WEST BENGAL STATE UNIVERSITY

DRAFT

SYLLABUS FOR THREE-YEAR DEGREE COURSE IN ZOOLOGY (GENERAL) UNDER CHOICE BASED CREDIT SYSTEM (CBCS)

(With effect from the session 2018-2019)

BSc General with Zoology
(Credit values given within brackets)

Core Courses for Zoology (CC)

Core Course (CC)			
CC- 1A: Animal Diversity	**CC- 1B: Human Physiology and Biochemistry**	**CC- 1C: Insect Vector and diseases**	**CC- 1D: Environment and Public Health**

Choices for Discipline Specific Electives (DSE)

Discipline Specific Elective (DSE) Any Four (2) Course from 1 to 4			
Applied Zoology	**Food Nutrition and Health**	**Aquatic Biology**	**Immunology**

Choices for Skill Enhancement Courses (SEC)

Skill Enhancement Course-1 & Skill Enhancement Course-2, any two course from 4	
Aquarium Fish Keeping	**Vermicompost**

Sem	Core*	DSE	GE	AECC	SEC	Total credits
I	ZOOGCOR01T (4) ZOOGCOR01P (2) **(Animal Diversity)** CEMGCOR01T (4) CEMGCOR01P (2) BOTGCOR01T (4) BOTGCOR01P (2)			ENVSAEC01T (2)		**20**
II	ZOOGCOR02T (4) ZOOGCOR02P (2) **(Human Physiology & Biochemistry)** CEMGCOR02T (4) CEMGCOR02P (2) BOTGCOR02T (4) BOTGCOR02P (2)			ENGSAEC01T (2)		**20**
III	ZOOGCOR03T (4) ZOOGCOR03P (2) **(Insect Vectors and Diseases)** CEMGCOR03T (4) CEMGCOR03P (2) ZOOGCOR03T (4) ZOOGCOR03P (2)				ZOOSSEC01M (2) **(Aquarium Fish Keeping)** **OR** An SEC offered by any other department	**20**
IV	ZOOGCOR04T (4) ZOOGCOR03P (2) **(Environment and Public Health)** CEMGCOR04T (4) CEMGCOR04P (2)				ZOOSSEC02M (2) **Vermicompost Production** **OR** An SEC offered by any other department	**20**

	BOTGCOR04T (4) BOTGCOR04P (2)					
V		ZOOGDSE01T (4) ZOOGDSE01P (2) **(Applied Zoology)** **OR** ZOOGDSE02T (4) ZOOGDSE02P (2) **(Food Nutrition and Health)** ---------- BOTGDSE01T (4) BOTGDSE01P (2) OR BOTGDSE02T (4) BOTGDSE02P (2) ---------- CEMGDSE01T (4) CEMGDSE01P (2) OR CEMGDSE02T (4) CEMGDSE02P (2)			An SEC offered by any other department	**20**
VI		ZOOGDSE03T (4) ZOOGDSE03P (2) **(Aquatic Biology)** OR ZOOGDSE04T (4) ZOOGDSE04P (2) **(Immunology)** ---------- BOTGDSE03T (4) BOTGDSE03P (2) OR BOTGDSE04T (4) BOTGDSE04P (2) ---------- CEMGDSE03T (4) CEMGDSE03P (2) OR CEMGDSE04T (4) CEMGDSE04P (2)			An SEC offered by any other department	**20**
Total number of	**12**	**6**	**0**	**2**	**4**	**120**

Core Courses for Zoology (CC)

ZOOGCOR01T: Animal Diversity	
Theory (Credits 4)	**Class**
Unit-1 Kingdom Protista	
General characters and classification of Subkingdom Protozoa up to Phylum (Levine et al., 1980); Locomotory Organelles and locomotion in Protozoa	**3**
Unit-2 Phylum Porifera	
General characters and classification up to classes; Canal System in *Sycon*	**3**
Unit-3 Phylum Cnidaria	
General characters and classification up to classes; Polymorphism in Hydrozoa	**3**
Unit-4 Phylum Platyhelminthes	
General characters and classification up to classes; Life history of *Taenia solium*	**3**
Unit-5 Phylum Nematoda	
General characters and classification up to classes; Life history of *Ascaris lumbricoides* and its parasitic adaptations	**3**
Unit-6 Phylum Annelida	
General characters and classification up to classes; Nephridia in Annelida	**3**
Unit 7 Phylum Arthropoda	
General characters and classification up to classes; Vision in insect, Metamorphosis in Insects	**5**
Unit-8 Phylum Mollusca	
General characters and classification up to classes; Respiration in *Pila*	**3**
Unit-9 Phylum Echinodermata	
General characters and classification up to classes; Water-vascular system in *Asterias*	**4**
Unit-10 Protochordates	
General features; Feeding in *Branchiostoma*	**2**
Unit-11 Agnatha	
General features and classification up to classes (Young, 1981)	**2**
Unit-12 Pisces	
General features and Classification up to Subclasses (Romer, 1959); Osmoregulation in Fishes	**3**
Unit-13 Amphibia	
General features and Classification up to living orders (Duellman & Trueb, 1986); Metamorphosis in Toad	**3**
Unit-14 Reptiles	
General features and Classification up to living Subclass (Young, 1981); Poisonous and non-poisonous snakes, Biting mechanism in snakes	**4**
Unit-15 Aves	
General features and Classification up to orders (Young, 1981); Flight adaptations in birds	**3**
Unit-16 Mammals	
Classification up to Subclasses (Young, 1981); Origin & distribution of Cranial nerves in *Cavia*	**3**

Suggested Readings [Consult Latest Editions]

1. Barnes, R. D. & Ruppert, E. E., (1994). Invertebrate Zoology. 6thEd. Brooks Cole.
2. Brusca, R. C. & Brusca, G. J. (2002). Invertebrates. 4th Ed. Sinauer Associates.
3. Kardong, K.V. (2002). Vertebrates: Comparative anatomy, function evolution. Tata McGraw Hill.
4. Kent, G.C. & Carr, R.K. (2001). Comparative anatomy of theVertebrates. 9thEd. McGraw Hill.
5. Romer, A.S. & Parsons,T.S.(1986).The vertebrate body. 6thEd. Saunders College Pub.
6. Ruppert E. E., Fox, R. & Barnes R. D. (2003). Invertebrate Zoology: a Functional Evolutionary Approach. 7th Ed. Brooks Cole.
7. Young,J. Z.(2004).The Life of Vertebrates. III Edition. Oxford university press.

ZOOGCOR01P: Animal Diversity Lab (Credits 2)

1. Spot identification of the following specimens:

Amoeba, *Euglena, Plasmodium, Paramecium, Sycon*, *Euspongia,, Obelia, Physalia, Aurelia, Tubipora, Metridium, Taenia solium,* Male and female *Ascaris lumbricoides, Aphrodite, Nereis, Pheretima, Hirudinaria, Palaemon, Cancer*, *Limulus*, *Palamnaeus, Scolopendra*, *Julus*, *Periplaneta, Apis, Chiton, Dentalium, Pila, Unio, Loligo, Sepia, Octopus, Pentaceros, Ophiura, Echinus, Cucumaria* and *Antedon, Balanoglossus, Herdmania, Branchiostoma, Petromyzon, Sphyrna, Pristis, Torpedo, Labeo, Exocoetus, Anguilla, Ichthyophis/Ureotyphlus, Salamandra, Bufo, Hyla, Chelone, Hemidactylus, Chamaeleon, Draco, Vipera, Naja, Crocodylus, Gavialis, Passer, Psittacula, Alcedo*,

Sorex, *Pteropus*, *Funambulus, Suncus*

2. Study of the following permanent slides: Transverse section of male and female *Ascaris*

3. Identification of poisonous and non-poisonous snakes

4. An "animal album" containing photographs, cut outs, with appropriate write up about the above mentioned taxa. Different taxa/ topics may be given to different sets of students for this purpose.

Suggested Readings:

1. Chatterjee and Chatterjee: Practical Zoology
2. Ghosh, K.C. and Manna, B. (2015): Practical Zoology, New Central Book Agency, Kolkata

ZOOGCOR02T, Physiology and Biochemistry	
Theory (Credits 4)	**Class**
Unit-1 Nerve and muscle	**8**
1. Structure of a neuron, Resting membrane potential, Graded potential, Origin of Action potential and its propagation in myelinated and non-myelinated nerve fibres. **2.** Ultra-structure of skeletal muscle, Molecular and chemical basis of muscle contraction.	
Unit-2 Digestion	**5**
Physiology of digestion in the alimentary canal; Absorption of carbohydrates, proteins, lipids	
Unit-3 Respiration	**5**
Pulmonary ventilation, Respiratory volumes and capacities, Transport of Oxygen and carbon dioxide in blood	
Unit-4 Excretion	**5**
Structure of nephron, Mechanism of Urine formation, Counter-current Mechanism	
Unit-5 Cardiovascular system	**6**
Composition of blood, Homeostasis, Structure of Heart, Origin and conduction of the cardiac impulse, Cardiac cycle	
Unit-6 Reproduction and Endocrine Glands	**7**
Physiology of male reproduction: hormonal control of spermatogenesis; Physiology of female reproduction: hormonal control of menstrual cycle. Structure and function of pituitary, thyroid, pancreas and adrenal	
Unit 7 Carbohydrate: Structure and Metabolism	**8**
Introduction to Carbohydrates, Structure & Types of Carbohydrates, Isomerism, Introduction to Intermediary metabolism: Glycolysis, Krebs cycle, Pentose phosphate pathway, Gluconeogenesis, Electron transport chain	
Unit-8 Lipid: Structure and Metabolism	**5**
Introduction to Lipids: Definitions; fats and oils; classes of lipids; Lipoproteins; Biosynthesis and β oxidation of palmitic acid	
Unit-9 Protein: Structure and metabolism	**5**
Proteins and their biological functions, functions of amino acids, physicochemical properties of amino acids. Peptides – structure and properties; primary structure of protein, secondary, tertiary and quaternary structures. Transamination, Deamination and Urea Cycle.	
Unit-10 Enzymes	**4**
Introduction, Classification of Enzymes, Mechanism of action, Enzyme Kinetics, Inhibition and Regulation	
Suggested Readings 1. Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). Biochemistry. VI Edn. W.H Freeman & Co. 2. Chatterjea, MN and Shinde, R (2012) . A Textbook of Medical Biochemistry. 8th Edn. Jaypee Pub., N.Delhi 3. Guyton, A.C. and Hall, J.E. (2011). Textbook of Medical Physiology, XII Edition, Harcourt Asia Pvt. Ltd/ W.B. Saunders Company 4. Murray, R.K., Granner, D.K., Mayes, P.A. and Rodwell, V.W. (2009). Harper'sIllustrated Biochemistry. XXVIII Edition. Lange Medical Books/Mc Graw3Hill. 5. Nelson, D. L., Cox, M. M. and Lehninger, A.L. (2009). Principles of Biochemistry. IV Edition. W.H. Freeman and Co. 6. Sherwood, L. (2013). Human Physiology from cells to systems. 8th Edn., Brooks & Cole 7. Tortora, G.J. and Derrickson, B.H. (2009). Principles of Anatomy and Physiology, XII Edition, John Wiley & Sons, Inc. 8. Widmaier, E.P., Raff, H. and Strang, K.T. (2008) Vander's Human Physiology, XI Edition., McGraw Hill 9. Elaine N. Marieb, 2006. Human Anatomy & Physiology, Pearson Education.	

ZOOGCOR02P: Physiology and Biochemistry Lab (Credits 2)

1. Preparation of haemin crystals
2. Identification of permanent histological sections of mammalian pituitary, thyroid, pancreas, adrenal gland, small intestine, liver, lung, kidney
3. Qualitative tests to identify functional groups of carbohydrates in given solutions: Glucose (Benedict's test),Sucrose (Iodine test)
4. Quantitative estimation of total protein in given solutions by Lowry's method.
5. Study of activity of salivary amylase under optimum conditions.

ZOOGCOR03T: Insect, Vectors and Diseases	
Theory (Credits 4)	**Class**
Unit-1 Introduction to Insects	**6**
General Features of Insects, Morphological features, Head – Eyes, Types of antennae, Mouth parts with respect to feeding habit	
Unit-2 Concept of Vectors	**6**
Brief introduction to Vectors (mechanical and biological), Reservoirs, Host-vector relationship, Adaptations as vectors, Host specificity	
Unit-3 Insects as Vectors	**8**
Detailed features of insect orders as vectors – Diptera, Siphonoptera, Siphunculata, Hemiptera	
Unit-4 Dipteran as Disease Vectors	**14**
Study of important Dipteran vectors – Mosquitoes, Sand fly, Houseflies Study of mosquito-borne diseases – Malaria, Dengue, Chikungunya, Viral encephalitis, Filariasis Control of mosquitoes	
Unit-5 Siphonaptera as Disease Vectors	**6**
Fleas as important insect vectors; Host-specificity, Study of Flea-borne diseases – Plague, Typhus fever; Control of fleas	
Unit-6 Siphunculata as Disease Vectors	**4**
Human louse (Head, Body and Pubic louse) as important insect vectors; Control of human louse	
Ùnit-7 Hempitera as Disease Vectors	**6**
Bugs as insect vectors; Blood-sucking bugs; Chagas disease, Bed bugs as mechanical vectors, Control and prevention measures	

ZOOGCOR03P: Insect Vectors and Diseases Lab (Credits 2)

List of Practical

1. Mounting and Study of different kinds of mouth parts of insects
2. Spot identification of following insect vectors through permanent slides/photographs:*Aedes*,*Culex*,*Anopheles*, *Pediculus humanuscapitis*, *Pediculus humanuscorporis*, *Phithiruspubis*, *Xenopsylla cheopis*, *Cimex lectularius*, *Phlebotomus argentipes*, *Musca domestica*
3. Study of different diseases transmitted by above insect vectors
4. Submission of a project report on any one of the insect vectors and disease transmitted

Suggested Readings

1. Anathakrishnan : Bio resources Ecology 3rdEdition
2. Goldman : Limnology, 2ndEdition
3. Odum and Barrett : Fundamentals of Ecology, 5thEdition
4. Pawlowski : Physicochemical Methods for Water and Wastewater Treatment, 1stEdition
5. Trivedi and Goyal : Chemical and biological methods for water pollution studies
6. Welch : Limnology Vols. I-II
7. Wetzel : Limnology, 3rdedition
8. Bose, M. (2017). Parasitoses and Zoonoses, New Central Book Agency

ZOOGCOR04T , Environment and Public Health	
Theory (Credits 4)	Class
Unit 1: Introduction	
Sources of Environmental hazards, Hazard identification and accounting, Fate of toxic and persistent substances in the environment, Dose response evaluation, Exposure assessment	10
Unit 2: Climate Change	
Greenhouse gases and global warming, Acid rain, Ozone layer destruction, Effect of climate change on public health	10
Unit 3: Pollution	
Air, water, noise pollution sources and effects, Pollution control	5
Unit 4: Waste Management Technologies	
Sources of waste, types and characteristics, Sewage disposal and its management, Solid waste disposal, Biomedical waste handling and disposal, Nuclear waste handling and disposal, Waste from thermal power plants.	15
Unit 5: Diseases	
Causes, symptoms and control of tuberculosis, Asthma, Cholera, Minamata disease, typhoid, filariasis	10

Suggested Readings [Consult Latest Editions]

1. Cutter, S.L., Environmental Risk and Hazards, Prentice-Hall of India Pvt. Ltd., New Delhi, 1999.
2. Kolluru Rao, Bartell Steven, Pitblado R and Stricoff "Risk Assessment and Management Handbook", McGraw Hill Inc., New York, 1996.
3. Kofi Asante Duah "Risk Assessment in Environmental management", John Wiley and sons, Singapore, 1998.
4. Kasperson, J.X. and Kasperson, R.E. and Kasperson, R.E., Global Environmental Risks, V. N. University Press, New York, 2003.
5. Joseph F Louvar and B Diane Louver Health and Environmental Risk Analysis fundamentals with applications, Prentice Hall, New Jersey 1997.
6. Bose, M. (2017). Parasitoses and Zoonoses, New Central Book Agency

ZOOGCOR03P: Environment and Public Health Lab (Credits 2)

1. To determine pH, Cl, SO4, NO3 in soil and water samples from different locations.

Discipline Specific Electives (DSE)

DSE 1 Credits: 6	
ZOOGDSE01T: Applied Zoology	
Theory (Credits 4)	**Class**
Unit-1 Introduction to Host-parasite Relationship	**3**
Host, Definitive host, Intermediate host, Parasitism, Symbiosis, Commensalism, Reservoir, Zoonosis	
Unit-2 Epidemiology of Diseases	**7**
Transmission, Prevention and control of diseases: Tuberculosis, Typhoid	
Unit-3 Rickettsia and Spirochetes	**3**
Brief account of *Rickettsia prowazekii, Borrelia recurrentis* and *Treponema pallidum*.	
Unit-4 Parasitic Protozoa	**6**
Life history and pathogenicity of *Entamoeba histolytica, Plasmodium vivax* and *Trypanosoma gambiense*	
Unit-5 Parasitic Helminthes	**4**
Life history and pathogenicity of *Ancylostoma duodenale* and *Wuchereria bancrofti*	
Unit-6 Insects of Economic Importance	**8**
Biology, Control and damage caused by *Helicoverpa armigera*, *Pyrilla perpusilla* and *Papilio demoleus, Callosobruchus chinensis, Sitophilus oryzae* and *Tribolium castaneum*	
Unit-7 Insects of Medical Importance	**8**
Medical importance and control of *Pediculus humanus corporis*, *Anopheles, Culex, Aedes, Xenopsylla cheopis*	
Unit-8 Animal Husbandry	**3**
Preservation of semen and artificial insemination in cattle	
Unit-9 Poultry Farming	**4**
Principles of poultry breeding, Management of breeding stock and broilers, Processing and preservation of eggs	

Unit-10 Fish Technology	**4**
Genetic improvements in aquaculture industry; Induced breeding and transportation of fish seed	

Suggested Readings

1. Arora, D. R and Arora, B. (2001). *Medical Parasitology*. II Edition. CBS Publications and Distributors.
2. Atwal, A.S. (1986). *Agricultural Pests of India and South East Asia*, Kalyani Publishers.
3. Banerjee, G.C. (). Animal husbandry.
4. Banerjee, G.C. (). Animal husbandry.
5. Chatterjee, K. D. (2009).Parasitology: Protozoology and Helminthology. XIII Edition, CBS Publishers & Distributors(P) Ltd
6. Dennis, H. (2009). *Agricultural Entomology.* Timber Press (OR).
7. Dunham R.A. (2004). *Aquaculture and Fisheries Biotechnology Genetic Approache*s. CABI publications, U.K.
8. Hafez, E. S. E. (1962). *Reproduction in Farm Animals*. Lea & Fabiger Publisher
9. Kumar and Corton. *Pathological Basis of Diseases*.
10. Paniker, C.K.J., Ghosh, S. [Ed} (2013). Paniker's Text Book of Medical Parasitology. Jaypee, New Delhi.
11. Parija, S.C. Text book of medical parasitology, protozoology & helminthology (Text and colour Atlas), II Edition, All India Publishers & Distributers, Medical Books Publishers, Chennai, Delhi
12. Park, K. (2007). *Preventive and Social Medicine*. XVI Edition. B.B Publishers.
13. Pedigo, L.P. (2002). *Entomology and Pest Management*, Prentice Hall.
14.RatanLalIchhpujaniandRajeshBhatia.MedicalParasitology,IIIEdition,JaypeeBrothersMedicalPublishers(P)Ltd.,NewDelhi
15. Bose, M. (2017). Parasitoses and Zoonoses, New Central Book Agency
16. Chaudhuri, S. (2017). Economic Zoology, New Central Book Agency

ZOOGDSE01P: Applied Zoology, Lab (Credits 2)

1. Study and Identification of *Plasmodium vivax*, *Entamoeba histolytica, Ancylostoma duodenale* and *Wuchereria bancrofti* and their life stages through permanent slides/photomicrographs or specimens.
2. Study and Identification of arthropod vectors associated with human diseases: *Pediculus, Culex,Anopheles, Aedes* and *Xenopsylla.*
3. Study and Identification of insect damage to different plant parts/stored grains through damaged products/photographs.
4. Identifying features and economic importance of *Nilaparvata lugens, Apion corchori, Scirpophaga incertulus, Callosobruchus chinensis, Sitophilus oryzae* and *Tribolium castaneum*
5. Visit to poultry farm/ animal breeding centre/ vector biology/ parasitology Centre. Submission of visit report
6. Maintenance of freshwater aquarium.

DSE 2 Credits: 6	
ZOOGDSE02T: Food, Nutrition and Health	
Theory (Credits 4)	**Class**
Unit 1: Basic concept of food and nutrition	6
Food Components and food-nutrients Concept of a balanced diet, nutrient needs and dietary pattern for various groups- adults, pregnant and lactating mothers, infants, school children, adolescents and elderly	
Unit 2: Nutritional Biochemistry	16
Carbohydrates, Lipids, Proteins- Definition, Classification, their dietary source and role Vitamins- Fat-soluble and Water-soluble vitamins- their dietary source and importance Minerals- Iron, calcium, phosphorus, iodine, selenium and zinc: their biological functions	
Unit 3: Health	14
Introduction to health- Definition, concept of health and disease Major nutritional Deficiency diseases- Protein Energy Malnutrition (kwashiorkor and marasmus), Vitamin A deficiency disorders, Iron deficiency disorders, Iodine deficiency disorders- their causes, symptoms, treatment, prevention and government programmes, if any. Life style related diseases- hypertension, diabetes mellitus, and obesity- their causes and prevention through dietary and lifestyle modifications Social health problems- smoking, alcoholism, drug dependence and Acquired Immuno Deficiency Syndrome (AIDS) - their causes, treatment and prevention Common ailments- cold, cough, and fevers, their causes and treatment Concepts of Nutrigenomics and health informatics	

Unit 4: Food hygiene and Community health	14
Potable water- sources and methods of purification at domestic level Food and Water borne infections: Bacterial infection: cholera, typhoid fever, dysentery; Viral infection: hepatitis, poliomyelitis, Protozoan infection: Amoebiasis, Giardiasis; Helminths infection: Taeniasis, Ascariasis, Vector borne diseases: Malaria and Dengue, their transmission, causative agent, sources of infection, symptoms and prevention Brief account of food spoilage: Causes of food spoilage and their preventive measures	
SUGGESTED READINGS 1. Mudambi, SR and Rajagopal, MV. Fundamentals of Foods, Nutrition and Diet Therapy; Fifth Ed; 2007; New Age International Publishers 2. Srilakshmi B. Nutrition Science; 2002; New Age International (P) Ltd. 3. Srilakshmi B. Food Science; Fourth Ed; 2007; New Age International (P) Ltd. 4. Swaminathan M. Handbook of Foods and Nutrition; Fifth Ed; 1986; BAPPCO. 5. Bamji MS, Rao NP, and Reddy V. Text Book of Human Nutrition; 2009; Oxford & IBH Publishing Co. Pvt Ltd. 6. Wardlaw GM, Hampl JS. Perspectives in Nutrition; Seventh Ed; 2007; McGraw Hill. 7. Lakra P, Singh MD. Textbook of Nutrition and Health; First Ed; 2008; Academic Excellence. 8. Manay MS, Shadaksharaswamy. Food-Facts and Principles; 1998; New Age International (P) Ltd. 9. Gibney et al. Public Health Nutrition; 2004; Blackwell Publishing	
ZOOGDSE02P: Food Nutrition and Health, Lab (Credits 2) 1To detect adulteration in a) Ghee b) Sugars c) Tea leaves and d) Turmeric 2. Lactose and calcium estimation in food by titrimetry 3. Methylene Blue Reductase Test (MBRT) of milk. Gram staining of bacteria. 4. Study of the stored grain pests and mosquito vectors (Anopheles, Culex and Aedes) from slides/ photograph (Sitophilus oryzae, Trogoderma granarium, identification, habitat and food sources, damage caused and control. Preparation of temporary mounts of the above stored grain pests. 5. Project- Undertake computer aided diet analysis and Anthropometric nutritional assessment for different age groups. OR Identify nutrient rich sources of foods (fruits and vegetables), their seasonal availability and price OR Study of nutrition labelling on selected foods	

DSE 3 Credits: 6	
ZOOGDSE03T: Aquatic Biology	
Theory (Credits 4)	**Class**
Unit-1 Aquatic Biomes	**10**
Brief introduction to the aquatic biomes: Fresh water ecosystem(lakes, wetlands, streams and rivers), estuaries, intertidal zones, oceanic pelagic zone, marine benthic zone and coral reefs	
Unit-2 Freshwater Biology	**20**
Lakes: Origin and classification, Lake as an Ecosystem, Lake morphometry, Physico–chemical Characteristics: Light, Temperature, Thermal stratification, Dissolved Solids, Carbonate, Bicarbonates, Phosphates and Nitrates, Turbidity, dissolved gases (Oxygen, Carbon dioxide). Nutrient Cycles in Lakes (Nitrogen, Sulphur and Phosphorous). **Streams:** Different stages of stream development, Physico-chemical environment, Adaptation of hill- stream fishes.	
Unit-3 Marine Biology	**10**
Salinity and density of Sea water, Continental shelf, Adaptations of deep sea organisms, Coral reefs, Sea weeds.	
Unit-4 Management of Aquatic Resources	**10**
Causes of pollution: Agricultural, Industrial, Sewage, Thermal and Oil spills, Eutrophication, Management and conservation (legislations), Sewage treatment; Water quality assessment- BOD and COD.	
Suggested Readings 1. Anathakrishnan : Bio resources Ecology 3rdEdition 2. Goldman : Limnology, 2ndEdition 3. Odum and Barrett : Fundamentals of Ecology, 5thEdition 4. Pawlowski : Physicochemical Methods for Water and Wastewater Treatment, 1stEdition 5. Trivedi and Goyal : Chemical and biological methods for water pollution studies	

6. Welch : Limnology Vols. I-II
7. Wetzel : Limnology, 3rdedition
8. Chaudhuri, S. (2017). Economic Zoology, New Central Book Agency

ZOOGDSE03P: Aquatic Biology, Lab (Credits 2)

1. Determine the area of a lake using graphimetric and gravimetric method.
2. Identify the important macrophytes, phytoplanktons and zooplanktons present in a lake ecosystem.
3. Determine the amount of transparency, Dissolved Oxygen, and Free Carbon dioxide, in water collected from a nearby lake / water body.
4. Instruments used in limnology (Secchi disc, Van Dorn Bottle, Conductivity meter, Turbidity meter, PONAR grab sampler) and their significance.
5. A Project Report on a Sewage treatment plant/Marine bio reserve/ Fisheries Institutes.

DSE 4 Credits:6	
ZOOGDSE04T: Theory (Credits 4) Immunology	**Class**
Unit-1 Overview of the Immune System	**5**
Introduction to basic concepts in immunology, components of immune system, principles of innate and adaptive immune system	
Unit-2 Cells and Organs of the Immune System	**8**
Haematopoiesis, Cells of immune system and organs (primary and secondary lymphoid organs) of the immune system	
Unit-3 Antigens	**5**
Basic properties of antigens, B and T cell epitopes, haptens and adjuvants	
Unit-4 Antibodies	**8**
Structure, classes and function of antibodies, monoclonal antibodies, antigen antibody interactions as tools for research and diagnosis	
Unit-5 Working of the immune system	**12**
Structure and functions of MHC, exogenous and endogenous pathways of antigen presentation and processing, Basic properties and functions of cytokines, Complement system: Components and pathways	
Unit-6 Immune system in health and disease	**10**
Gell and Coombs' classification and brief description of various types of hypersensitivities, Introduction to concepts of autoimmunity and immunodeficiency	
Ùnit-7 Vaccines	**2**
General introduction to vaccines, Types of vaccines	
Suggested Readings 1. Abbas, K. Abul and Lechtman H. Andrew (2003.) Cellular and Molecular Immunology. V Edition. SaundersP ublication. 2. Abbas, K. Abul and Lechtman H. Andrew (2011.) Basic Immunology: Functions and Disorders of Immune System. Saunders Elsevier Publication. 3. Delves, Martin, Burton and Roitt (2006). Roitt's Essential Immunology. 11th Edn. Blackwell Pub. 4.Kindt,T.J.,Goldsby,R.A.,Osborne,B.A.andKuby,J(2006).Immunology,VIEdition.W.H.FreemanandCompany. 5. Parija, SC (2012). Text book of Microbiology and Immunology. 2nd Edn. Elsevier. 6. Playfair, JHL and Chain, BM (2001) Immunology at a glance. 7th Edn. Blackwell Pub. 7. Virella, G (2007). Medical Immunology 6th Edn. Informa Healthcare.	

ZOOGDSE04P: Immunology, Lab (Credits 2)

1. Demonstration of lymphoid organs in human through model/ photograph.
2. Histological study of spleen, thymus and lymph nodes through slides/photographs
3. Preparation of stained blood film to study various types of blood cells.
4. ABO blood group determination

Skill Enhancement Courses (SEC)

ZOOSSEC01M: Credits:2 Aquarium Fish Keeping	
Aquarium Fish Keeping	**Class**
Unit 1: Introduction to Aquarium Fish Keeping	2
The potential scope of Aquarium Fish Industry as a Cottage Industry, Exotic and Endemic species of Aquarium Fishes	
Unit 2: Biology of Aquarium Fishes	10
Common characters and sexual dimorphism of Fresh water and Marine Aquarium fishes such as Guppy, Molly, Sword tail, Gold fish, Angel fish, Blue morph, Anemone fish and Butterfly fish	
Unit 3: Food and feeding of Aquarium fishes	**7**
Use of live fish feed organisms. Preparation and composition of formulated fish feeds, Aquarium fish as larval predator	
Unit 4: Fish Transportation	**3**
Live fish transport - Fish handling, packing and forwarding techniques.	
Unit 5: Maintenance of Aquarium	**3**
General Aquarium maintenance – budget for setting up an Aquarium Fish Farm as a Cottage Industry	

ZOOSSEC02M (2 credits): Vermicompost Production	
Vermicompost Production	**Class**
Unit 1: Introduction to Vermicompost Production	4
Natural role of earthworms in soil fertility, Concept of Vermicompost- the need for it	
Unit 2: Productions	8
Suitable worm species and their availabity– for Large scale/small scale, Climate and Temperature, Feedstock – for small scale or home farming / large scale or commercial	
Unit 3: Operations and maintenance	8
Smells, Moisture, Pest species, Worms escaping, Nutrient levels	
Unit 4: Harvesting	2
Unit 5: Properties of the vermicompost	2
Unit 6: Benefits of vermicompost	1
Unit 7: Use as soil conditioner	1
Unit 8: Applications of vermicompost	1
Unit 9: Visit to Vermicompost centre and Submission of Report	
Suggested References 1. https://en.wikipedia.org/wiki/Vermicompost You tube audio-visual training: 2.https://www.google.co.in/search?rlz=1C1CHZL_enIN766IN766&ei=2Kz2Wr6yDoPIvgTLw6aYDQ&q=vermicompost+preparation&oq=vermicompost&gs_l=psy-ab.1.0.0i71k1l8.0.0.0.8499.0.0.0.0.0.0.0.0..0.0....0...1c..64.psy-ab..0.0.0....0.RNrPR98LJOg#kpvalbx=1 3. https://www.youtube.com/watch?v=sQKI0Y7fj24 4. https://www.youtube.com/watch?v=oGf7Oe7oP4Y 5. http://www.ivri.nic.in/services/vermi.aspx 6. Vermicompost production training in 24 Parganas- North: http://www.swanirvar.in/help.php	