. (2013). The Cell: a Molecular Approach (6th Ed.). Washington: ASM ; Sunderland.
 - 17 Green M. R., & Sambrook J. (2012). Molecular Cloning: a Laboratory Manual. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.

ZOO/MJ/653 Practical based on ZOO/MJ/650 Evolution and Behavior

1. Practical based on Hardy-Weinberg law.
2. Lederberg experiment.
3. Courtship behavior in *Drosophila*.
4. Wing beat and song produced.
5. Duration intervals of courtship songs (wing buzzing).
6. Reading behavior of praying Mantis.
7. Schooling behavior of fish.
8. Field visit to an animal husbandry centre.
9. Visit to NCCS, NCL, NIV, NARI Pune.

ZOO/MJ/654 Practical based on ZOO/MJ/651 General and comparative physiology

1. Qualitative survey of digestive enzymes in any vertebrate.
2. Estimation of salivary amylase activity.
3. Determination of abnormal and normal constituents of urine.
4. Estimation of chloride from haemolymph/ urine of cow.
5. Estimation of uric acid from serum.
6. Total count of R.B.C from human blood.
7. Differential count of W.B.C from human blood.
8. Estimation of Haemoglobin and carrying capacity of blood,
9. Measurement of blood pressure.
10. Hematin crystal formation.
11. Effect of temperature on the heart beat and Q10 measurement.
12. Effect of temperature on the rate of oxygen consumption
13. Measurement of respiratory quotients.

ZOO/MJ/655 Practical based ZOO/MJ/652 Applied Biotechnology II

1. Study of cell viability determination by fluorescence staining method.
2. Study of cell viability determination by Trypan blue exclusion.
3. Characterization of cells by indirect immunofluorescences staining.
4. Isolation of hepatocytes by differential pelleting.
5. Standard procedure for cell separation by centrifugal elutriation (free electrophoresis).
6. Purification and preparation of neutrophils for FFE (Eggleton, 1989).
7. Isolation of erythrocytes.
8. Precipitin reaction: The ring test
9. Agglutination reaction: The febrile antibody test.
10. Cultivation of *E.coli* and isolation of its plasmid DNA by Mini prep Methods.
11. To cultivate lambda phage (1) using appropriate *E.coli* culture.
12. To isolate DNA of bacteriophage lambda.
13. To culture animal viruses on various membrane of a developing chick embryo.
14. Drug Toxicity-LC50 and ED 50
15. Visit to Marine Research Laboratory or National Laboratory.
16. Antibiotic Potency test- Plate diffusion method (Minimum Inhibitory Concentration)

Elective Course
ZOO/DSE/656
Applied parasitology II
credits-3
Contact Hours: 45

Learning Objectives:

1. To know basic and general concepts of parasitology.
2. To understand major types of parasites of medical and veterinary importance.
3. To design and evaluate an intervention to control food and waterborne diseases.
4. To prepare the experts in the field of medical and veterinary parasitology.

Learning Outcomes: By the end of the course students will be able to:

1. Explain parasite and its relation to global public health.
2. Describe about parasites, host and their relationship.
3. Have knowledge about various types of parasites and their life cycles.

Unit I: Parasites and Health

Parasite and Global Public Health, Global burden of infectious diseases, Biology, epidemiology and control of waterborne and foodborne parasites, Ecological changes and emerging diseases. General pattern of parasitic transmission, Parasitic zoonosis, Bioterrorism threats.

Unit II: Clinical and pathological signs of parasite infection.

1. Parasitic diseases of:

a) Alimentary canal: GI tract, liver, abdominal cavity, protozoal entities, coccidiosis, strongyloidiasis, Tricho-strongyloidiasis, Oxyurid infection.

b) Urinary system: *Klossiella equi*, *Dioctophymenale*.

Nervous system: *Parastrongylus cantonensis*, *Stephanurus dentatus*, Trichunosis.

In human: Giardiasis, Toxoplasmosis, Trichuriasis, Hook worm diseases.

Unit III: Strategies in the fight against parasites

1. Approaches to control of parasitic diseases: Analysis of biological systems. Targets for intervention, Approaches, measures against parasitic diseases, hygiene, Agricultural hygiene, personal hygiene, municipal hygiene, housing environmental management, control of vectors and intermediate hosts,
2. Strategies-planning and control: Protozoan and helminth parasites. Strategies in designing parasitic vaccines. Limitations in preparation of vaccines against parasites

Unit IV: Parasitism in phylum apicomplexa. Life cycle and pathogenicity of malarial parasites and control of malaria..Coccidian parasites in vertebrates, *Theileria* and *Babesia*

of class *Piroplasma*. Parasitic *Acanthocephala* and *Annelida* (Any one example each),

Study of medically and veterinary important Parasitic Nematodes.-

Human : *Strongyloides stercoralis*, *Trichuris trichura*, *Loa loa*.

Veterinary, *Haemonchus contortus*, *Thelazia callipaeda*

UNIT-V

Morphology life history, diseases/ harm caused and the control of following-

a) Parasitic *Acanthocephala* and *Annelida* (Any one example each)

b) Parasitic Siphonoptera, Anupleura, Mallophaga

c) Parasitic Diptera

d) Parasitic Hemiptera and Pentastomidea

e) Parasitic Crustacean and Acarids (any one example).

References

1. Infectious Disease Epidemiology: theory and practice. 2nd edition. Nelson & Williams (Eds.). 2007.
2. A good additional online text: Global Burden of Disease and Risk Factors. Disease Control Priorities Project. It is available at <http://www.ncbi.nlm.nih.gov/books/bv.fcgi?rid=gbd.TOC&depth-2>
3. Medical Parasitology by Markell, Voge and John, 8th ed. W.B. Saunders Co.
4. Reingold, A.L.. Outbreak Investigations: A Perspective. Emerging Infectious Diseases 1998; (1): 21-27
Jones, K.E., Patel, N.G., Levy, M.A., Storeygard, A., Balk, D., Gittleman, J.L. and P. Daszak. Global trends in emerging infectious diseases. Nature 2008; 451(21): 990-993
5. Applied parasitology Hiware, Jadhav and Mohekar
6. Helminth, Arthropod and Protozoa of domesticated animal -Solbsy E.J.W
7. Chatterjee K. D. (1969) -Parasitology (Protozoology and Helminthology)
8. Text book Medical Parasitology of Jaypee Brothers, Panikar C.K.J (1988) Medical Publishers, New York.
9. Bio-Chemistry and physiology of protozoa -Hutner and Lwoff II Ed. Vols I and II
10. Protozoan Parasites of domestic animals and man-Levine
11. Foundations of Parasitology by L.S. Roberts and J. J. Janory
12. Animal Parasitology by J.D Smith
13. Microbiology and Microbial infections 10th Edition by Topley and Wilson publis.
14. General Parasitology by T.C. Cheng
15. Medical Parasitology by K.J. Ryan and C.G. Ray Eds : An introduction to infectious diseases 4th Edn. McGraw, US

ZOO/DSE/657
Animal physiology II
credits-3
Contact Hours: 45

Learning Objectives:

To understand the basic mechanisms involved in physiological processes of vertebrates studied in animal, veterinary and medical sciences.

Learning Outcomes: By the end of the course students will be able to:

1. Explain cell transport, its types, cell growth and cell regulation.
2. Describe hormonal mechanism and reproductive physiology.
3. Knowledge about respiratory, nervous and excretory physiology.

Unit I:

1. Colloidal properties of cell; the cell as a polyphasic colloidal system. 2. Active transport, principles and mechanisms involved in transport: a) endocytosis - Pinocytosis, Phagocytosis. Phagotrophy. Autophagy
b) exocytosis

Unit II:

1. Cell growth: Measurement of cell growth and regulation of growth; cell growth in tumors,
2. Bioluminescent organs in different vertebrates, physical properties of bioluminescence: chemistry of light production and functional significance of bioluminescence.

Unit III:

1. Structure of myofibrils, protein molecules in myofibrils; mechanism of muscle contraction, force and shortening velocity, role of calcium in cross Bridge attachment.
2. Nerve cell and their classification; how resting potential is maintained: origin and development of action potential; synapses and theories of synaptic transmission.

Unit IV:

1. Osmotic balance and ionic regulation in different vertebrates, role of hormones in osmoregulation.
2. Nitrogenous excretory products: Their detoxification, formation of ammonia, ornithine cycle, ammonia toxicity and detoxification, role of aldosterone, ADH hormone and renin- angiotensin system in Renal physiology.
3. Physiology of respiration: Structure of organs of respiration in air an
4. Respiratory pigments and Chemistry of oxygen transport.
5. Factors af of thyroid hormones in basal metabolic rate.

Unit V

1. Sex determination and differentiation, differentiation of gonads in mammals.
2. Leydig cells, morphology, differentiation and its regulation.
3. Spermatogenesis, composition and formation of semen, Capacitation.
4. Ovarian follicular growth and differentiation, oogenesis, vitellogenesis, ovulation and ovum transport in mammals.
5. Hormonal mechanisms of implantation, pregnancy, parturition and lactation in mammals.

Reference Books:

1. EckertN Animal Physiology by David Randall.
2. Comparative animal physiology by Prosser C.L.
- 3.. General and comparative physiology by- Florey W.A
4. General and comparative physiology by Hoar W.B.
5. Animal physiology by Neilsen K.S.
6. Cell physiology by Giese A.C.
7. General physiology by Giese A.C.
8. A textbook of Biochemistry by West E.S. and Told W.R.
9. Cell Biology by Ambrose and Fastly
10. Principle of animal physiology by Wilson J.A
11. Animal physiology by Gordon G.S.
12. Modern physiology by Strang F.L.
13. Comparative physiology of animals by Hill R.W.
14. Medical physiology Guyton
15. General endocrinology C.D. Turner
16. Endocrinology, Hadley, M.E. Pearson education (Singapore).

ZOO/DSE/658
Molecular biology II
credits-3
Contact Hours: 45

Learning Objectives:

1. To impart knowledge in evolving biological science at molecular level.
2. To impart understanding of the fundamental process governing life and information flow.
3. To inculcate interest in research molecular biology and creating human resource for this region.

Learning Outcomes: By the end of the course students will be able to:

1. Explain gene, heredity and DNA, RNA as a genetic material.
2. Describe about DNA damage and types of repairs.
3. Have knowledge about genomic organization, cot and rot values, gene families etc.

Unit I:

1. Gene and heredity, concept of heredity.
2. DNA as the genetic material: transformation experiment, DNA as a Transforming principle Avery. Meleod and Me Carty experiment, Blender experiment (Hershey and Chase experiment).
3. RNA as a genetic material in some viruses, property of genetic material.

Unit II:

1. Chromatin: Structure, Genetic code, Characteristics of genetic code
2. DNA damage and repair: DNA damages, different DNA repair systems: Nucleotide excision repair, base excision repair, mismatch repair, recombination repair, double strand. break repair, transcriptional coupled repair, photosensitive repair, SOS response.

Unit III: Recombination

1. Homologous and site specific recombination, models of homologous recombination: The holiday model, proteins involved in recombination: RecA, RuvA,B,C, site-specific recombination, Gene conversion.

Unit IV: Mobile DNA elements

1. Discovery of transposons, transposable elements in bacteria, IS elements, composite transposons.
2. Process of transposition, Replicative non replicative transposons, Mu transposition. controlling elements in Tn A and Tn 10 transposition, SINES and LINES, retroviruses and retrotransposon.

Unit V: Genome organization

1. C value Paradox and genome size, cot curves, repetitive and non-repetitive.
2. DNA sequence, Cot and Rot values, Pseudogenes, Gene families, Gene clusters,

Reference Books:

1. Molecular Biology of gene, 5th edition (2004), James D. Watson, Tania Baker. Stephen P. Bell. Alexander Gann, Michael Levine, Richard Lodwick, Publisher Pearson Education, Inc. and Dorling Kindersley Publishing Inc.
2. Molecular Biology, 4th edition (2007), Weaver R., Publisher-McGraw Hill Science.
3. Molecular Biology of Cell, 4th Edition (2004), Bruce Alberts. Dennis Bray, Julian Lewis, Martin Raff. Keith Roberts and James D. Publisher: Garland Publishing.
4. Essential Cell Biology, 2nd edition (2003), Bruce Alberts, Dennis Bray, Karen Hopkin. Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter, Publisher: Garland Publishing.
5. Fundamentals of Molecular Biology, (2009), Pal J.K. and Saroj Ghaskadbi, Publisher: Oxford University Press.
6. Genes X, (2010), Benjamin Lewin, Publishers Jones and Barlett Inc.
7. Molecular Biology-DeRobertis and DeRobertis.8. Genetics-Strickberger

ZOO/DSE/659
Fishery science II
credits-3
Contact Hours: 45

Learning Objectives:

1. To provide knowledge to the students about the recent trends and techniques of fishery
2. To impart knowledge about various physiological processes of fish.
3. To inculcate knowledge about adaptations, migration, feeding etc. in fish.

Learning Outcomes:

By the end of the course students will be able to:

1. Explain physiological processes including respiration, reproduction, digestion etc.
2. Describe coloration, feeding habits, migration and bioluminescence.
3. Develop knowledge about structure and functioning of endocrine glands of fish.
4. Explain the hormonal control and mechanisms in physiological processes.

Unit I:

1. Food and feeding habits, . General account and functional morphology of digestive system, natural fish food, feeding habits, feeding adaptations, digestion and absorption of food.
 2. Age and growth of fish – absolute and relative growth, isometric and allometric growth.
 3. Methods for determination of growth – length frequency analysis. Estimation of growth by direct methods – known age methods. Mark and recapture method, marking and tagging.
- Types of scales, fins, girdles in fish

Unit II

1. Circulatory system of fish, structure of heart, blood vascular and peripheral circulatory system.
2. Respiratory organs, physiology of respiration, swim bladder and Weberian ossicle
3. Structure of kidney, ionic balance and osmoregulation and physiology of excretion in fish.
4. Reproductive system and physiology of reproduction, embryological development in fish.
5. Central nervous system (CNS) and cranial system, structure of eye and image formation in fish.

Unit III.

1. Coloration in fish, physiology of collaboration.
 2. Types of migration, hill stream and deep sea adaptations.
 3. Bioluminescence and physiology of light production in fish.
 4. Venom and Venomous gland, electric organ in fish.
- Lateral line system and its role in fish life, sensory organ in fish.

Unit IV. 1. Structure and function of endocrine glands.

2. Pituitary gland: Hormones of adenohypophysis and neurohypophysis,
3. Adrenal gland: Adrenocortico-steroids, corpuscles of stannius, adrenal medullary hormones, pituitary-adrenal axis.
4. Urohypophysis: Role of Urotensin I and II
5. Thyroid gland: Thyroid hormone synthesis, thyro-trophic hormones and their functions.
6. Pancreas: Pancreatic hormones, structure and their role in glucose metabolism homeostasis,

Unit V:

1. Hormones and control mechanism.
2. General classification of hormones, principal, nature and functions of hormones, hormone receptor.
3. Sex hormones, Types of sex steroids and their biosynthesis pathway.

4. Prolactin cells and its hormones, functions, role of prolactin in osmoregulation and melanogenesis.
5. Calcium regulation in fish.
6. Gonadotropin-releasing hormones (GnRh), role of gonadotropins, biochemical nature.
7. Hormonal control of reproductive behavior, role of sex hormones in sex differentiation.

References Books:

1. Prosser & Brown-Comparative Physiology
2. Pillay.T.V.R.& M.A. Dill. Advances in Aquaculture. Fishing News (Books)Ltd., England, 1979,
- 3.Stickney, R.R. -Principles of Warm water Aquaculture. John Wiley & Sons Inc.. 1979.
4. Boyd, C.E. Water Quality Management for Pond Fish Culture. Elsevier Scientific Publishing Company, 1982.
5. Jhingran, V.G. -Fish and Fisheries of India. Hindustan Publishing Corporation India, 1982
6. Bardach, et. al. Aquaculture The Farming and Hushandry of Freshwater and Marine Organisms. John Wiley & Sons, NY, 1972.
7. Santhanam. R. et. al. A Manual of Freshwater Aquaculture. Oxford & IBH Publishing Co. Pvt. Ltd., 1987.
8. Cheng. T.C. -The Biology of Animal Parasites. Saunders, Philadelphia, 1964.
9. Ribelin, W.E. & G. Miguki- The Pathology of Fishes. The Univ. of Wisconsin Press Ltd... Great Russel st., London, 1975
10. Schaeperclaus Fish Diseases. Vol. I & II
11. Douglas P Anderson-Text Book of Fish Immunology
12. Nandini Shetty- Immunology. Introductory Textbook
13. Karunasagar, I. -Aquaculture and Biotechnology. Oxford-IBH Publishers, New Delhi.
14. Govindan, T.K. -Fish Processing Technology, Oxford-IBH, 1985.
15. Shang, Y.C.-Aquaculture Economic Analysis An Introduction, 1990.
16. Nikolsky, G.V. -Ecology of Fishes. Academic Press, NY, 1963.
17. Hoar, W.S. & D.J. Randal- Fish Physiology, Vols. 1-4, Academic Press, NY, 1970,
18. Carl, B.E. Biology of Fishes- Saunders, 1979.
19. Turnor- Textbook of endocrinology
20. Day. F. -The fishes of India.

ZOO/DSE/660 Practical based ZOO/DSE/656 on Applied parasitology II

1. Study of prevalence and intensity of parasites from locally available hosts.
2. Demonstrate/study the effect of season/phonological factors as the prevalence and intensity of parasites
3. Separation of immunological protein (alpha, beta, gamma) by paper or gel electrophoresis.
4. Estimation of antigen and antibodies in samples by quantitative precipitation essay
5. Examination of fecal sample of sheep, goat and chicken.
6. Histopathology of Caeca of chicken to study different stages of schizonts.
7. Techniques for collection, fixation, preservation, staining and identification of different nematodes from different/various hosts.
Acanthocephalans and Arthropods.
8. Collection, preservation and identification of veterinary and medically important Annelids,
11. Study of different types of mouthparts of vectors
12. Visit to veterinary and medical parasitology/ pathology laboratory and study of food and water borne parasites.
13. Submission of permanent slides at the time of examination

ZOO/DSE/661 Practical based ZOO/DSE/657 on Animal physiology II

1. Denaturation and Coagulation of egg albumen.
2. Isoelectric point of Casein.
3. Effect of temperature on Heartbeat of fish, Q 10 measurement.
4. Effect of drugs on respiration of fish..
5. Estimation of Chloride from urine.
6. Estimation of Uric acid from rectum/blood of lizard/birds.
7. Determination of clotting time of blood.
8. Differential count of WBC form blood of human,
9. Effect of drugs on rate of heart beat.
10. Demonstration of Adrenalectomy and ovariectomy in rat.

ZOO/DSE/662 Practical based ZOO/DSE/658 on Molecular biology II

1. Transformation of DNA in Bacteria.
2. Gene expression by Gal-x.
3. Detection/ determination of Auxotroph mutant.
4. Chromatin digestion with micrococcal nuclease.
5. Isolation of DNA from animal/plant/bacterial cells by using kits.
6. Restriction digestion of DNA using nucleases
8. Molecular weight determination using column chromatography and PAGE.
7. DNA amplification using PCR.
9. Isolation of plasmids from bacteria.

ZOO/DSE/663 Practical based ZOO/DSE/659 on Fishery science II

1. Quantitative determination of glycogen, proteins and fats.
2. Dissections (any Bony fish)- digestive, reproductive, brain, pituitary gland and cranial Nerves.
3. Methods of food analysis with different feeding habits.
4. Study of different maturity stages and fecundity in fish.
5. Determination of growth in fish by scale or otolith method.
6. Determination of GSI and PI.
7. Histological preparation: Different glands and tissues.
8. Visiting CIFE, CIFA, FSI and CIFT etc.9. Field work: Visit to fish production unit.

ZOO/RP/699- RP2:

The research project will commence from Semester III and the Final Dissertation should be submitted in the Semester IV Examination. The students have to defend their dissertation by means of open defense and viva voce. The presentation should be with minimum 6-8slides

