Academic Council Meeting No. and Date: 11 / June 27, 2025

Agenda Number: 2 Resolution Number: 50, 51 / 2.6, 2.12

Vidya Prasarak Mandal's

B. N. Bandodkar College of Science

(Autonomous), Thane

Syllabus for

Programme Code: BUZO

Programme: Bachelor of Science

Specific Programme: Zoology

(Major/Minor/DSE/VSEC)

T. Y. B. Sc. (Zoology)

Level 5.5

CHOICE BASED GRADING SYSTEM

Revised under NEP

From Academic Year 2025-2026

Preamble

I am glad to introduce this modified syllabus to the Department of Zoology to pursue wise and able aspects of the subject to be instilled in the students of the semester V and semester VI under the quest of 'Autonomy' sanctioned by the University of Mumbai to VPM's B. N. Bandodkar College of Science, Thane.

It is foresighted to involve experts from all the relevant sectors of society to design this syllabus with their valued advice and suggestions. The syllabus has been finalized unanimously by the priory appointed members of the Board of Studies in Zoology Subject which includes industrial technical advice from Reliable Analytical Laboratory which practices the most advance analytical techniques in biological sciences. It gives me great pleasure to involve our meritorious alumni who have successfully made their careers in zoology in this venture.

However, with the constraint of the UGC guidelines in changing the syllabus, it was envisaged to change 20% of the syllabus at the initial phase and has been planned to migrate sly to a metamorphic pattern of the syllabus, which shall eliminate the existent short comings, during forthcoming cycles of syllabus framing.

Also, the syllabus will be framed in accordance with the PG programs of various national and international Universities so that our students will be able to avail their education in them.

Although, due to the guidelines of UGC, the use of animals is excluded from the practical, substituting the same with audiovisual instruction, simulations aids, and the use of ICT to make the syllabus more interesting and interactive. Pedagogy will guide our teachers to know content and objectives along with the desired outcome of every topic.

It is expected that the teaching process is expected to be boosted with exciting outcomes of the syllabus with further improvement and enthusiasm of the teachers. At the initiation, the department introduces the 'Choice-Based Credit System' (CBCS) of teaching-learning, under autonomy. The evaluation process involves 30-20 pattern of theory to ensure continuous learning from the academic year 2025-26, onward**.**

Prof. Dr. Vinda Manjramkar,

Chairperson, BOS in Zoology,

VPM's B. N. Bandodkar College of Science

(Autonomous), Thane

PROGRAMME OUTCOMES (POs) OF BACHELOR OF SCIENCE (B. Sc.)

The Undergraduate Programmes of Science are intended to provide quality education and attain holistic development of learners through the following programme outcomes:

PO1 - Disciplinary Knowledge

Lay a strong foundation of conceptual learning in science. Instil ability to apply science in professional, social and personal life.

PO2 - Inculcation of Research Aptitude

Ignite spirit of inquiry, critical thinking, analytical skills and problem-solving approach which will help learners to grasp concepts related to research methodology and execute budding research ideas.

PO3 - Digital Literacy

Enhance ability to access, select and use a variety of relevant information e-resources for curricular, co-curricular and extracurricular learning processes.

PO4 - Sensitization towards Environment

Build a cohesive bond with nature by respecting natural resources, encouraging eco-friendly practices and creating awareness about sustainable development.

PO5 - Individuality and Teamwork

Encourage learners to work independently or in collaboration for achieving effective results through practical experiments, project work and research activities.

PO6 - Social and Ethical Awareness

Foster ethical principles which will help in developing rational thinking and becoming socially aware citizens. Build an attitude of unbiased, truthful actions and avoid unethical behaviour in all aspects of life.

Eligibility: Successfully completed second year of B. Sc. in Zoology.

Duration: 1 years

Mode of Conduct: Offline/Online lectures, Laboratory practical's

Discipline/Subject: Zoology

Specific Programme: B.Sc. Zoology

Qualification Title: UG Degree Certificate

Program Specific Outcomes

1.	Describe the diversity and structural organization of animal life that govern biological systems.	L-1
2.	Explain cellular, physiological, genetic, and biochemical processes that regulate the life.	L-2
3.	Demonstrate laboratory skills, operate scientific instruments and analyze results.	L-3

4.	Examine disease-causing agents, evaluate preventive and control strategies with indigenous knowledge.	L-4
5.	Interpret computational, statistical tools, biological datasets, and present scientific findings.	L-5
6.	Develop research-based outputs that reflect scientific inquiry and critical thinking.	L-6

Specific Programme: T. Y. B. Sc. (Zoology – Major/ Minor/ DSE/ VSEC)

Assessment: Weightage for assessments (in percentage) For Major and Minor

Type of Course	Formative Assessment / IA	Summative Assessment
Theory	40%	60%

Curriculum Structure for the Undergraduate degree

Programme T. Y. B. Sc. Zoology

SEMESTER – V			
Course Code	**Course Title**	**No. of Lectures in hrs.**	**Credits**
Major Course Title			
25BUZO5T01	Taxonomy of Non-Chordates	30	2
25BUZO5T02	Haematology and Immunology	30	2
25BUZO5T03	Developmental Biology and Osteology	30	2
25BUZO5P01	Practical based on course - 25BUZO5T01	60	2
25BUZO5P02	Practical based on course - 25BUZO5T02	60	2
25BUZO5P03	Practical based on course - 25BUZO5T03	60	2
Discipline Specific Elective (DSE) Course Title			
25BUZO5TE1	Fisheries and Equipments	30	2
25BUZO5PE1	Practical based on course - 25BUZO5TE1	60	2
25BUZO5TE2	Animal Tissue Culture and Toxicology	30	2
25BUZO5PE2	Practical based on course - 25BUZO5TE2	60	2
Minor Course Title			
25BUZO5TMN	Wildlife and Zoopharmacognosy	30	2
	Vocational Skill Enhancement Course (VSEC) Title		
25BUZO5VSC	Experimental Biostatistics	45	2
25BUZO5OJT/ 25BUZO5FPR	On Job Training in Zoology I/ Field Project in Zoology III	60	2
	Total	**495**	**22**

SEMESTER – VI			
Course Code	**Course Title**	**No. of Lectures in hrs.**	**Credits**
Major Course Title			
25BUZO6T01	Homeostasis and Enzymology	30	2
25BUZO6T02	Molecular Biology and Endocrinology	30	2
25BUZO6T03	Genetics and Bioinformatics	30	2
25BUZO6P01	Practical based on course - 25BUZO6T01	60	2
25BUZO6P02	Practical based on course - 25BUZO6T02	60	2
25BUZO6P03	Practical based on course - 25BUZO6T03	60	2
Discipline Specific Elective (DSE) Course Title			
25BUZO6TE1	Farm Engineering and Byproducts of fish	30	2
25BUZO6PE1	Practical based on course - 25BUZO6TE1	60	2
25BUZO6TE2	Taxonomy of Chordates	30	2
25BUZO6PE2	Practical based on course - 25BUZO6TE2	60	2
Indian Knowledge System Course Title			
25BUZO6IKS	Ancient Zoology	30	2
	Vocational Skill Enhancement Course (VSEC) Title		
25BUZO6VSC	Environment Management	45	2
25BUZO6OJT/ 25BUZO6FPR	On Job Training in Zoology II/ Field Project in Zoology IV	60	2
	Total	**495**	**22**

Semester - V

MAJOR COURSE CODE: 25BUZO5T01	(02 Credits)	No. of lecture in Hrs. 30

Taxonomy of Non-Chordates

COURSE OUTCOME

Students will be wanted to learn OR on completion of this course, students will be able to learn:

CO1	Interpret the knowledge of a taxonomy of non-chordate animals.	L-5
CO2	Categorize lower and higher non-chordate phyla based on the taxonomy.	L-4
CO3	Examine the features that define major invertebrate phyla.	L-4
CO4	Evaluate the evolutionary relationships among higher invertebrates.	L-5

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	0	0	0	0	0
CO2	0	2	0	0	0	0
CO3	0	3	0	0	0	0
CO4	0	2	0	0	0	0

Unit	Description	No. of Hours.
I	**Non-Chordates I** **1.1 Kingdom: Protista** General Characteristics of protozoa. Classification of protozoa with distinguishing feature and example: Phylum Sarcomastogophora e.g. *Amoeba* Phylum Ciliophora e.g. *Paramoecium* Phylum Sporozoa e.g. *Sarcocystis* **1.2 Phylum: Porifera** General Characteristics of phylum Porifera. Classification of phylum Porifera with distinguishing feature and example: Class Calcarea e.g. *Leucosolenia* (Branched sponge) Class Hexactinellida e.g. *Hyalonema* (Glass-rope sponge) Class Demospongia e.g. *Euspongia* (Bath sponge) **1.3 Phylum: Cnidaria** General Characteristics of Phylum Cnidaria. Classification of phylum Cnidaria with distinguishing feature and example: Class Hydrozoa e.g. Hydra Class Scyphozoa e.g. *Aurelia* (Jelly fish) Class Anthozoa e.g. *Meandrina* (Maze Coral)	**15**

	1.4 Phylum: Platyhelminthes General Characteristics of Phylum Platyhelminthes. Classification of Platyhelminthes with distinguishing feature and example: Class Turbellaria e.g. *Dugesia* (Planaria) Class Trematoda e.g. *Schistosoma* (Blood-fluke) Class Cestoda e.g. *Taenia* (Tapeworm) **1.5 Phylum: Nematoda** General Characteristics of Phylum Nematods. Classification of phylum Platyhelminthes with distinguishing feature and example: Class: Aphasmida (Adenophorea) e.g. *Trichinella* (Trichina worm) Class: Phasmida (Secernentea) e.g. *Ascaris* (Round worm)	
II	**Non-Chordates II** **2.1 Phylum: Annelida** General Characteristics of Kingdom Annelida. Classification of kingdom annelida with distinguishing feature and example: Class Polychaeta e.g. *Neris* (Clamworm) Class Oligochaeta e.g. *Pheretima* (Earthworm) Class Hirudinae e.g. *Hirudinaria* (Leech) **2.2 Phylum: Arthropoda** General Characteristics of Phylum Arthropoda. Classification of Phylum Arthropoda with distinguishing feature and example: Subphylum Chelicerata Class Arachnida e.g.*Hottentota* (Scorpion) Class Merostomata e.g. *Limulus* (Horse-shoe crab) Class Pycnogonida e.g.*Nymphon* (Sea spider) Subphylum Crustacea Class Malacostraca e.g. *Scylla* (Crab) Class Maxillipoda e.g. *Balanus* (Barnacle) Subphylum Uniramia Class Chilopoda e.g. S*colopendra* (Centipede) Class Diplopoda e.g. *Xenobolus* (Millipede) Class Insecta e.g. *Attacus* (Moth) **2.3 Phylum: Mollusca** General Characteristics of Phylum Mollusca. Classification of phylum Mollusca with distinguishing feature and example:	**15**

	Class Aplacophora e.g. *Chaetoderma* (Glisten worm solenogaster) Class Polyplacophora e.g. *Chiton* (Coat of mail shell) Class Monoplacophora e.g. *Neopilina* Class Gastropoda e.g. *Nerita* (Nerit) Class Pelecypoda e.g. *Solen* (Razor clam) Class Scaphopoda e.g. *Dentalium* (Tusk shell) Class Cephalopoda e.g. *Nautilus* (Pearly nautilus) **2.4 Phylum: Echinodermata** General Characteristics of Phylum Echinodermata Classification of Phylum Echinodermata with distinguishing feature and example: Class Asteroidea e.g. P*rotorester* (Star fish) Class Ophiuroidea e.g. *Ophiothrix* (Brittle star) Class Echinoidea e.g. *Echinus* (Sea urchin) Class Holothuroidea e.g. *Cucumaria* (Sea cucumber) Class Crinoidea e.g. *Crinoid* (Sea lily) **2.5 Phylum: Hemichordata** General Characteristics of Phylum Hemichordata Classification of Phylum Hemichordata with distinguishing feature and example: Class Enteropneusta e.g. *Saccoglossus* Class Pterobranchia e.g. *Rhabdopleura* Class Planctosphaeroidea e.g. *Planctosphaera*	

REFERENCES	
25BUZO5T01	
1.	A manual of Zoology - Part I, Invertebrate; Ayyar, M. Ekambaranath Invertebrate Zoology - Volumes of different Phyla; Hyman L.H. Instant Notes in Animal Biology by Richard D. Jurd.
2.	Introduction to Zoology - Vol I: K. K. Chaki, G. Kundu and S. Sarkar, New Crystal Book. Agency.
3.	Modern text book of Zoology - Invertebrates; Eleventh; Edition Professor R.L. Kotpal; Rastogi publication
4.	Invertebrate Zoology by E. L.Jordan & P. S. Verma Rev. edition, 2009, Chand publications
5.	Invertebrate Zoology by P. S. Verma, edition, 2009, Chand publications
6.	Zoology for degree students, Non chordates by V.K. Agarwal 2011, S. Chand Publication Zoology for Degree Students, B.Sc. First Year, by V. K. Agarwal, Pub. S. Chand Coy.
7.	B. Sc. Zoology, Invertebrate Zoology by V.K. Aggarwal 2017, S. Chand publications Invertebrate Zoology by Fatik Baran 2012, PHI Learning
8.	A Textbook of Invertebrates by N.C. Nair et al. 2010 Saras publications

9.	Practical Zoology: Invertebrate, by S. S. Lal, 2016
10.	Invertebrate Zoology by Ruppert, Fox, Barnes, 7thedition,2003 publications Cengage
11.	Learning Invertebrate Zoology by D.T. Anderson 2nd edition 2002, publications Oxford Invertebrates by Richard C. Brusca et. al, 3rdedition2016, publications Oxford
12.	Biology of the invertebrates by Jan A. Pechenik, 7th edition,2014 publications McGraw Hill
13.	An introduction to the invertebrates by Janet Moore, 2ndedition2006, publications Cambridge
14.	Protozoology, by S. V. Nikam & S. T. Tanveer ed. 2011, Pub. Oxford Book Company (N.B.: This book includes Phylum Sarcomastigophora).

MAJOR COURSE CODE: 25BUZO5T02	**(02 Credits)**	**No. of lecture in Hrs. 30**

Haematology and Immunology

COURSE OUTCOME

Students will be wanted to learn OR on completion of this course, students will be able to learn:

CO1	Identify and interpret the characteristics of blood cells and examine the abnormalities.	L-3
CO2	Differentiate among blood cancers based on origin, pathology, and symptoms.	L-4
CO3	Demonstrate and analyze immunological test reactions.	L-3
CO4	Describe the structure and properties of antigens and antibodies.	L-2

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	0	3	0	0	0	0
CO2	0	3	0	0	0	0
CO3	0	3	0	0	0	0
CO4	2	0	0	0	0	0

Unit	Description	No. of Hours
I	**Haematology** **1.1 Basic Components and Processes** Organic, Inorganic, Erythropoiesis, Leucopoiesis and Thrombopoiesis **1.2 Haemoglobinopathies and Coagulopathies:** Haemoglobin structure, formation and degradation; Haemoglobinopathies (Sickle Cell Anaemia, Thalassemia), Haemophilia and Purpura **1.3 Erythrocytes, Leucocytes, Thrombocytes:** Structure and functions, abnormalities in structure, Total count, variation in	**15**

	number **1.4 Clotting** Factors of clotting, Mechanism of clotting **1.5 Blood Cancer** Lymphoma, Myeloma **1.6 Biochemical Examination of Blood:** Carbohydrate metabolism tests: Blood Sugar Fasting (BSF), Glucose tolerance test (GTT), Glycosylated haemoglobin (HBA1c) Liver Function Tests (LFT): AST, ALT, LDH, Alkaline phosphatase, Total and direct bilirubin Kidney function test (KFT or RFT): Serum creatinine, Blood Urea Nitrogen (BUN), Thyroid Function Test (TFT): T3/T4/TSH	

II	**Immunology** **2.1 Concept of Immunity** Innate immunity: Definition, Factors, Mechanism, Types Adaptive or Acquired immunity: Definition, Factors, Mechanism, Types **2.2 Cells and Organs of Immune System**: Cells of immune system – (B cells, T cells and Null cells, Macrophages, Dendritic cells and Mast cells) Organs of immune system Primary: (Thymus and bone marrow) Secondary (Lymph nodes and spleen) **2.3 Antigens and Antibody** Antigen structure and properties; haptens Antibodies structure, Classes of antibodies - IgG, IgA, IgM, IgD and IgE **A**ntigen processing and presentation: Endogenous antigens - cytosolic pathways, exogenous antigens - endocytic pathways **2.4 Reaction Mechanism** Precipitation- Definition, characteristics and mechanism. Precipitation in gels (slide test), Radial immunodiffusion (Mancini method), Double immunodiffusion (Ouchterlony's method) Agglutination: Characteristics and Mechanism. Hemagglutination (Slide and micro-tray agglutination) Passive agglutination (Coomb's test). **2.5 Transplantation Immunology:** Introduction, Types of grafts	**15**

	Immunologic basis of graft rejection: MHC compatibility in organ transplantation, Lymphocyte and Antibody mediated graft rejection; Precautionary measures against graft rejection.	

REFERENCES	
25BUZO5T02	
1.	Human Physiology - Volume 1; C.C. Chatterjee.
2.	Essentials of Haematology; Shirish M. Kawthalkar; Jaypee Brothers.
3.	Williams Hematology; Kenneth Kaushansky, Marshall A. Lichtman, E. Beutler, Thomas J. Kipps, Josef Prchal, Uri Seligsohn.
4.	Essential Haematology; Victor Hoffbrand, Paul Moss, John Pettit. Rapid Review of Hematology; Ramadas Nayak; Jaypee Brothers.
5.	Precise Haematology; Usha Rusia, Meera Sikka, Renu Saxena; Wiley India. Short Textbook of Haematology; Shah B.S.; C.B.S. Publisher and Distributor.
6.	Practical Zoology; Second Edition; Dr. K.C. Ghose & Dr. B. Manna; New Central Book Agency Pvt. Ltd., Kolkata; 1999.
7.	Mechanisms of Body Functions; Second Edition; Dexter M. Easton; Prentice-Hall of India Pvt. Ltd., New Delhi; 1978.
8.	A Text book of Practical Physiology; First Edition; V.G. Ranade; A.V.G. Prakashan, Pune; 1968.
9.	Principles of Anatomy & Physiology; Thirteenth Edition; Gerard J. Tortora & Bryan Derrickson; Biological Science Textbooks, Inc.; 2012.
10.	Concepts in Biochemistry; Third Edition; Rodney Boyer; John Wiley & Sons, Inc.; 2006. Medical Biochemistry; Fourth Edition; John Baynes& Marek Dominiczak; Saunders (Elsevier); 2014.
11.	Harrison's Hematology and Oncology; 3rd Edition (Harrison's Specialty);Dan Longo; McGraw-Hill.
12.	Essentials of Haematology; Second Edition; Kawthalkar Shirish M.; Jaypee; 2013. Medical Biochemistry by C. Jaypee; 2012.
13.	Essentials in Hematology and Clinical Pathology; Nayak, Ramadas. Clinical Pathology and Hematology; Maheshwari, Nanda; Jaypee.
14.	Practical Hematology; Dacie J V; Churchill Livingstone; 2006.
15.	Lecture Notes: Haematology; Hatton, Chris S. R. Hughes-Jones, Nevin C. Hay, Deborah; Wiley-Blackwell.

16.	ABC series: ABC of Clinical Haematology; Provan; Drew Publisher: BMJBooks. Principles of Anatomy & Physiology; Thirteenth Edition; Gerard J. Tortora & Bryan Derrickson; Biological Science Textbooks, Inc.; 2012.
17.	Biochemistry; Fourth Edition; U. Satyanarayana & U. Chakrapani; Elsevier; 2013.
18.	Immunology - Introductory Textbook; Shetty N.; New Age International; 2005.
19.	Immunology - Essential and Fundamental; Pathak S., & Palan U.; Science Publishers;2005.
20.	Immunology: A textbook; Rao C. V.; Alpha Science Int'l Ltd.; 2005
21.	Textbook of Immunology; Haleem Khan, Rajendra Sagar, Sadguna.
22.	Prescott's Microbiology; Ninth Edition; Joanne M. Willey, Linda M. Sherwood & Christopher
23.	J. Woolverton; McGraw-Hill Education; 2014.
24.	Immunology; Third Edition; Janis Kuby; W.H. Freeman; 1997.
25.	Kuby Immunology; Sixth Edition; Thomas J. Kindt, Richard A. Goldsby, Barbara Osborne & Janis Kuby; W.H. Freeman; 2007.
26.	Concepts in Biochemistry; Third Edition; Rodney Boyer; John Wiley & Sons, Inc.; 2006.
27.	Medical Biochemistry; Fourth Edition; John Baynes& Marek Dominiczak; Saunders (Elsevier); 2014.
28.	Cellular and Molecular immunology; Abbas A. K., Lichtman A. H. &Pillai S.; Elsevier Health Sciences; 2014.
29.	Roitt's Essential Immunology - Vol. 20; Delves P. J., Martin S. J., Burton D. R., &Roitt I. M.; John Wiley & Sons; 2011.
30.	The Elements of Immunology; Khan F.H.; Pearson Education, India; 2009.
31.	Janeway's Immunobiology; Murphy K. & Weaver C.; Garland Science; 2016. Fundamental Immunology; Paul W. E.; Philadelphia: Lippincott-Raven; 1999. Immunology - Introductory Textbook; Shetty N.; New Age International; 2005.
32.	Prescott's Microbiology; Ninth Edition; Joanne M. Willey, Linda M. Sherwood & Christopher

MAJOR COURSE CODE: 25BUZO5T03	**(02 Credits)**	**No. of lecture in Hrs. 30**
Developmental Biology and Osteology		
COURSE OUTCOME		

Students will be wanted to learn OR on completion of this course, students will be able to learn:		
CO1	Explain the basics of developmental biology.	L-2
CO2	List different stages of development of different organisms.	L-4
CO3	Identify the bone structures and its functions.	L-3
CO4	Simplify axial and appendicular skeleton.	L-4

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	0	0	0	0	0
CO2	2	0	0	0	0	0
CO3	2	0	0	0	0	0
CO4	2	0	0	0	0	0

Unit	Description	No. of Hours
I	**Developmental Biology** **1.1 Basic concept of Development:** Growth, Differentiation, Morphogenesis, Commitment-Specification and Determination, Induction, Competence, Morphogenetic gradients, Fate maps and Potency of cell **1.2 Gametogenesis and Fertilization** Production of gametes, Spermatogenesis in mammals, Structure of sperm Oogenesis in mammals, Structure of eggs and types Fertilization and Early Development **1.3 Morphogenesis and organogenesis in animals:** Axis and pattern formation in *Drosophila*, Amphibians and Chick Organogenesis- Vulva formation in *Caenorhabditis elegans*	**15**
II	**Osteology** **2.1 Introduction:** Bone structure (Histology), Physical properties, Chemical composition and general functions of bones. Cartilage: General structure, functions. **2.2 Axial skeleton**	**15**

	Skull: General characteristics of skull bones - Cranial and facial bones Vertebral column: General characteristics of a vertebra, structure of different types of vertebrae (cervical, thoracic, lumbar, sacrum and coccyx) **2.3 Ribs and sternum:** General skeleton of ribs and sternum **2.4 Hyoid bone:** Structure and Function **2.5 Appendicular skeleton** Pectoral girdle and bones of forelimbs Pelvic girdle and bones of hind limbs	

REFERENCES	
25BUZO5T03	
1.	Developmental Biology- 11st Edition, Scot F. Gilbert, Sinauer Associates Inc.
2.	Developmental Biology- Subramoniam T., Narosa Publishers.
3.	Developmental Biology- Berril N. J., Tata McGraw– Hill Publication.
4.	Essential Reproduction- Martin H. Johnson, Wiley- Blackwell Publication.
5.	Chick Embryology- Bradley M. Pattern.
6.	Embryology- Mohan P. Arora.
7.	Chordate Embryology- Dalela, Verma and Tyagi
8.	Atlas of Human Anatomy - Vol I; R.D. Sinelnikov; Mr. Publishers Moscow. A Guide of Osteology (for medical students); Prakash Kendra, Lucknow. Text Book of Comparative Anatomy and Physiology; Tortora.
9.	Human Osteology - Tim D White.
10.	Text Book of Human Osteology - Singh Inderbir.
11.	Mechanisms of Body Functions; Second Edition; Dexter M. Easton; Prentice-Hall of India Pvt. Ltd., New Delhi; 1978.
12.	Human Anatomy - John W. Hole, Jr., Karen A. Koos, Publisher: W. C. Brown Publisher, USA.

DSE COURSE CODE: 25BUZO5TE1	**(02 Credits)**	**No. of lecture in Hrs. 30**
Fisheries and Equipments		
COURSE OUTCOME		

Students will be wanted to learn OR on completion of this course, students will be able to learn:		
CO1	List different instruments, equipment's and their application in oceanography.	L-4
CO2	Classify physical, chemical and biological oceanography.	L-2
CO3	Discuss and develop skills in breeding techniques and management of various carps and prawn.	L-6
CO4	Explain the rearing practices of fin fish and shell fish.	L-2

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	0	0	0	0	0
CO2	0	2	0	0	0	0
CO3	0	3	0	0	0	0
CO4	0	3	0	0	0	0

Unit	Description	No. of Hours
I	**Oceanography** **1.1 Navigational and sea safety equipment:** i) Life saving devices ii) Global Positioning System (GPS) iii) Rudder iv) Signaling devices **1.2 Oceanographic Instruments:** i) Niskin water sampler ii) Peterson's grab iii) Dredges iv) Fish finding instruments / Methods v) Remote sensing **1.3** Introduction to basic physical, chemical and biological Oceanography	**15**

II	**Fish Farming** **2.1 Breeding hatchery and nursery of:** Major carps: *Labeo rohita* (Rohu), *Catla catla* (Catla), *Cirrhinus mrigala* (Mrigal), *Macrobrachium rosenbergii* (Freshwater prawn) **2.2 Breeding, hatchery, nursery management and rearing (extensive, semi-intensive, intensive)** i) *Lates calcarifer* (Sea bass) ii) *Litopenaeus vannamei* (Pacific white shrimp) iii) *Scylla serrata* (Giant mud Crab) iv) *Pinctada vulgaris* (Pearl)	**15**

REFERENCES	
25BUZO5TE1	
1.	A Text Book of Marine Ecology by Nair M.B. and Thumpy D.H. – Tata MacGraw Hill Pub. – New Delhi.
2.	An Introduction to Fishes by Khanna S.S. – Central Book Depot, Allahabad (1993).
3.	Aquaculture, Principles and Practices by Pillay T.V.R. – Fishing New Books (1988).
4.	Course Manual in Fishing Technology by Latha Shenoy, CIFE, Versova, Mumbai
5.	Fish Biology by C.B.C. Srivastava – Narendra Pub. House.
6.	Fish and Fisheries by Chandy – National Book Trust.
7.	Fish and Fisheries in India – by Jhingran V.G. – Hindustan Pub. Corporation – New Delhi.
8.	Fisheries Biology, Assessment and Management by Michael King – Fishing News Publishers (1995).
9.	Fishery Science by Samtharam R. – Daya Pub. House – 1990.

DSE COURSE CODE: 25BUZO5TE2	**(02 Credits)**	**No. of lecture in Hrs. 30**
Animal Tissue Culture and Toxicology		
COURSE OUTCOME		
Students will be wanted to learn OR on completion of this course, students will be able to learn:		
CO1	Classify toxins and toxicants and describe their sources and biological effects.	L-2
CO2	Analyze the characteristics of exposure and evaluate their toxic outcomes.	L-4
CO3	Elaborate the principles and significance of aseptic techniques.	L-6
CO4	Assess the advantages and limitations of cell culture applications.	L-5
Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping		

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	0	0	0	0	0
CO2	0	3	0	0	0	0
CO3	0	3	0	0	0	0
CO4	0	0	0	0	0	0

Unit	Description	No. of Hours
I	**Animal Tissue Culture** **1.1 Aseptic Techniques** Sterilization: Principle, Importance Sterile handling: swabbing, capping, flaming, handling bottles and flasks, pipetting, pouring **1.2 Culture Media** Components: Amino acids, vitamins, salts, glucose, oxygen supplements, Hormones, Growth factors, Antibiotics **Types:** Natural and Artificial **1.3 Factors influencing cell culture** Physical factor, Chemical factor **1.4 Advantages and Limitations** In vitro Modelling, Hybridoma technology, Large Scale setup **1.5 Culture Techniques** Preparation of cells / organs for culture, Cover slip, Flask and Tube culture, Primary and established cell lines	**15**
II	**Toxicology** **2.1 Basic toxicology** Introduction to toxicology Scope of toxicology, Animal models used Types of Toxicity: Acute, Sub-acute, Sub-chronic, Chronic **2.2 Toxins and Toxicants** Phytotoxins (Caffeine, nicotine), Mycotoxins (Aflatoxins) Zootoxins (Cnidarian toxin, bee venom, scorpion venom, snake venom) **2.3 Characteristics of Exposure** Duration of exposure Frequency of exposure	**15**

	Routes and sites of exposure **2.4 Dose Response** Concept of LD_{50}, LC_{50}, ED_{50}, EC_{50} Concept of extrapolation of dose **2.5 Target organ toxicity** Hepatotoxicity (Susceptibility of the liver, types of liver injury, examples of hepatotoxicants) Neurotoxicity (Vulnerability of nervous system, types of Nerve injury, examples of neurotoxicants) Nephrotoxicity (Susceptibility of kidney, examples of nephrotoxicants) **2.6 Regulatory toxicology** Guidelines for testing (OECD, CPCSEA) Ethical Issue and Alternative methods	

REFERENCES

25BUZO5TE2

1.	Casarett and Doulls Toxicology - The basic science of poisons; Edited by Curtis Klaassen; McGraw-Hill; 2001.
2.	Toxicological testing handbook - Principles, applications and data interpretation; David Jacobson-Kram and Kit Keller; CRC Press; 2006.
3.	Principles and methods of toxicology; A. Wallace Hayes; CRC Press; 2007. Toxicology - principles and methods; M.A. Subramanian; MJP Publishers, Chennai; 2004.
4.	Fundamentals of Toxicology; Kamleshwar Pandey and JP Shukla; New Central book agency Ltd., Kolkata; 2011.
5.	Elements of Toxicology; Kamleshwar Pandey and JP Shukla; Wisdom Press, New Delhi; 2010.
6.	Principles and Applications of Toxicology; Lahir Y.K.; Seekay Publications; 2013. Essentials of Clinical Toxicology; Lall S.; Narosa Publishing House; 1998.
7.	Culture of animal cells - A manual of basic technique; R. Ian Freshney; John Wiley andSons Publications; 2005.
8.	Basic cell culture - A practical approach; J. M. Davis; Oxford University Press; Indian Edition; 2005.
9.	Animal cell culture - Biotechnology Series: Vol.1; Bina Mishra, B. P. Mishra, Pran P. Bhat, P. N. Bhat; Studium Press (India) Pvt. Ltd; 2011.

10.	Animal cell culture - Concept and Applications; Shweta Sharma; Oxford book Company; 2012.
11.	Biotechnology of Animal Tissues; Dr. P. R. Yadav and Dr. Rajiv Tyagi; Discovery Publishing House, New Delhi; 2006

MINOR COURSE CODE: 25BUZO5TMN	(02 Credits)	No. of lecture in Hrs. 30

Wildlife and Zoopharmacognosy

COURSE OUTCOME

Students will be wanted to learn OR on completion of this course, students will be able to learn:

CO1	Design a basic wildlife management of a specific species or ecosystem.	L-6
CO2	Analyze wildlife management strategies and assess their suitability.	L-4
CO3	Interpret case studies of animal self-medication and evaluate the behaviour.	L-5
CO4	Elaborate the key concepts of bioprospecting and zoopharmacognosy.	L-5

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	0	0	0	2	0	0
CO2	0	2	0	0	0	0
CO3	0	3	0	0	0	0
CO4	0	0	0	3	0	0

Unit	Description	No. of Hours
I	**Wildlife Management** **1.1 Habit, Habitat, Territory:** Solitary, social (flock, pod, community), pack and herd, types of habitats and territories, niche and niche concept of wild animals **1.2 Threats to Wildlife:** Poaching and hunting, deforestation, encroachment, competition (intra-specific and inter-specific), overgrazing, diseases (zoonosis and reverse zoonosis). **1.3 Wildlife Conservation:** Techniques and methods used for wildlife census: Aerial counts, camera trap, line transect census and track surveys, capture mark recapture	15

	method, wildlife radio telemetry. **Forest management:** Harvesting and its different sources, Prescribed burning, Reforestation	
II	**Zoopharmacognosy** **2.1 Bio-prospecting:** Traditional and modern bioprospecting, Economic value of bioprospecting Conservation, Advantages and Disadvantages. **2.2 Zoopharmacognosy** Definition and Types **2.3 Classification of Zoopharmacognosy** Self-medication, mechanism and methods a) Ingestion - ants and mammals b) Geophagy - invertebrates and birds c) Anting **2.4** Applications - Social and trans-generational aspects of insects, birds and mammals (human medicines).	**15**

REFERENCES	
25BUZO5TMN	
1.	Text book of environmental science; S. C. Santra.Wild life management; Rajesh Gopal.
2.	Wildlife Management and Conservation - Contemporary Principles and Practices**;** Paul R.Krausman and James W. Cain III.
3.	Wildlife Ecology, Conservation, and Management; John M. Fryxell, Anthony R. E. Sinclair, Graeme Caughley.
4.	Pharmacognosy and Pharmaco biotechnology- Ashutosh Kar.Trease and Evans Pharmacognosy - Evans, W.C.
5.	Pharmacognosy - Kokate, C. K. A. and Purohit, A.P. Practical Pharmacognosy- Gokhale, S. B. and Kokate, C. K.Text book of Pharmacognosy; T. E. Wallis.
6.	Molecular Biotechnology - Principles and Practices; Channarayappa.
7.	Biotechnology - P. K. Gupta.
8.	Biotechnology Fundamentals & Applications - S. S. Purohit.
9.	Concepts in Wildlife Management by B. B. Hosetti.

10.	Wildlife Management Practices by James Durell.

MAJOR COURSE CODE: 25BUZO5P01	(02 Credits)	No of lecture in Hrs. 60
Practical based on 25BUZO5T01		
COURSE OUTCOME		
Students will be wanted to learn OR on completion of this course, students will be able to learn:		
CO1	Explain the classification of invertebrates and apply taxonomic principles.	L-5
CO2	Distinguish the invertebrates based on morphological and anatomical features.	L-4
CO3	Interpret and classify the invertebrate taxa.	L-2
CO4	Relate the structural features of invertebrates according to their habitat.	L-2

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	0	0	0	0	0
CO2	0	2	0	0	0	0
CO3	2	0	0	0	0	0
CO4	2	0	0	0	0	0

1.	Study the classification and general characters of Kingdom Protista upto class with examples. Kingdom Protista: Phylum: Sarcomastigophora Class Sarcodina e.g. *Entamoeba histolytica*, Foraminifera Class Mastigophora e.g. *Trypanosoma, Giardia.*
2.	Study the classification and general characters of Kingdom Protista upto class with examples. Kingdom Protista: Phylum: Ciliophora Class Ciliata e.g. *Tetrahymena, Vorticella* Class Phyllopharyngea e.g. *Trichodina, Chilodonella.*
3.	Study the classification and general characters of Kingdom Protista upto class with examples. Kingdom Protista: Phylum: Sporozoa,

	Class Aconoidasida e.g. *Babesia, Theileria.* Class Conoidasida e.g. *Toxoplasma gondii, Eimeria.*
4.	Study the classification and general characters of phylum Porifera upto class with examples. Phylum: Porifera Class Calcarea e.g. *Scypha, Clathrina*. Class Hexactinellida e.g. *Farrea, Euplectella.* Class Demospongia e.g. *Spongilla, Cliona*
5.	Study the classification and general characters of phylum Cnidaria upto class with examples. Phylum Cnidaria Class Hydrozoa e.g. *Vellela, Obelia.* Class Scyphozoa e.g. *Rhizostoma, Cassiopea.* Class Anthozoa e.g. *Corallium, Acropora.*
6.	Study the classification and general characters of phylum Nematoda upto class with examples. Phylum Nematoda Class Aphasmida (Adenophorea) e.g. *Enoplus, Trichuris* Class Phasmida (Secernentea) e.g. *Ascaris, Wuchereria.*
7.	Study the classification and general characters of phylum Annelida upto class with examples. Phylum Annelida Class Polychaeta e.g. *Arenicola, Sabella* Class Oligochaeta e.g. *Tubifex, Allolobophora* Class Hirudinea e.g. *Pontobdella, Macrobdella*
8.	Study the classification and general characters of phylum Arthropoda upto class with examples. Phylum Arthropoda - Subphylum Chelicerata: Class Arachnida e.g. Spiders, Mites. Class Merostomata e.g. *Limulus* (Horseshoe crab), *Eurypterida,* Class Pycnogonida e.g. *Ammothea, Pycnogonum*
9.	Study the classification and general characters of phylum Arthropoda upto class with examples.

	Phylum Arthropoda - Subphylum Crustacea: Class Malacostraca e.g. *Panulirus, Penaeus.* Class Maxillipoda e.g. *Cyclops, Barnacle.*
10.	Study the classification and general characters of phylum Arthropoda upto class with examples. Phylum Arthropoda - Subphylum Uniramia Class Chilopoda e.g. *Lithobius, Scolopendra* Class Diplopoda e.g. *Narceus, Tachypodoiulus* Class Insecta e.g. Ant, Butterfly
11.	Study the classification and general characters of phylum Mollusca upto class with examples. Phylum Mollusca: Class Aplacophora e.g. ***Solenogastres, Caudofoveata*** Class Polyplacophora e.g. *Tonicella, Mopalia.* Class Monoplacophora e.g. *Micropilina, Adenopilina* Class Gastropoda e.g. *Patella, Crepidula*
12.	Study the classification and general characters of phylum Mollusca upto class with examples. Phylum Mollusca: Class Pelycypoda e.g. *Donax, Tegillarca.* Class Scaphopoda e.g. *Gadilida, Dentaliida* Class Cephalopoda e.g. Octopus, Sepia.
13.	Study the classification and general characters of phylum Hemichordata upto class with examples. Phylum Hemichordata: Class Enteropneusta e.g. *Balanoglossus, Saccoglossus* Class Pterobranchia e.g. *Graptolite, Tetragraptus* Class Planctosphaeroidea e.g. *Planctosphaera*
14.	Preparation of *Paramecium* culture.
15.	Study tour - Visit to fish market / Aquarium / Local Gardens / Local available niche / National Parks / Sanctuaries / and such other places to observe invertebrates with special emphasis on Western Ghats and coast of Maharashtra and submit a report. College may conduct more than one field visit for wide exposure, if feasible. However, at least one field

	visit should be such that it is affordable to every student.

MAJOR COURSE CODE: 25BUZO5P02	(02 Credits)	No of lecture in Hrs. 60

Practical based on 25BUZO5T02

COURSE OUTCOME

Students will be wanted to learn OR on completion of this course, students will be able to learn:

CO1	Interpret the function and composition of blood.	L-5
CO2	Develop the skill to perform various haematological techniques.	L-3
CO3	Apply the basic immunological techniques.	L-3
CO4	Explain the principle and significance of antigen-antibody reactions.	L-5

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	0	2	0	0	0	0
CO2	0	2	0	0	0	0
CO3	0	2	0	0	0	0
CO4	0	2	0	0	0	0

1.	Enumeration of Erythrocytes - Total Count.
2.	Enumeration of Leucocytes - Total Count.
3.	Erythrocyte Sedimentation Rate by suitable method - Westergren or Wintrobe method.
4.	Estimation of haemoglobin by Sahli's acid haematin method.
5.	Estimation of serum/ plasma total triglycerides by Phosphovanillin method.
6.	Latex agglutination test - Rheumatoid Arthritis.
7.	Determination of bleeding and clotting time.
8.	Study of immune organs – Spleen, Thymus, and Bone marrow
9.	To perform double immunodiffusion (DID) by using Ouchterlony's method.
10.	To analyze the antigen of *Salmonella typhi* antigen by Widal test method.
11.	Study of blood profiles of various types of patients and interpretation.
12.	Study of various types of haemoglobinopathies.
13.	Study of leukemia using permanent slides.
14.	Estimation of bleeding time and clotting time.
15.	Visit to pathology laboratory.

MAJOR COURSE CODE: 25BUZO5P03	(02 Credits)	No of lecture in Hrs. 60

Practical based on 25BUZO5T03

COURSE OUTCOME

Students will be wanted to learn OR on completion of this course, students will be able to learn:

CO1	Identify the stages of development in model organisms.	L-5
CO2	Explain the principles and stages of embryonic development.	L-5
CO3	Identify the various bones of axial and appendicular skeletons of the human.	L-3
CO4	Categorize the types of bones based on structure, position, and function.	L-4

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	0	0	0	0	0
CO2	0	2	0	0	0	0
CO3	2	0	0	0	0	0
CO4	0	2	0	0	0	0

1.	Study of ontogeny of chick embryo using permanent slides - 18 hours, 24 hours, 33 hours.
2.	Study of ontogeny of chick embryo using permanent slides - 48 hours and 72 hours.
3.	Preparation of temporary mounting of chick embryo up to 48 hours of incubation.
4.	Types of pregnancy.
5.	Study of developmental stages of human embryo.
6.	Study of Human Axial Skeleton - Skull (whole).
7.	Study of Human Axial Skeleton - Vertebral column.
8.	Study of Human Appendicular Skeleton - Pectoral and pelvic girdle.
9.	Study of Human Appendicular Skeleton - Limb bones.
10.	Disorders of bones.
11.	Study of histological structure of bones and cartilage.
12.	Study of normal and abnormal X-rays/ Scan/ MRI related to injuries and fractures: a) Skull
13.	Study of normal and abnormal X-rays/ Scan/ MRI related to injuries and fractures: b) Thoracic and abdomen region
14.	Study of normal and abnormal X-rays/ Scan/ MRI related to injuries and fractures: c) Limbs
15.	Visit to IVF center or MRI scan center.

DSE COURSE CODE: 25BUZO5PE1	(02 Credits)	No of lecture in Hrs. 60

Practical based on 25BUZO5TE1

COURSE OUTCOME

Students will be wanted to learn OR on completion of this course, students will be able to learn:

CO1	List the fishing crafts and gears used in fisheries.	L-4
CO2	Explain the working principles and uses of fishing equipment.	L-5
CO3	Identify the various stages of development and sexual dimorphism in the fishes.	L-3
CO4	Explain fish diseases and preventive measures in aquaculture practices.	L-5

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	0	0	0	0	0
CO2	2	0	0	0	0	0
CO3	3	0	0	0	0	0
CO4	3	0	0	0	0	0

1.	Identification and functioning of oceanographic instruments: 1. Niskin water sampler 2. Peterson's Grab 3. Dredge
2.	Layout of fishing vessels and sectional view of 2 stroke and 4 stroke diesel engines, lifesaving equipment, winch and deck side equipment.
3.	Identification of various stages, development, and study of sexual dimorphism in adults Indian major carps: 1. *Labeo rohita* (Rohu) 2. *Catla catla* (Catla) 3. *Cirrhinus mrigala* (Mrigal)
4.	Identification of various stages, development, and study of sexual dimorphism in adults exotic carps: 1. *Cyprinus carpio* (Common Carp) 2. *Hypophthalmichthys molitrix* (Silver Carp) 3. *Ctenopharyngodon idella* (Grass Carp)
5.	Identification of shell fishes 1. *Litopenaeus vannamei* (Pacific white shrimp)

	2. *Macrobrachium rosenbergii* (Freshwater prawn)
6.	Study of sexual dimorphism in major carp and exotic carp
7.	Study of sexual dimorphism in pacific white shrimp and freshwater prawn
8.	Identification of aqua farm accessories
9.	Assessment of quality of shell fish with reference to bacterial contamination (Sample organism: prawn for *E. coli*)
10.	Isolation and identification of bacterial colony from contaminated fish by using agar T shaped streaking method
11.	Organoleptic tests for fish and Prawn / Shrimp
12.	Total plate count (TPC) of bacteria from fish
13.	Extraction of lipids from fish by using Soxhlet and quantitative estimation.
14.	Identification of Packaging materials 1. Wax duplex cartoon 2. Master carton 3. Simple cans 4. Coated cans 5. Polyolefin
15.	Photographic documentation of fishery biology related topics and assignment

DSE COURSE CODE: 25BUZO5PE2	**(02 Credits)**	**No of lecture in Hrs. 60**
Practical based on 25BUZO5TE2		
COURSE OUTCOME		
Students will be wanted to learn OR on completion of this course, students will be able to learn:		
CO1	Develop the skills of laboratory safety practices.	L-3
CO2	Measure viability of cell by various methods.	L-5
CO3	Demonstrate the toxicological principles and analysis of toxicity.	L-2
CO4	Evaluate the toxicity of chemical substances.	L-5

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2	0	0	0	0
CO2	0	3	0	0	0	0
CO3	0	2	0	0	0	0
CO4	0	0	0	0	0	0

1.	Instruments for tissue culture – Autoclave, Millipore filter, CO2 incubator, Laminar air-flow (Principle and use).
2.	Packaging of glassware for tissue culture. Test tube, Conical Flask, Petri dish
3.	Aseptic transfer techniques. i. Conical flask to Test tube ii. Conical flask to Petri dish iii. Test tube to test tube under Laminar Air flow.
4.	Equipment used for cell culture
5.	Isolation of cell by using enzymatic digestion (Trypsinization)
6.	To check viability of cells under sterile staining technique (Trypan blue staining Technique).
7.	Measurement of viable cell number using Neutral red.
8.	Measurement of viable cell number using XTT.
9.	To study the effect of CCl_4 on the level of enzyme activity in liver on acid phosphatase.
10.	To study the effect of CCl_4 on the level of enzyme activity in liver on alkaline phosphatase.
11.	To study the effect of CCl_4 on the level of enzyme activity in liver on alanine amino transferase.
12.	To study the effect of CCl_4 on the level of enzyme activity in liver on aspartate.
13.	Effect of toxicity on heart rate of *Daphnia.*
14.	Calculation of LD_{50} and LC_{50} by Probit analysis.
15.	Presentations based on toxicity studies.

VSEC COURSE CODE: 25BUZO5VSC	**(02 Credits)**	**No of lecture in Hrs. 45**
Experimental Biostatistics		
COURSE OUTCOME		
Students will be wanted to learn OR on completion of this course, students will be able to learn:		
CO1	Apply the basic statistical principles relevant to experiments.	L-3
CO2	Illustrate the results of statistical tests to evaluate hypotheses.	L-2
CO3	Apply statistical tests to the data of biological sciences.	L-3
CO4	Interpret statistical results in the field studies.	L-5
Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping		

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**

CO1	0	3	0	0	0	0
CO2	0	3	0	0	0	0
CO3	0	3	0	0	0	0
CO4	0	3	0	0	0	0

Unit	Description	No. of hours
I	**Tools of Biostatistics** **1.1 Measures of Variation:** Variance, standard deviation, standard error **1.2 Testing of Hypothesis:** Basic concepts in hypothesis. types of hypothesis: Null hypothesis and Alternate hypothesis Level of significance and testing of hypothesis **1.3 Parametric and non-parametric test:** Parametric tests: two-tailed z-test and t-test Nonparametric test: Chi-square test and its applications **1.4** ANOVA test	**15**
	VSEC Practical	**30 Hours**
1.	Problems based on Std. deviation	
2.	Problems based on Std. error	
3.	Problems based on T-Test	
4.	Problems based on Z- Test	
5.	Problems based on Chi- square test	
6.	Problems based on ANOVA test	
7.	Study the methods use of computers in biostatistics	

REFERENCES

25BUZO5VSC

1.	Biostatistics - The Bare Essentials; Third Edition; Geoffrey 1.R. Norman, David L. Streiner; 18. B.C. Decker, Inc., Hamilton; 2008.
2.	Fundamentals of Biostatistics; Second Edition; Veer Bala Rastogi; Ane Books Pvt. Ltd., New Delhi; 2009 (Reprint 2010).
3.	Fundamentals of Biostatistics; Second Revised Edition; Irfan Ali Khan and Atiya Khanum; Ukaaz Publications, Hyderabad; 2004.

4.	Instant Medical Biostatistics; Dr. Ranjan Das and Dr.Papri N. Das; Ane Books Pvt. Ltd., New Delhi; 2009.
5.	Primer of Biostatistics; Fifth Edition; Stanton A. Glantz; McGraw-Hill Companies, Inc.; 2002.
6.	Basic Biostatistics - Statistics for Public Health Practice; Second Edition; B. Burt Gerstman; Jones and Bartlett Learning Burlington; 2015.
7.	Biostatistics - A Guide to Design, Analysis, and Discovery; Second Edition; Ronald N. Forthofer, Eun Sul Lee and Mike Hernandez; Elsevier, Inc., (Academic Press), USA; 2007.
8.	Statistics in Biology and Psychology; Sixth Edition; Debajyoti Das and Arati Das; Academic Publishers, Kolkata.

OJT COURSE CODE: 25BUZO5OJT	**(02 Credits)**	**No of Hrs. 60**
On Job Training in Zoology I		
COURSE OUTCOME		
Students will be wanted to learn OR on completion of this course, students will be able to learn:		
CO1	Apply educational and technical skills in real-world, industry-ready environments.	L-3
CO2	Analyze and summarize the training processes and skills required in professional settings.	L-4
CO3	Develop and demonstrate effective teamwork strategies while collaborating with industry project groups.	L-6
CO4	Explain and describe the knowledge, practices, and expectations of job-ready industries	L-5

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	0	2	0	0	0	0
CO2	0	2	0	0	0	0
CO3	0	0	0	0	3	0
CO4	2	0	0	0	0	0

FIELD PROJECT COURSE CODE: 25BUZO5FPR	(02 Credits)	No of Hrs. 60

Field Project in Zoology III

COURSE OUTCOME

Students will be wanted to learn OR on completion of this course, students will be able to learn:

CO1	List the basic field tools and zoological terms.	L-1
CO2	Summarize the data and make a field report.	L-2
CO3	Analyze collected data to find patterns of animal behaviour.	L-4
CO4	Evaluate field technique and findings.	L-5

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	0	0	0	0	3	0
CO2	0	0	0	0	3	0
CO3	0	0	0	0	2	0
CO4	0	0	0	0	2	0

Semester - VI

MAJOR COURSE CODE: 25BUZO6T01	(02 Credits)	No. of lecture in Hrs. 30

Homeostasis and Enzymology

COURSE OUTCOME

Students will be wanted to learn OR on completion of this course, students will be able to learn:

CO1	Analyze osmotic, ionic regulation and physiological strategies.	L-4
CO2	Evaluate the adaptive responses to temperature changes.	L-5
CO3	Illustrate the mechanism of enzyme action and analyze the enzymatic activity.	L-3
CO4	Differentiate between enzyme inhibitions and relate to therapeutic applications.	L-4

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	0	3	0	0	0	0
CO2	0	2	0	0	0	0
CO3	0	3	0	0	0	0
CO4	0	3	0	0	0	0

Unit	Description	No. of Hours.
I	**Homeostasis** **1.1 Introduction** External and internal environment; Negative and positive feedback Mechanism Acclimation and acclimatization **1.2 Body Clock** Circadian, Diurnal rhythm and mechanism **1.3 Thermoregulation** Endothermy and ectothermy Thermogenesis: Mechanism of Heat production - shivering and non-shivering; brown fat, Mechanisms of heat loss **1.4 Adaptive response to temperature** Daily torpor Hibernation Aestivation **1.5 Osmotic and Ionic Regulation**	**15**

	Regulation in hypo-osmotic, hyper-osmotic and terrestrial environment Water absorption, salt water ingestion and salt excretion, salt glands, metabolic water, Role of kidney in ionic regulation	
II	**Enzymology** **2.1 Introduction and Nomenclature** Definition; concept of activation energy; nomenclature and classification (based on IUB - Enzyme Commission) of enzymes; chemical nature of enzyme, co-factors and Co-enzymes **2.2 Enzyme Action and Kinetics** Mechanism; Factors affecting enzyme activity- substrate, pH and temperature. Derivation of Michaelis- Menten equation and Lineweaver-Burk plot; Concept and significance of K_m, V_{max} and K_{cat} **2.3 Enzyme Inhibition** Competitive and non-competitive inhibitors and their kinetics; therapeutic applications of enzyme inhibitors **2.4 Regulation of Enzyme Activity** Allosteric regulation and regulation by covalent modification of enzymes; Isozymes (LDH) **2.5 Industrial Applications of Enzymes** Food and detergents, artificial digestive enzymes	**15**

REFERENCES	
25BUZO6T01	
1.	A textbook of Enzymes: Shailendra Singh; Campus Book International, New Delhi 2007.
2.	Biochemical Adaptation: Mechanism and Process in Physiological Evolution: Peter W. Hochachka & George N. Somero, Oxford University Press.
3.	Comparative Animal Physiology: P. C. Withers, Thomson Publishing Co.

MAJOR COURSE CODE: 25BUZO6T02	**(02 Credits)**	**No. of lecture in Hrs. 30**
Molecular Biology and Endocrinology		
COURSE OUTCOME		
Students will be wanted to learn OR on completion of this course, students will be able to learn:		
CO1	Analyze the intricacies of chemical and molecular processes that affect genetic material.	L-4
CO2	Elaborate the significance of molecular biology.	L-6

CO3	Explain the types and secretions of endocrine glands and their functions.	L-5
CO4	Identify the major endocrine glands, their hormones, and their roles.	L-3

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	0	3	0	0	0	0
CO2	3	0	0	0	0	0
CO3	3	0	0	0	0	0
CO4	3	0	0	0	0	0

Unit	Description	No. of Hours.
I	**Molecular Biology** **1.1 Types of mutation** Point mutations - Substitution, deletion and insertion mutations, Substitution mutations- silent, missense and non-sense mutations, transition and transversion, Deletion and Insertion mutations - frameshift mutations, Trinucleotide repeat expansions - Fragile X syndrome, Huntington disease Spontaneous mutation - Tautomeric shifts, Spontaneous lesions **1.2 Induced mutations** Physical agents: Ionizing radiation (X-rays, α, β and γ rays), Non ionizing radiation (UV light) Chemical agents: Base analogs (5-bromouracil), Intercalating agents (ethidium bromide), Deaminating agents (nitrous acid), Hydroxylating agents (hydroxylamine) Alkylating agents (mustard gas), Aflatoxin (Aflatoxin B_1) **1.3 Preventative and repair mechanisms for DNA damage** Mechanisms that prevent DNA damage - Superoxide dismutase and catalase Mechanisms that repair damaged DNA - Direct DNA repair (Alkyl transferases, Photoreactivation, Excision repair) Postreplication repair - Recombination repair, Mismatch repair, SOS repair **1.4 Eukaryotic gene expression** Regulatory protein domains - Zinc fingers, helix-turn-helix domain and leucine zipper, DNA methylation	**15**

II	**Endocrinology** **2.1** General organization of mammalian endocrine system **2.2** Hormones: Classification, properties, mechanism of hormone action **2.3** Histology, functions and disorders of the endocrine glands: Pituitary, Thyroid, Parathyroid, Pancreas, Adrenal	**15**

REFERENCES	
25BUZO6T02	
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2.	Introduction to Molecular Biology; Peter Paolella; Tata McGraw Hill; 2010.
3.	Molecular Biology; David Freifelder; Narosa Publishing House; 2008.
4.	Genetics; Robert Weaver and Philip Hedrick; McGraw Hill; 2001.
5.	Genetics - A Molecular Approach; Third Edition; Peter J. Russell; Pearson Education, Inc. (Benjamin Cummings), San Francisco; 2010.
6.	Molecular Biology - Academic Cell Update; Update Edition; David Clark; Elsevier, Inc.; 2010.
7.	Genetics; M.W. Farnsworth; Harper and Row Publishers, Inc., USA; 1978.
8.	Principles of Genetics; Eighth Edition; Gardner, Simmons and Snustad; John Wiley and Sons (Asia) Pte. Ltd., Singapore; 2002.
9.	Molecular Biology - Bios Instant Notes; Fourth Edition; Alexander McLennan, Andy Bates, Phil Turner & Mike White; Garland Science; 2013.
10.	Cell and Molecular Biology; Eighth Edition; E.D.P. De Robertis, E.M.F. De Robertis Jr.; Info-Med Ltd.; 1988.
11.	Textbook of Endocrinology Hardcover; Dharmalingam; 2010.
12.	Endocrinology; 6th Edition; Mac Hadley, Jon E. Levine.
13.	Text book of Endocrinology; Williams.
14.	Bailey's textbook of histology Hardcover; Frederick R Bailey.
15.	Mechanisms of Body Functions; Second Edition; Dexter M. Easton; Prentice-Hall of India Pvt. Ltd., New Delhi; 1978.
16.	Textbook of Comparative Physiology; R Nagabhushanam, MsKodarkar, Sarojini R. India Book House Pvt. Ltd.

MAJOR COURSE CODE: 25BUZO6T03	(02 Credits)	No. of lecture in Hrs. 30

Genetics and Bioinformatics

COURSE OUTCOME

Students will be wanted to learn OR on completion of this course, students will be able to learn:

CO1	Identify chromosomal aberrations in human genetics.	L-3
CO2	Explain genetic disorders and prenatal diagnosis.	L-2
CO3	Create a computational approach in learning the organization of genomes.	L-6
CO4	Explain biological databases and sequence alignment methods in Bioinformatics.	L-2

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	0	0	0	0	0
CO2	2	0	0	0	0	0
CO3	0	3	0	0	0	0
CO4	0	2	0	0	0	0

Unit	Description	No. of Hours.
I	**Human Genetics** **1.1 Chromosomal Aberrations** Structural: Deletion: types, effects and disorders; Translocation and its types: Robertsonian and Non-Robertsonian disorders; Inversion: Types, Effects and Significance; Duplication and their evolutionary significance (Multigene families) Numerical: Aneuploidy and Polyploidy (Autopolyploidy and Allopolyploidy) **1.2 Genetic Disorders** Inborn Errors of Metabolism: Phenylketonuria, G-6-PD deficiency, Alkaptonuria, Albinism Single gene mutation: Cystic fibrosis, Multifactorial: Breast Cancer Uniparental Disomy: Angelman Syndrome and Prader-Willi Syndrome **1.3 Prenatal Diagnosis** Amniocentesis and Chorionic villus sampling, Banding techniques (G, C, Q), FISH, Protein truncation test (PTT), Genetic counseling	**15**
	Bioinformatics **2.1 Introduction**	

II	Introduction to Bioinformatics and Bioinformatics web resource (NCBI, EBI, OMIM, PubMed), Applications of Bioinformatics **2.2 Databases - Tools and their uses** Biological databases; Primary sequence databases: Nucleic acid sequence databases (GenBank, EMBL-EBI, DDBJ), Protein sequence databases (UniProtKB, PIR), Secondary sequence databases, Derived databases - PROSITE, BLOCKS Structure databases and bibliographic databases **2.3 Sequence Alignment Methods** BLAST, FASTA Types of sequence alignment (Pairwise and Multiple sequence alignment)	**15**

REFERENCES

25BUZO6T03

1.	Genetics (Bios Instant Notes); Third Edition; G.I. Hickey, H.L. Fletcher and P. Winter; Taylor and Francis Group, New York; 2007. 29. Genetics - A Conceptual Approach; Third Edition; Benjamin A. Pierce; W.H. Freeman and Company, New York; 2008.
2.	New Clinical Genetics; Second Edition; Andrew Read and Dian Donnai; Scion Publishing Ltd., UK; 2011.
3.	Genetics; Third Edition; Robert F. Weaver and Philip W. Hedrick; Wm. C. Brown Publishers (The McGraw-Hill Companies, Inc.); 1997.
4.	Human Molecular Genetics; Fourth Edition; Tom Strachan and Andrew Read; Garland Science, USA; 2011. 33. Genetics; M.W. Farnsworth; Harper and Row Publishers, Inc., USA; 1978. Human Genetics - An Overview; Alice Marcus; Narosa Publishing House; 2010.
5.	The Science of Genetics - An Introduction to Heredity; Fourth Edition; George W. Burns; Macmillan Publishing Co., Inc., New York; 1980. https://www.ncbi.nlm.nih.gov/books/ https://ghr.nlm.nih.gov/
6.	Bioinformatics - Concepts, Skills, and Applications; S.C. Rastogi & others; CBS Publishing; 2003. 36. Bioinformatics - A practical guide to analysis of Genes & Proteins; Andreas D Baxevanis & B F Francis; John Wiley; 2000.
7.	Introduction to Bioinformatics; 1st Edition; T K Attwood, D J parry-Smith; Pearson Education, 11th Reprint; 2005.

8.	Bioinformatics; 1st Edition; C S V Murthy; Himalaya Publishing House; 2003. Bioinformatics sequence and genome analysis; David W. Mount; Cold spring Harbor Laboratory Press; 2004.
9.	Basic Bioinformatics; S. Ignacimuthu, S.J.; Narosa Publishing House; 1995.
10.	An Introduction to Bioinformatics Algorithms; Neil C. Jones and Pavel A. Pevzner; MITPress, First Indian Reprint; 2005.
11.	Bioinformatics - Managing Scientific Data; Zoe Lacroix, Terence Critchlow; Morgan Kaufmann Publishers (Elsevier Science); 2003 (for the V unit).
12.	Phylogenetics: Theory and Practice of Phylogenetic Systematics; Second edition; Bruce S. Lieberman; Wiley-Blackwell; 2011.
13.	Molecular Evolution: A Phylogenetic Approach; Roderick D.M. Page, Dr Edward C. Holmes; Well Publishing; 1998.
14.	Essential Bioinformatics; Jin Xiong; Cambridge University Press; 2006.
15.	Proteomics - From Protein Sequence to Function; 12 S. R. Pennington, M. J. Dunn; First edition; Springer publications; 2001.
16.	Proteomics; Timothy Palzkill; Springer; 2002

DSE COURSE CODE: 25BUZO6TE1	**(02 Credits)**	**No. of lecture in Hrs. 30**

Farm Engineering and By-products of Fish

COURSE OUTCOME

Students will be wanted to learn OR on completion of this course, students will be able to learn:

CO1	Develop the skill in fish farming.	L-3
CO2	Categorize different confinement cultures in fish farming.	L-2
CO3	Build the knowledge of fish byproducts.	L-6
CO4	List various types of value-added products from fish and shellfish.	L-2

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	0	2	0	0	0	0
CO2	2	0	0	0	0	0
CO3	2	0	0	0	0	0
CO4	3	0	0	0	0	0

Unit	**Description**	**No. of Hours.**

I	**Farm Engineering** **1.1 Farm Engineering** Site selection, designing and construction of hatchery and farms for extensive, semi-intensive and intensive freshwater/ brackish-water aquaculture **1.2 Types of Confinement Culture** Raft culture, Rope culture, Pen culture, Cage culture **1.3** Equipment and accessories used in various aqua farms	**15**
II	**By-products of Fish** **2.1** Proximate composition of fish meat and products **2.2 Introduction to by-products:** Fish protein concentrate Fish maws / Isinglass Fish hydrolysates Chitin, Chitosan Gelatin Fish silage Surimi and imitation products Pearl essence **2.3 Different types of value added products from fish and shell fish:** Fish/ Prawn/ Shrimp pickle Fish wafers *Acetes indicus* (Jawla) chutney Fish soup powder	**15**

REFERENCES	
25BUZO6TE1	
1.	Marine Fish and Fisheries by Dr. D. V. Bal and K.V. Rao - Tata MacGraw Hill Pub. – New Delhi.
2.	An Introduction to Fishes by Khanna S.S. – Central Book Depot, Allahabad (1993).
3.	Aquaculture, Principles and Practices by Pillay T.V.R. – Fishing New Books (1988).
4.	Course Manual in Fishing Technology by Latha Shenoy, CIFE, Versova, Mumbai.
5.	Fish Biology by C.B.C. Srivastava – Narendra Pub. House.
6.	Fish and Fisheries by Chandy – National Book Trust.

7.	Fish and Fisheries in India – by Jhingran V.G. – Hindustan Pub. Corporation – New Delhi.
8.	Fishery Science by Samtharam R. – Daya Pub. House – 1990.
9.	Handbook of Fish Biology and Fisheries Edited By J.B. Hart and John Reynold.
10.	Handbook of Fresh Water Fishes of India by Beaven C.R. – Narendra Pub. House.
11.	Marine Ecology by Tait R.B. – Oxford Press.
12.	Marine Fish and Fisheries by Dr. D. V. Bal and K.V. Rao - Tata MacGraw Hill Pub. – New Delhi.

DSE COURSE CODE: 25BUZO6TE2	(02 Credits)	No. of lecture in Hrs. 30

Taxonomy of Chordates

COURSE OUTCOME

Students will be wanted to learn OR on completion of this course, students will be able to learn:

CO1	Interpret the knowledge of a taxonomy of chordate animals.	L-5
CO2	Categorize lower and higher chordate phyla based on the taxonomy.	L-4
CO3	Examine the features that define major vertebrate phyla.	L-4
CO4	Evaluate the evolutionary relationships among higher vertebrates.	L-5

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	0	0	0	0	0
CO2	0	2	0	0	0	0
CO3	0	3	0	0	0	0
CO4	0	2	0	0	0	0

Unit	Description	No. of Hours.
	Chordata- I **1.1** Phylum: Protochordata General characters, Difference between non-chordates General characters of Group Protochordata **1.2** Subphylum: Urochordata and Subphylum: Cephalochordata Subphylum: Urochordata Class Ascidiacea e.g. *Herdmania* Class Thaliacea e.g. *Salpa*	

I	Class Larvacea e.g. *Oikopleura* Subphylum Cephalochordata Class Leptocardii e.g. *Branchiostoma* (*Amphioxus*) Group: Euchordata General characters of group Euchordata Subphylum Vertebrata: General characters Division Agnatha and Gnathostomata: Distinguishing characters **1.3** Division: Gnathostomata Superclass - Pisces: Distinguishing characters Classification of Superclass - Pisces Class Placodermi e.g. *Climatius* Class Chondrichthyes e.g. *Rhinobatos* (Guitar fish) Class Osteichthyes e.g. *Exocetus* (Flying fish) **1.4** Dipnoi (Lung fish): Distribution, habit and habitat, external and internal characters	**15**
II	**Chordata- II** **2.1 Superclass Tetrapoda** General Characteristics of Superclass Tetrapoda. Class Amphibia: General characters and their examples a. Limbless amphibian e.g. *Ichthyophis* (Caecilian) b. Tailed amphibian e.g. *Amphiuma* Tailless amphibian e.g. *Hyla* (Tree frog) **2.2 Class Reptilia** Class Reptilia: General characters Examples Examples: a. Extinct reptile e.g. *Ichthyosaurus* b. Living fossil e.g. *Sphenodon* (Tuatara) c. Aquatic reptile e.g. *Chelonia* (*Sea turtle*) d. Arboreal reptile e.g. *Chamaeleo* (Chamaeleon) **2.3 Class Aves** General Characteristics of Class Aves Examples: a. Arboreal bird e.g. *Melanerpes* (Wood pecker) b. Terrestrial bird e.g. *Gallus* (Fowl) c. Swimming bird e.g. *Phalacrocorax* (Cormorant)	**15**

	d. Wading bird e.g. *Ardeola* (Heron) e. Birds of prey e.g. *Tyto* (Owl) **2.4 Class Mammalia** General Characteristics of Class Mammalia Examples: a. Egg-laying mammals e.g. *Ornithorhyncus* (Duck-billed platypus) b. Pouched mammals e.g. *Macropus* (Kangaroo) c. Insect eating mammals e.g. *Sorex* (Common shrew)	

REFERENCES	
25BUZO6TE2	
1.	Modern text book of Zoology - Vertebrates; Professor R.L. Kotpal; Rastogi publication; Third Edition 2012.
2.	Vertebrate Zoology for Degree students; V. K. Agarwal; S. Chand Publication; 2012. Fundamentals of Zoology, Dr. K. C. Ghosh and Dr. B. Manna, New Central book Agency (P) Ltd.
3.	Chordate Zoology Volume II, Prof. N. Arumogam. Saras Publication. Chordate Anatomy Mohan P. Arora, Himalaya Publishing House, First edition.
4.	The life of Vertebrates; J.Z. Young; ELBS - Oxford University Press; Third edition, 2006 Textbook of chordate Zoology, Vol. II, G.S. Sandhu, H. Bhaskar; Campus Book International, First edition, 2005.
5.	Introduction to Zoology - Vol II: K. K. Chaki, G. Kundu and S. Sarkar, New Crystal Book Agency.
6.	Chordate Zoology by E. L. Jordan and P. S. Verma, edition,2009, Chand publications. Chordate Zoology by P. S. Verma, edition, 2009, Chand publications.
7.	Modern Textbook of Zoology Vertebrates by R.L. Kotpal, edition Jan 2015, Rastogi publications.
8.	Practical Zoology: Vertebrate, by S. S. Lal, 2015.
9.	A Textbook of Invertebrate Zoology & Cell Biology, by V. S. Kanwate, A. N. Kulkarni et al. ed. Alka Prakashan.
10.	The Animal Kingdom: An Elementary Textbook in Zoology; Specially Classified and Arranged for the Use of Science Classes, Schools and Colleges (Classic Reprint), by Ellis.

IKS COURSE CODE: 25BUZO6IKS	(02 Credits)	No. of lecture in Hrs. 30

Ancient Zoology

COURSE OUTCOME

Students will be wanted to learn OR on completion of this course, students will be able to learn:

CO1	Demonstrate understanding of Indian animal philosophical perspectives.	L-2
CO2	Interpret traditional wisdom with modern zoological concepts.	L-2
CO3	Apply ethical frameworks to zoological studies.	L-3
CO4	Evaluate animal products in Indian ayurveda.	L-5

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	0	0	0	0	0
CO2	3	0	0	0	0	0
CO3	0	0	0	2	0	0
CO4	0	2	0	0	0	0

Unit	Description	No. of Hours.
I	**Traditional and modern perspective of zoology** **1.1** Animals of ancient India: Fossils, Vedas, Puranas. **1.2** Traditional uses of animals in rituals, folklore, and daily life. **1.3** Cultural practices involving animals in different regions of India: Conservation of animals through religious practices (Cowrie, Conch) **1.4** Ethical considerations, conservation implications, and modern perspectives.	**15**
II	**Zoological implications in Ayurveda** **2.1 Introduction to animal products used in Ayurveda:** Egg shell ash, Cow dung, Cow urine, Musk of deer, Bones of animals, Honey, Lac and Cuttle bone ash. **2.2 Influence of animal usage in Ayurvedic therapy:** Bee and Snake Venom, Leech, Bile of animals, Ghee. **2.3 Animal derived substances or organs used in formulation and surgical practices:** Tail of peacock, Threads from animal products, Swim bladder of fish.	**15**

	2.4 Ayurvedic insights of animal on human health and diseases and case studies.	

REFERENCES	
25BUZO6IKS	
1.	"The Web of Life: A New Scientific Understanding of Living Systems" by Fritjof Capra.
2.	"Indian Zoology: Humane Approach" by Ramesh Gupta.
3.	"Ethics for Our Times: Essays in Gandhian Perspective" by M. M. Verma.
4.	India's Contribution to World Culture – Sudheer Birodkar.
5.	Ancient India – R. C. Majumdar.
6.	Animal Husbandry in Ancient Indian Literature- Aruna Tomar Kumar, Rajbir Singh, Vir Singh, LAP Lambert Academic Publishing (2013).

MAJOR COURSE CODE: 25BUZO6P01	**(02 Credits)**	**No of lecture in Hrs. 60**
Practical based on 25BUZO6T01		
COURSE OUTCOME		
Students will be wanted to learn OR on completion of this course, students will be able to learn:		
CO1	Determine enzyme activity and factors affecting it.	L-5
CO2	Evaluate experimental results to assess enzyme behaviour.	L-5
CO3	Analyze the effects of physiological factors on homeostasis.	L-4
CO4	Design an experimental set up to demonstrate homeostasis.	L-6

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	0	2	0	0	0	0
CO2	0	2	0	0	0	0
CO3	0	2	0	0	0	0
CO4	0	2	0	0	0	0

1.	Effect of varying pH on activity of enzyme Acid Phosphatase.
2.	Effect of varying enzyme concentration on activity of enzyme Acid Phosphatase.
3.	Effect of varying substrate concentration on activity of enzyme Acid Phosphatase.
4.	Effect of varying temperature on the enzyme Acid Phosphatase.
5.	Effect of inhibitor on the activity of enzyme Acid Phosphatase.

6.	Preparation of immobilized calcium alginate beads.
7.	Estimation of enzyme activity by using calcium alginate beads.
8.	Problems based on enzyme kinetics.
9.	Effect of varying temperature/ ecotoxicants on heart rate of *Daphnia*.
10.	Study of salt glands of different animals.
11.	To study separation of hormones by Chromatography.
12.	To study diffusion of glucose through intestine of goat/chicken.
13.	To study effect of temperature on chromatophores of crabs.
14.	To study glucose metabolism by eyestalk ablation on crabs.
15.	To determine viscosity of fluids using Ostwald Viscometer.

MAJOR COURSE CODE: 25BUZO6P02	**(02 Credits)**	**No of lecture in Hrs. 60**
Practical based on 25BUZO6T02		
COURSE OUTCOME		
Students will be wanted to learn OR on completion of this course, students will be able to learn:		
CO1	Interpret molecular data and evaluate the results.	L-5
CO2	Solve the problems based on molecular biology.	L-6
CO3	Identify the location and functions of endocrine glands and their disorders.	L-3
CO4	List the endocrine glands and study their mechanisms in various animals.	L-4

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	0	2	0	0	0	0
CO2	0	2	0	0	0	0
CO3	0	2	0	0	0	0
CO4	0	2	0	0	0	0

1.	Quantitative estimation of RNA by orcinol method.
2.	Quantitative estimation of DNA by diphenylamine method.
3.	Separation of Genomic DNA by agarose gel electrophoresis.
4.	Problems based on restriction endonucleases.
5.	Problems based on gel banding patterns resulting from radiogram.
6.	Problems based on Sanger’s sequence method.
7.	Preparation of DNA model.

8.	Histology of endocrine glands: T. S. of pituitary, thyroid, parathyroid, pancreas, adrenal.
9.	Disorders of endocrine glands- Pituitary, thyroid.
10.	Disorders of endocrine glands- Parathyroid, Pancreas, Adrenal.
11.	Disorders of endocrine glands- Ovaries and Testis.
12.	To study chromatophores in fish.
13.	To study fish brain hormones.
14.	To prepare and mount neurosecretory cells of insect brain.
15.	To study endocrine hormones in insect development stages.

MAJOR COURSE CODE: 25BUZO6P03	**(02 Credits)**	**No of lecture in Hrs. 60**
Practical based on 25BUZO6T03		
COURSE OUTCOME		
Students will be wanted to learn OR on completion of this course, students will be able to learn:		
CO1	Interpret chromosomal abnormalities through karyotyping.	L-5
CO2	Solve the problems based on genetics.	L-6
CO3	Assess the biological database and sequence alignment.	L-5
CO4	Design and execute bioinformatics workflow using different tools.	L-6

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	0	2	0	0	0	0
CO2	0	2	0	0	0	0
CO3	0	0	3	0	0	0
CO4	0	0	3	0	0	0

1.	Karyotype (Idiogram) analysis for the following syndromes with comments on numerical and / or structural variations in chromosomes: a. Turner's syndrome b. Klinefelter's syndrome
2.	Karyotype (Ideogram) analysis for the following syndromes with comments on numerical and / or structural variations in chromosomes: a. Down's syndrome b. Cri-du-chat syndrome
3.	Karyotype (Ideogram) analysis for the following syndromes with comments on numerical and / or structural variations in chromosomes:

	a. D-G translocation b. Edward's syndrome c. Patau's syndrome
4.	Interpretation of genetic formulae: Deletion, Duplication, Inversion and Translocation.
5.	Problems based on ABO blood group.
6.	Problems based on monohybrid and dihybrid cross.
7.	Problems based on sex linked inheritance.
8.	Calculation of mitotic index from the photograph or stained preparation of onion root tip or cancer cells.
9.	Study of gene frequency and mutants of man. i. Attached and free ear lobe ii. Colour of eye iii. Rolling of tongue iv. Blood group frequency
10.	Observation of common mutants of *Drosophila.*
11.	Explore the database of Nucleotide at NCBI for querying a nucleotide sequence.
12.	Explore the database of Protein at NCBI for querying a protein sequence.
13.	Explore BLAST for nucleotide sequence comparison.
14.	Explore BLAST for protein sequence comparison.
15.	Exploring bibliographic database PubMed for downloading a research paper on subject of interest with the use of operators.

MAJOR COURSE CODE: 25BUZO6PE1	**(02 Credits)**	**No of lecture in Hrs. 60**
Practical based on 25BUZO6TE1		
COURSE OUTCOME		
Students will be wanted to learn OR on completion of this course, students will be able to learn:		
CO1	Summarize the fish farm tools and machinery.	L-2
CO2	Identify the fishes and crustaceans.	L-3
CO3	Interpret the infections in aquatic organisms.	L-5
CO4	Develop skills to prepare the value-added products.	L-6
Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping		

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**

CO1	2	0	0	0	0	0
CO2	2	0	0	0	0	0
CO3	2	0	0	0	0	0
CO4	0	0	0	0	2	0

1.	Preparation of Chitin-Chitosan, Pearl essence
2.	Identification of various farm equipment such as: Feeding cups/ Trays, Paddle wheel aerator, Fountains, Sluicegate models, Elbow pipe outlets
3.	Study of models of raft, pen culture
4.	Study the materials used in cage and rope culture
5.	Preparation of Surimi, Fish protein concentrate
6.	Fish morphometry– Length weight relationship of a suitable fish
7.	Fish dressing, filleting, prawn peeling– PUD, DV and grading.
8.	Preparation of formulated feed for fish and prawn.
9.	**Identification of marine fishes** *Stromateus cinereus* (Silver pomfret) *Stromateus niger* (Black pomfret) *Pseudosciaena diacanthus* (Two- spined jewfish or Ghol) *Trichiurus haumela* (Ribbonfish)
10.	**Identification of marine fishes** *Scomber microlepeidotus* (Mackerel) *Cybium guttatum* (Seerfish or Surmai) *Sardinella longiceps* (Indian Oil Sardine)
11.	**Identification of Crustaceans** *Penaeus monodon* (Giant Tiger Prawn) *Metapenaeus affinis* (Jinga shrimp) *Acetes indicus* (Jawala paste shrimp) *Scylla serrata* (Giant mud crab)
12.	**Identification of parasitic infections in aquatic organisms** Fungal- Dermatomycosis Bacterial- Fin/ Tail rot and Dropsy Protozoan- Costiasis and White Spot

	Crustacean- Argulosis
13.	Preparation of jawala chutney/ Fish fingers/ Fish nuggets.
14.	Project- Feasibility/ Scientific report.
15.	Field Visit Report

MAJOR COURSE CODE: 25BUZO6PE2	**(02 Credits)**	**No of lecture in Hrs. 60**
Practical based on 25BUZO6TE2		

COURSE OUTCOME

Students will be wanted to learn OR on completion of this course, students will be able to learn:

CO1	Explain the classification of vertebrates and apply taxonomic principles.	L-5
CO2	Distinguish the vertebrates based on morphological and anatomical features.	L-4
CO3	Interpret and classify the vertebrate taxa.	L-2
CO4	Relate the structural features of vertebrates according to their habitat.	L-2

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	0	0	0	0	0
CO2	0	2	0	0	0	0
CO3	2	0	0	0	0	0
CO4	2	0	0	0	0	0

1.	Classification and general characters of Protochordata upto class with examples Group Protochordata Subphylum Urochordata a. Class Larvacea e.g. *Fritillaria, Kowalevskia* b. Class Ascidiacea e.g. *Styela, Botryllus* Class Thaliacea e.g. *Doliolum, Thalia*
2.	Classification and general characters of Protochordata upto class with examples Group Protochordata Subphylum Cephalochordata a. Class Leptocardii e.g. *Epigonichthys, Asymmetron* Subphylum Vertebrata: Division Agnatha b. Class Ostracodermi e.g. *Pharyngolepis, Cephalaspis* Class Cyclostomata e.g. *Myxine, Eptatretus*
3.	Classification and general characters of Pisces upto class with examples

	Superclass Pisces: a. Class Placodermi e.g. *Bothriolepi*, *Asterolepis* b. Class Chondrichthyes e.g. *Chimaera*, *Torpedo* Class Osteichthyes e.g. *Protopterus*, *Clarius* (Catfish)
4.	Study of connecting link between the pisces and ambhibians (Dipnoi)
5.	Classification and general characters of Amphibians upto class with examples Superclass Tetrapoda: Class Amphibia e.g. *Rana* and *Ichthyophis*
6.	Study of connecting links between the amphibia and reptiles. (*Acanthostega*, *Temnospondyls*)
7.	Classification and general characters of reptiles upto class with examples Superclass Tetrapoda: Class Reptilia e.g. *Varanus* (Monitor lizard) and *Crocodylus* (Crocodile)
8.	Study the connecting links between the reptiles and birds (***Archaeopteryx,*** *Dromaeosaurs*)
9.	Classification and general characters of aves upto class with examples Class Aves: Examples: *Eudyptes* (Penguin), *Phoenicopterus* (Flamingo) and *Gyps* (Vulture)
10.	Study the connecting links between the birds and mammals. (*Morganucodon*, *Pelycosaurs*)
11.	Study the classification and general characters of Mammals upto class with examples. Class Mammalia: Examples: *Dasyurus* (Quoll), *Petaurista* (Flying squirrel) and *Macaca* (Monkey).
12.	Study of aquatic mammals. (Sea cows, Polar bear)
13.	Study of Mammals based on the climatic condition.
14.	Comparative study of the homeothermic and poikilothermic animals based on their characters.
15.	Visit to fish market / Aquarium / Zoo/ National Park / Local Gardens / Local available niche / Sanctuaries / and such other places in Maharashtra and / or India and / or abroad to observe chordates and prepare a report. College may conduct more than one field visit for wide exposure, if feasible. However, at least one field visit should be such that it is affordable to every student.

VSEC COURSE CODE: 25BUZO6VSC	(02 Credits)	No of lecture in Hrs. 45

Environment Management

COURSE OUTCOME

Students will be wanted to learn OR on completion of this course, students will be able to learn:

CO1	Classify the natural resources based on origin, renewability and usage.	L-4
CO2	Assess the impact of resource exploitation.	L-5
CO3	Develop the skill to perform qualitative analysis of water samples.	L-3
CO4	Classify the types of forests and fauna with respect to habitat and adaptation.	L-2

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	0	0	0	3	0	0
CO2	0	2	0	0	0	0
CO3	0	2	0	0	0	0
CO4	2	0	0	0	0	0

Unit	Description	No. of hours
I	**Natural Resources and Their Classification** **1.1 Natural Resources:** Forest, Water (surface and ground) and Mineral resources **1.2 Energy resources: Renewable and Non-renewable resources feasibility** Renewable resources (solar, tidal, wind, biofuel) Non-renewable resources (coal, petroleum oil, natural gas) **1.3** Natural Resources exploitation, Audit and Environment protection act **1.4** Impact on flora, fauna and climate, Energy Audit – Water and electricity	15
	VSEC Practical	**30 Hours**
1.	Estimation of phosphate from sample water.	
2.	Estimation of acidity and alkalinity of sample water by methyl orange and phenolphthalein indicator.	
3.	Estimation of Chemical oxygen demand (COD) from sample water.	
4.	Estimation of Biological oxygen demand (BOD) from sample water.	
5.	To identify and study different types of forests based on their	

	characteristics, vegetation, climate and geographical distribution. i) Tropical evergreen forests ii) Tropical deciduous forests iii) Tropical thorn forests iv) Montane forests v) Littoral and swamp forests	
6.	To study types of fauna with reference to their habitat and ecological adaptation. i) Forest: Tiger, Deer ii) Desert: Camel, Lizard iii) Grassland: Lion, Zebra	
7.	To study types of fauna with reference to their habitat and ecological adaptation. i) Mountain/Alpine: Snow, Yak ii) Polar: Polar bears, Penguin iii) Mangrove: Crocodile, Mudskippers	
8.	Assessment of different water bodies by using physicochemical parameters (Examples: Lakes, Pond, River, Estuary, Wetland and Well water).	

REFERENCES	
25BUZO6VSC	
1.	A textbook of Environmental Science; Arvind Kumar; A P H Publishing Corporation, New Delhi 110002.
2.	Environmental Biology; P.S Verma, V.K Agarwal; S. Chand & company Ltd. New Delhi 110055.
3.	Environmental Biotechnology - Basic Concepts and Application; Indu Shekhar Thakur.
4.	Environmental Science; N. Vasudevan; Narosa Publishing House Pvt. Ltd. New Delhi 110002.
5.	K. International Pvt. Ltd. New Delhi 110016. 6. Text book of environmental science; S. C. Santra. Wild life management; Rajesh Gopal.

OJT COURSE CODE: 25BUZO6OJT	(02 Credits)	No of Hrs. 60

On Job Training in Zoology II

COURSE OUTCOME

Students will be wanted to learn OR on completion of this course, students will be able to learn:

CO1	Apply educational and technical skills in real-world, industry-ready environments.	L-3
CO2	Analyze and summarize the training processes and skills required in professional settings.	L-4
CO3	Develop and demonstrate effective teamwork strategies while collaborating with industry project groups.	L-6
CO4	Explain and describe the knowledge, practices, and expectations of job-ready industries	L-5

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	0	2	0	0	0	0
CO2	0	2	0	0	0	0
CO3	0	0	0	0	3	0
CO4	2	0	0	0	0	0

FIELD PROJECT COURSE CODE: 25BUZO6FPR	(02 Credits)	No of Hrs. 60

Field Project in Zoology IV

COURSE OUTCOME

Students will be wanted to learn OR on completion of this course, students will be able to learn:

CO1	List the basic field tools and zoological terms.	L-1
CO2	Summarize the data and make a field report.	L-2
CO3	Analyze collected data to find patterns of animal behaviour.	L-4
CO4	Evaluate field technique and findings.	L-5

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	0	0	0	0	3	0
CO2	0	0	0	0	3	0
CO3	0	0	0	0	2	0
CO4	0	0	0	0	2	0

VPM's B. N. Bandodkar College of Science (Autonomous), Thane

Curriculum Mapping for the Undergraduate Degree Programme T. Y. B. Sc. Zoology

	SEMESTER – V	**Course imparts Employability (EM), Entrepreneurship (EN), Skill Development (SD)**			**Course integrates with Professional Ethics (PE), Gender Equity (GE), Human Value (HV), Environmental Sustainability (ES)**			
Course Code	**Major Course Title**	**EM**	**EN**	**SD**	**PE**	**GE**	**HV**	**ES**
25BUZO5T01	Taxonomy of Non-Chordates	--	--	--	--	--	--	√
25BUZO5T02	Haematology and Immunology	√	√	√	√	--	--	--
25BUZO5T03	Developmental Biology and Osteology	√	√	√	√	--	√	--
25BUZO5P01	Practical based on course 25BUZO5T01	--	--	--	--	--	--	√
25BUZO5P02	Practical based on course 25BUZO5T02	√	√	√	√	--	--	--
25BUZO5P03	Practical based on course 25BUZO5T03	√	√	√	√	--	--	--
Course Code	**DSE - Course Title**							
25BUZO5TE1	Fisheries and Equipment's	√	√	√	√	--	--	√
25BUZO5PE1	Practical based on course 25BUZO5TE1	√	√	√	√	--	--	√
25BUZO5TE2	Animal Tissue Culture and Toxicology	√	√	√	√	--	--	--
25BUZO5PE2	Practical based on course 25BUZO5TE2	√	√	√	√	--	--	--
Course Code	**Minor Course Title**							
25BUZO5TMN	Wildlife and Zoopharmacognosy	√	√	√	√	--	√	√
Course Code	**VSEC Course Title**							
25BUZO5VSC	Experimental Biostatistics	√	√	√	√	--	--	--
25BUZO5OJT/	On Job Training in Zoology I /	√	√	√	√	--	√	√
25BUZO5FPR	Field Project in Zoology III	√	√	√	--	--	√	√
	Total	**11**	**11**	**11**	**11/10**	**00**	**03**	**06**

	SEMESTER – VI	Course imparts Employability (EM), Entrepreneurship (EN), Skill Development (SD)			Course integrates with Professional Ethics (PE), Gender Equity (GE), Human Value (HV), Environmental Sustainability (ES)			
Course Code	**Major Course Title**	**EM**	**EN**	**SD**	**PE**	**GE**	**HV**	**ES**
25BUZO6T01	Homeostasis and Enzymology	--	--	--	--	--	--	--
25BUZO6T02	Molecular Biology and Endocrinology	--	--	--	--	--	--	--
25BUZO6T03	Genetics and Bioinformatics	√	√	√	√	√	√	--
25BUZO6P01	Practical based on course - 25BUZO6T01	--	--	√	--	--	--	--
25BUZO6P02	Practical based on course - 25BUZO6T02	√	√	√	--	--	√	--
25BUZO6P03	Practical based on course - 25BUZO6T03	√	√	√	--	√	√	--
Course Code	**DSE - Course Title**							
25BUZO6TE1	Farm Engineering and Byproducts of fish	√	√	√	√	--	--	√
25BUZO6PE1	Practical based on course - 25BUZO6TE1	√	√	√	√	--	--	√
25BUZO6TE2	Taxonomy of Chordates	--	--	--	--	--	--	√
25BUZO6PE2	Practical based on course - 25BUZO6TE2	--	--	--	--	--	--	√
Course Code	**IKS Course Title**							
25BUZO6IKS	Ancient Zoology	√	--	--	√	--	--	--
Course Code	**VSEC Course Title**							
25BUZO6VSC	Environmental Management	√	√	√	√	--	--	√
25BUZO6OJT / 25BUZO6FPR	On Job Training in Zoology II /	√	√	√	√	--	√	√
	Field Project in Zoology IV	√	√	√	--	--	√	√
	Total	**08**	**07**	**08**	**06/05**	**02**	**04**	**06**