B.S. Zoology (2017 Board)

Semester V

Major Core V - Physiology

Course Code: ZC1751

No. of hours/week	No. of credits	Total number of hours	Marks
6	5	90	100

Learning Objectives

1. To make students understand the functional significance of the different organs and organ systems of animals.
2. To provide job opportunities in academic institutions, National Health Service Centers.

Course Outcomes

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	understand the basic anatomy of digestive, respiratory, excretory, homeostatic, neuromuscular, endocrine and reproductive system.	PSO - 1	U
CO - 2	describe the functional mechanism of internal regulation by different organ systems.	PSO - 1	U; R
CO - 3	compare various organ systems and discuss the adaptations exhibited by animals.	PSO - 1	U; E
CO - 4	analyze the reason for diseases in man and other organisms.	PSO - 8	U; An
CO - 5	use anatomical knowledge to predict physiological consequences.	PSO - 8	Ap; C; An

Unit I **Nutrition:** Types, composition of food - importance of nutrients**.** Balanced diet. Basal metabolic rate (BMR) and Body mass index (BMI), Malnutrition (Marasmus, Kwashiorkor, Obesity, epidemic dropsy). **Digestion and Absorption:** Digestive system of man, Digestion of carbohydrate, protein and fat - absorption and assimilation of digested food materials. Physiology of ruminating stomach.

Unit II **Respiration:** Respiratory organs, respiratory pigments. Respiratory system of man, gaseous exchange - transport of O_2 and CO_2, oxygen dissociation curve, Bohr's effect, Chloride shift. Anaerobiosis, Respiratory Quotient. **Osmoregulation:** Osmoconformers and osmoregulators, Osmoregulation in crustaceans, fishes and mammals. **Thermoregulation:** Poikilotherms and Homeotherms, thermoregulatory mechanisms.

Unit III **Circulation:** Blood Composition, Myogenic and neurogenic heart, structure of human heart, heart beat - origin and conduction, pace maker, cardiac cycle and ECG, blood pressure. Heart diseases: arthrosclerosis, acute coronary occlusion, myocardial infarction. **Excretion:** Patterns of excretion, excretory organs in invertebrates, Structure of kidney in man, nephron, mechanism of urine formation, composition of urine. Nephritis and Dialysis.

Unit IV **Muscle physiology:** Types of muscles, ultrastructure and properties of skeletal muscle, mechanism of muscle contraction and Rigor mortis. **Neurophysiology:** Structure and types of neurons, neurotransmitters, conduction of nerve impulse through myelinated and non-myelinated nerve, synapse and neuromuscular junction. Reflex action. **Receptors:** Types, Physiology of photoreception and phonoreception.

Unit V **Endocrine Physiology:** Hormones and Pheromones, Endocrine glands - Pituitary, Thyroid, Parathyroid, Adrenal, Islets of Langerhans. Biological clock and biological rhythms. **Reproductive Physiology:** Male reproductive system – Female reproductive system, structure of graffian follicle. Sexual cycles: oestrus cycle and menstrual cycle - Menopause. Hormonal regulation of menstruation, pregnancy and lactation.

Text Book

Arora, M.P. (2007). Animal Physiology (6th ed.). Mumbai: Himalayan Publishing House.

Reference Books

1. Goel, K. A. and K.V. Sastry (1998). A Text Book of Animal Physiology (6thed.). Meerut: Rastogi Publications.

2. Singh, H.R. Shoban Lal Nagin (1995). Animal Physiology and Related Biochemistry New Delhi: S. Chand and Co.

3. Nagabhushan, R. Kodarkar, M.S. and Sarojini, R. (1982). Text book of Animal Physiology (2nded.). New Delhi: Oxford and IBH Publishing Co. Pvt. Ltd.

4. Agarwal R.A., Srivastava, A.K. and Kaushal Kumar (1998). Animal Physiology and Biochemistry (3rded.). New Delhi: S. Chand and Company Ltd.

5. William S. Hoar (1991). General and Comparative Physiology. New Delhi: Prentice Hall of India Publications.

Semester V

Major Core VI – Developmental Zoology
Course Code: ZC1752

No. of hours/week	No. of credits	Total number of hours	Marks
6	5	90	100

Learning Objectives

1. To understand the sequential changes from cellular grade of organization to organ grade of organization in the development of multicellular organisms.
2. To pursue a wide range of career related to women's health and also in fields concerned with maternal and reproductive medicine.

Course Outcomes

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	explain gametogenesis, fertilization and parthenogenesis.	PSO - 2	U
CO - 2	describe cleavage, morphogenetic movements and gastrulation.	PSO - 2	R
CO - 3	acquire knowledge on Organizer, gradient system foetal membranes and placentation in mammals	PSO - 6	U
CO - 4	demonstrate metamorphosis and regeneration	PSO - 2	R
CO - 5	discuss Nuclear cytoplasmic interaction, assisted reproductive echnology and birth control measures.	PSO - 8	R

Unit I **Gametogenesis:** Spermatogenesis, Oogenesis. Types of sperm and egg, egg membranes. Structure of sperm and egg of frog, chick and human. **Fertilization:** significance, types, chemical and cytological factors involved in fertilization - physiological changes in fertilization. Asexual reproduction. **Parthenogenesis:** types and significance.

Unit II **Cleavage:** Planes and patterns of cleavage, cleavage and blastulation in frog. Fate map of frog. Morphogenetic movements. Gastrulation in frog. **Organogenesis:** Stem cells. Development of brain, eye, heart, digestive system in frog. Transplantation.

Unit III **Organizer:** Spemann's experiments - organizer in amphibian embryo, embryonic induction - neural induction. Competence. **Gradient theory:** gradient system - types, experimental evidences, mechanism. Morphogenetic fields. **Extra embryonic membranes:** Development of foetal membranes. Placenta in mammals - classification, functions and development. Placental preservation.

Unit IV **Metamorphosis:** Types, Insect and Amphibian metamorphosis - hormonal control. **Regeneration:** types, regeneration in Planaria, Amphibia and human liver, factors influencing regeneration, physiological changes involved in regeneration.

Unit V **Nucleo-cytoplasmic interaction:** Acetabularia. **In vitro fertilization**: Infertility – causes and diagnostic parameters – hormonal imbalance – Poly Cystic Ovarian Diseases (PCOD) - artificial insemination - cryopreservation of sperm and ovum - test tube babies – amniocentesis. **Birth control:** contraceptive devices - surgical method- hormonal and therapeutic methods - physical barriers - IUCD.

Text Book

Jain, P.C. (2013). Elements of developmental biology (7th ed.). Jalandhar: Vishal publishing Co.

Reference Books

1. Verma, P.S. and Agarwal, V.K. **(**2010). Chordate Embryology. New Delhi: Narosa Publishing House.
2. Sastry, K.V. and Shukla, V. (2003). Developmental Biology. Meerut: Rastogi Publications.
3. Balinsky, B. I. and B.C. Fabian (1981). An Introduction to Embryology (5th ed.). New York: Saunders Publishing College.
4. Gayatri Prakash (2007). Reproductive Biology. New Delhi: Narosa Publishing House.

Semester V
Major Core VII - Ecology and Toxicology
Course Code: ZC1753

No. of hours/ week	No. of credits	Total number of hours	Marks
5	4	75	100

Learning Objectives

1. To provide the opportunity for students to develop a deep understanding of various aspects of the environment and apply that knowledge to current environmental issues and for wise environmental management.
2. To seek employment in Food and Drug Administration agency and Environmental Protection Agency.

Course Outcomes

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	discuss the abiotic and biotic factors of the natural ecosystem.	PSO - 1	U
CO - 2	dentify the natural resources and its conservation.	PSO - 2	R
CO - 3	critically evaluate the environmental degradation and suggest measures for remediation.	PSO - 3	Ap; E
CO - 4	dentify hazardous environmental factors and assess their effects.	PSO - 7	Ap; An
CO - 5	utilize scientific literature and database to effectively communicate aspects of toxicology.	PSO - 5	Ap

Unit I **Ecology:** Scope - Branches of ecology, Abiotic factors: Biological effects of temperature and light. Concept of limiting factors: Liebig's law of minimum, Shelford's law of tolerance. Biotic factors: mutualism – commensalism – antagonism (antibiosis, parasitism, predation and competition). **Habitat ecology:** Characteristics and communities of Aquatic – freshwater (pond) and marine – terrestrial (forest, grass land, Desert) and adaptations of organisms.

Unit II **Ecosystem:** Structure (abiotic and biotic) - food chain and food web - Trophic levels – energy flow and ecological pyramids. Biogeochemical cycle: nitrogen and phosphorous cycle. **Population ecology:** density, natality, mortality, age distribution, population growth, biotic potential, population dispersal and dispersion, regulation.

Unit III **Community Ecology:** Community structure, composition and stratification. Ecological niche, Ecotone and Edge effect, Ecotype. Ecological succession: types, general process, Concepts of climax, patterns of succession. Animal distribution – continuous, discontinuous. Zoogeographical regions of world.

Unit IV **Wild life conservation:** Necessity, causes, endangered species, methods of conservation - in situ (sanctuaries and national parks) and ex situ (zoo and germplasm bank). Remote sensing and its applications in agriculture, fisheries, forest management and food management.

Urbanization: Possible advantages of urbanization – problems, solutions. Environmental Auditing and Environmental Impact Assessment (EIA).

Unit V **Toxicology: T**oxicants - classification - toxicity (LC_{50}, and LD_{50}), toxic agents and their mode of action. Toxic effects of metals, solvents, pesticides, carcinogens, food additives, drugs and Poisons, Micro plastics and radiations. Environmental toxicology: environmental pollutants, toxicants and contaminants, behaviour of toxicants in the environment – effect of xenobiotics. Environmental Risk Assessment (ERA) in pharmaceutical industry.

Text book

Arumugam, N. (2014). Ecology and Toxicology. Nagercoil: Saras Publications.

Reference Books

1. Mercy, P.D. and Basil Rose, M.R. (2003). Ecology and Toxicology. Nagercoil: Sathana Publications.
2. Sharma, P.D. (1999). Ecology and Environment. Meerut: Rastogi Publications.
3. Dash, M.L., Tata M.C. (1996). Fundamentals of Ecology. New Delhi: McGraw Hill Publishing Company Ltd.
4. Trivedi, R.N. (1993). Textbook of Environmental Sciences. New Delhi: Anmol Publications Pvt. Ltd.
5. Shukla, S.K. and Srivastava, P.R. (1992). Water Pollution and Toxicology. New Delhi: Common-Wealth Publishers.
6. Subramanian, M.A. (2004). Toxicology: Principles and methods. Chennai: M. J. P. Publishers.
7. Verma, P.S. and Agarwal V. K. (1986). Principles of Ecology. New Delhi: S. Chand & Co. Pvt. Ltd.

Semester V

Major Elective III – (a) Aquaculture

Course Code: ZC1754

No. of hours/week	No. of credits	Total number of hours	Marks
5	5	75	100

Learning Objectives

1. To enable the students to realize the importance and culture of economically important aquatic organisms.
2. To provide means of sustenance and earning livelihood and monetary profit through commercial and industrial aquaculture.

Course Outcomes

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	explain the construction of aquatic ponds and water quality management.	PSO - 5	U
CO - 2	culture finfish and shellfish and live feed organisms.	PSO - 9	R; Ap
CO - 3	demonstrate different culture methods.	PSO - 5	U
CO - 4	gain knowledge on artificial feed preparation, diseases and their control measures.	PSO - 5	U
CO - 5	describe capture techniques, fish preservation and marketing	PSO - 9	U
CO - 6	establish aquarium as a profitable hobby.	PSO - 5	Ap

Unit I Introduction: Scope. Aquaculture organisms. Construction of ponds. Water quality management in India – freshwater, coastal and marine. Culturable Types of fish ponds – nursery, rearing and culture ponds.

Unit II Types of culture: Extensive, intensive, semi – intensive, monoculture, monosex culture, poly culture, cage culture and pen culture. Integrated fish farming – paddy cum fish culture, animal husbandry cum fish culture and sewage-fed fish culture. Fish Nutrition: Artificial feed – feed formulation.

Unit III **Culture of aquatic organisms:** Fin fish culture – culture of Indian major carp – collection of seed, breeding - bundh breeding and induced breeding, transport of seeds. Shell fish culture – freshwater prawn culture and edible oyster culture. Seaweed culture. Live feed and their culture – Artemia, diatoms, rotifers and algae (Spirulina).

Unit IV **Diseases:** Bacterial - Bacterial Gill Rot, Enteritis, Infectious Dropsy. Viral - Epizotic Ulcerative Syndrome, Viral Haemorrhagic Septicemia. Fungal – Gill rot and Saprolegniasis.

Ectoparasitic and Endoparasitic diseases – Argulosis, Lernaeasis, Dactylogyrosis, Ligulosis, Piscicolosis, Ichthyopthiriasis, Myxobolosis and Costiasis. Nutritional deficiency diseases. Genetically modified species of fishes.

Unit V **Harvesting and Marketing:** Crafts and gears - Post-harvest technology – Transportation - Rigor mortis – fish spoilage - Fish storage and preservation techniques, natural and derived aqua products. Fish marketing: Co-operative marketing in fisheries. Governmental agencies in aquaculture: CMFRI, CIFRI, MPEDA, FFDA, CIFA and CIBA.

Text Book

Pillay, T.V.R. and M.N. Kutty (2011). Aquaculture: Principles and Practices (2nd ed.). Delhi: Wiley India Pvt. Ltd.

Reference Books

1. Chandral, Lily Premila and Latha. (2009). Aquaculture. Nagercoil: C.S.I. Diocesan Press
2. Santhana Kumar,G and A. M. Selvaraj (2002). Concepts of Aquaculture. Nagercoil: Meenam Publications.
3. Santhanam, R. (1995). Fisheries Science. New Delhi: Daya Publishing House.
4. Jhingran, V.G. (1997). Fish and Fisheries of India. New Delhi: Hindustan Publishing Co.
5. Khanna, S.S. (1988). Introduction to Fishes. Allahabad: Central Book Dept.

Semester V
Major Elective III – (b) Sericulture
Course Code: ZC1755

No. of hours/week	No. of credits	Total number of hours	Marks
5	5	75	100

Learning Objectives

1. To develop skills in sericulture in order to enable the students to adopt it as a vocation after their graduation as it is rural based and welfare-oriented agro based industry.
2. To develop entrepreneurial way of thinking that will allow them to identify and create business opportunities that may be commercialized successfully.

Course Outcomes

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	explain the cultivation and maintenance of mulberry plantation.	PSO - 5	U
CO - 2	dentify the diseases and pests of mulberry plant and silk worm.	PSO - 8	R
CO - 3	rear silkworms and gain knowledge on silk reeling.	PSO - 8	Ap
CO - 4	evaluate the quality of cocoon and marketing.	PSO - 9	An; E
CO - 5	acquire skills necessary for self-employment in sericulture.	PSO - 5	Ap; C

Unit I

Introduction: Importance of Sericulture - Silk Road - Sericulture industry in India - Sericulture as cottage industry - Birth and role of CSB. **Moriculture:** Important mulberry varieties - Optimum conditions for mulberry growth. Planting system. Methods of propagation - seedling, vegetative and new methods - irrigation. – Biofertilizers. Green manuring Triacontanol and Seriboost. Pruning - harvesting of leaves - preservation of leaves. Nutritive value of mulberry.

Unit II **Diseases of Mulberry:** Fungal - white and violet root rot and Fusarium root rot - fungal stem rot and stem canker and wilt diseases. Leaf spot and powdery mildew diseases; Bacterial - leaf blight and rot diseases. Viral - dwarf and leaf mosaic diseases. Nematode - root knot disease. Deficiency diseases - nitrogen, phosphorus, magnesium and potassium.

Unit III **Pests of Mulberry:** Leaf eating insect pests - Mulberry pyralid - Bihar hairy caterpillar - wasp moth and Almond leaf bore. Borer pest - Stem girdler beetle and stem borer. **Biology of silkworm:** Taxonomic position of Bombyx mori – habit and habitat of silkworm – classification of silkworms – Life cycle of B. mori – morphology of egg, larva, pupa and adult. Diseases of silkworm: Pebrine, Grasserie, Flacherie, Nucleo Polyhedral Viral (NPV) Disease and Muscardine.

Unit IV **Silkworm rearing:** Rearing appliances and rearing operations. Maintenance of optimum conditions for rearing. Feeding, bed cleaning, spacing, care during moulting. Rearing methods – Chawki, shelf, floor and shoot rearing. Sampoorna. Mounting - Methods of mounting – recautions to be taken during mounting – harvesting of cocoons. **Cocoon marketing**: transport of cocoons physical characteristic of cocoons – Defective cocoons – cocoon markets. **Grainage technology**: grainages – procedures in a grainage – diapause and non-diapasuing eggs – Transport of eggs.

Unit V **Silk reeling:** Stifling – Sun drying – steam stifling – Hot air stifling – storage of cocoons – sorting of cocoons – deflossing - cocoon riddling – cocoon mixing – cocoon cooking – open pan and three pan system – brushing – reeling – country charka, cottage basin and multi-end reeling, re-reeling- lacing – skeining. Raw silk testing marketing. By products of sericulture. **Wild silk worm**: Eri, Tasar and muga.

Text Book

Johnson, M. and Kesary, M. (2008). Sericulture. Marthandam: CSI Press.

Reference Books

1. Ganga, G and J. Sulochana Chetty (1997). An Introduction to sericulture. Delhi: Oxford and IBH Pub. Co. Pvt. Ltd.
2. Food and Agriculture organization (1976). Manual on sericulture I, II & III. Delhi: Oxford and IBH Pub. Co. Pvt. Ltd.
3. M.S. Jolly (1987). Appropriate Sericulture Techniques. Mysore: CSR & TI.
4. S.R. Ullal and M.N. Narasimhanna (1987). Hand book of practical sericulture. Bangalore: CSB.
5. M.N. Narasimhanna (1988). Manual on silkworm egg production. Bangalore: CSB.
6. S.B. Dandin and Giridhar, K. (2000). Hand book of Sericulture Technologies. Bangalore: CSB.
7. P. Venkatanarasaiah (2013). Sericulture. New Delhi: APH Publishing Corporation.

Semester V

Major Elective III – (c) Marine Biology
Course Code: ZC1756

No. of hours/week	No. of credits	Total number of hours	Marks
5	5	75	100

Learning Objectives

1. To enable the students to gain knowledge about the marine habitat and marine life.
2. To gain relevant knowledge and skills to acquire a range of diverse marine resource-based career.

Course Outcomes

CO	Upon completion of this course the students will be able to:	SO ddressed	CL
CO - 1	explain the influence of physico-chemical factors on marine organisms.	SO - 5	U
CO - 2	dentify the impact of waves and tides on animal and plant population.	SO - 2	U
CO - 3	discuss the energy flow in the marine environment.	SO - 5	U
CO - 4	evaluate the economic importance of marine resources and the impact of pollutants.	SO - 3	Ap; E
CO - 5	use scientific technology to assess quantitative parameters in relationo distribution of marine biota.	SO - 1	Ap; E

Unit I Scope of Marine Biology; Blue revolution - **Marine Ecosystem**: concepts and structure. Abiotic factors - light, temperature, dissolved gases, nutrients (major, minor and trace elements), salinity. Effect of temperature and salinity on marine organisms. Biotic factors - trophic levels, food Chain, food Web, productivity. Marine fauna and their relationships: intraspecific and inter specific (neutralism, symbiosis, antagonism) relationships.

Unit II **Marine Environment:** characteristics**, s**tratification of the ocean, pelagic and benthic communities and adaptations, Intertidal sea shore: biota - problems and adaptations, Intertidal rocky shore: zonation, biota, problems and adaptations, Intertidal sandy shore: biota and adaptations, Intertidal muddy shore: zonation, biota and adaptations, Interstitial fauna, Ecotone and Edge effect among oceanic communities.

Unit III Marine Habitat: temperate, tropic and polar seas and associated fauna, red tides, extremophiles. Mangrove Habitat: characteristics, ecological conditions and adaptations of flora and fauna. Estuarine Habitat: classification, biota and adaptations. Coral Reefs: types, reef ecosystem, distribution of coral reefs and adaptations of organisms. Deep sea Habitat: characteristics, biota and adaptations.

Unit IV Marine Resources: Food products - preservation and storage. Fishery by-products – pearls, fish meal, fish oil, agar, isinglass, fish glue and fish skin leather. Chemical resources - manganese nodules, beach placers, oil resource (petroleum), marine sediments and their economic importance. Tidal energy, Remote sensing and its application in marine biology.

Unit V Threats to marine ecosystem: over exploitation – habitat destruction - need for public awareness. Marine Pollution: pollutants - oil spills, radioactive wastes, plastics – causes, effects and Control measures. Climate change and marine fauna. Deep sea mining and underwater noise. **Conservation:** In situ - Ex situ - Marine national parks - Endangered marine species - Sand dune conservation and methods of restoration of turtle population. Laws – IUCN - Red List and Red Data Book - CITEs.

Text Book

Dubey, S.K. (2005). Marine Biology. New Delhi: Dominant Publishers and Distributors.

Reference Books

1. Peter Castro and Michael E. Huber (2009). Marine Biology. New Delhi: McGraw Hill Higher Education.
2. Manjushree Acharya (2011). Marine Biology. New Delhi: International Scientific Publishing House.
3. Veena (2010). Understanding Marine Biology. New Delhi: Discovery Publishing House.
4. Prasad, S.N. (2000). Marine Biology. New Delhi: Campus Book International.
5. Sir Frederick S. Russell and Sir Maurice Yonge (1971). Advances in Marine Biology. New York: Academic Press.
6. Philip V. Mladenov (2013). Marine biology: A very Short Introduction. UK: Oxford University press.

Semester VI

Major Practical V (Physiology and Developmental Zoology)

Course Code: ZC17P5

(Conducted during Semester V)

No. of hours/week	No. of credits	Total number of hours	Marks
4	2	60	100

Learning Objectives

1. To understand the basic principles of physiology and report experimental data.
2. To identify the stages of embryonic development and the structures in the temporary and permanent preparations.

Course Outcomes

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	explain the effect of abiotic factors on physiological process.	PSO - 3	Ap
CO - 2	describe the principles of analytical instruments and its uses in physiology.	PSO - 4	An; Ap
CO - 3	perform scientific mode of thinking; planning experiments, analyzing and evaluating data skills as scientific laboratory reports.	PSO - 6	Ap; An
CO - 4	develop methodological approach to embryonic development.	PSO - 7	An
CO - 5	identify instruments, tissues, embryonic structures in preparations, photographs and diagrams.	PSO - 8	R; An

Physiology

1. Rate of oxygen consumption in a fish.
2. Effect of temperature on the opercular movement of a fish and calculation of Q_{10}.
3. Effect of temperature on the ciliary movement of a bivalve.
4. Action of salivary amylase in relation to pH.
5. Action of salivary amylase in relation to enzyme concentration.
6. Estimation of haemoglobin - demonstration.
7. Counting of blood cells using haemocytometer (Demonstration).

Slides/ Models/ Chart

Haemoglobin, ECG, Sphygmomanometer, Kymograph, Cardiac muscle, Striated and Non-striated muscle, Simple muscle curve.

Developmental Zoology

1. Observation of sperm and egg of Frog.
2. Temporary mounting and observation of Chick embryo.
3. Induced ovulation in frog (demonstration only).
3. Effect of thyroxin on Amphibian metamorphosis (demonstration only).
5. Observation of developmental stages in an insect.

Museum specimens/ Slides/ Models/ Charts

Sperm and egg of Human.

Egg of insect, frog and bird.

Chick embryos of 24, 48, 72 and 96 hours.

Cleavage (2, 4, 8 and 16 cell stage), blastula and gastrula of frog.

Placenta – Diffuse, Discoidal, Zonary and Cotyledonary.

Semester V
Skill Based Course (SBC) – Vermitechnology
Course Code: ZSK175

No. of hours/week	No. of credits	Total number of hours	Marks
2	2	30	100

Learning Objectives

1. To impart knowledge on the production of vermicompost, a nutrient rich fertilizer.
2. To enable the students to generate and promote employment and organic farming.

Course Outcomes

CO	Upon completion of this course the students will be able o:	SO ddressed	CL
CO - 1	discuss the classification and categories of earthworms.	SO - 1	U
CO - 2	explain the biology of earthworms.	SO - 1	U
CO - 3	assess the importance of earthworms in soil fertility,medicine and pharmaceutics.	SO - 5	E
CO - 4	design the methodology for vermiculture and for theproduction of vermicompost and vermiwash.	SO - 8	Ap
CO - 5	prepare and market the vermicompost.	SO - 7	Ap

Unit I **Vermitechnology:** Definition and importance. Earthworm – Systematic position and salient features. Categories of earthworm – Anecic, Endogeic, Epigeic species. Biology of Eisenia fetida, Lumbricus terrestris, Eudrilus eugenia, Megascolex mauritii.

Unit II **Role of earthworms:** soil fertility and productivity. Earthworm and microorganisms, Pest and diseases of earthworm, Economic and medicinal importance.

Unit III **Vermiculture:** Collection and preservation. Vermiculture techniques -Types (monoculture and polyculture). Vermicast - formation, shape, composition and importance. Vermiwash – preparation, composition and applications.

Unit IV **Vermicomposting:** Requirements – earthworm, site, bed, feed, moisture and oxygen. Steps of vermicomposting - selection of site, containers, species, food, preparation of vermibed, inoculation of worms, feeding, watering the wormbed. Methods of vermicomposting,

Unit V **Harvesting and marketing:** Harvesting of earthworms and vermicompost. Packaging, storing, and marketing of vermicompost. Economic viability of vermicomposting. Vermi-remediation. Financial Support by Government and Non-Government funding agencies.

Text book

Seetha Lekshmy, M. and Santhi, R. (2012). Vermitechnology. Nagercoil: Saras Publications.

Reference Books

1. Mary Violet Christy, A. (2008). Vermitechnology. Chennai: MJP. Publishers.
2. Sultan Ahmed Ismail (2005). The Earthworm (2nd ed.). Goa: Other India Press.
3. Gupta, P.K. (2003). Vermicomposting for sustainable Agriculture. Jodhpur: Agrobios.
4. Ekambaranatha Ayyer (1989). A Manual of Zoology, Part I, Invertebrata. Chennai: S. Viswanathan Printers & Publishers Pvt. Ltd.
5. Dohama, A.K. (2004). Vermicompost, New Delhi: Vivekananda Kendra (NARDEP).
6. Dahama, A.K. (2009). Organic farming for sustainable Agriculture (2nd ed.). Jodhpur: Agrobios.

Semester VI

Major Core VIII – Biotechnology

Course Code: ZC1761

No. of hours/week	No. of credits	Total number of hours	Marks
6	5	90	100

Learning Objectives

1. To learn the basic concepts of biotechnology and understand the various techniques pertaining to biotechnology.
2. To get employability in biotech industries.

Course Outcomes

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	acquire knowledge of basic concepts of biotechnology and central dogma.	PSO - 3	
CO - 2	discuss the rDNA technology, DNA library, hybridoma echnology, animal cell and tissue culture and gene therapy.	PSO - 4	U
CO - 3	decide and apply appropriate tools and techniques in biotechnological manipulation.	PSO - 6	U
CO - 4	explain the general principles of generating transgenic plants, animals and application of microbes pharmaceutical products.	PSO - 6	Ap
CO - 5	undertake any responsibility as an individual and as a team in a multidisciplinary environment for landing in a job.	PSO - 8	Ap

Unit I **Plant and Animal cell culture:** Culture media - cell culture technique - establishment of cell culture – primary and sub-culture - explant culture, callus culture, Somatic hybridization and micro-propagation. Cell lines - large scale culture of cell lines - organ culture - 3D culture – In vitro organ development - embryo culture.

Unit II **Tissue engineering**: Artificial skin and cartilage. Stem cells: characteristics,types and applications. **Transgenic animaltechnology:** Transgenesis – methods of transgenesis, applications of transgenic animals. **Hybridoma technology:** Production of Hybridoma, monoclonal antibodies: production and applications. **Bioreactors:** stirred tank and air–lift bioreactor.

Unit III **Metabolite production**: Ethanol (primary metabolite) and Penicillin (secondary metabolite). Immobilization of enzymes and their applications. Biosensors – types and applications. Bacterial SCP and its applications. Sewage and waste water treatment. **Bioremediation:** Types, Degradation of Xenobiotics (hydrocarbon, pesticide), super bug – construction and application. Biomining and bioleaching**.** Biocontrol – Bacillus thuringiensis.

Unit IV **Genetic Engineering:** Restriction enzymes, cloning vectors: SV40, Ti plasmid. Preparation of desired gene - Isolation of plasmid vector - insertion of desired gene into the vector - Introduction of rDNA into host cell – Screening and identification of cloned gene. DNA library. Genome editing – CRISP. Next Generation sequencing techniques. Molecular markers (RAPD & RFLP). Polymerase chain reaction. Southern blotting. DNA sequencing: Sanger's method

Unit V **DNA applications:** Disease diagnosis – DNA probes, disease treatment – production of human insulin. Gene therapy – types and methods. SNP's for mutations. Finger printing and its application in forensic medicine. Human Genome Project. **Bioethics:** Ethical implications of transgenic animals. Biosafety: Possible dangers of Genetically Engineered organisms (GEOs) and biohazards of rDNA technology. **Nanotechnology:** applications of nanotechnology in medicine, drug designing and cancer treatment.

Text Book

Dubey, R.C. (2014). A Text book of Biotechnology (6th ed.). New Delhi: S. Chand and Co. Ltd.

Reference Books

1. Dubey, R.C. (2006). A Text book of Biotechnology (4th ed.). New Delhi: S. Chand and Co. Ltd.
2. Satyanarayana, V. (2005). Biotechnology. Kolkata: Books and Allied (P) Ltd.
3. Rema L.P. (2006). Applied Biotechnology. Chennai: MJP Publishers.
4. Prakash S. Lohar (2005). Biotechnology. Chennai: Kalyani Publishers.
5. Gupta P.K. (2004). Elements of Biotechnology. Meerut: Rastogi Publications.
6. Singh B.D. (2007). Biotechnology - Expanding Horizon, Chennai: Kalyani Publishers.
7. Trevan, M.D. Boffey, S., Goulding, K.H. and Stanbury, P. (2004). Biotechnology - The Biological Principles. New Delhi: Tata McGraw - Hill Publishing Company Limited.

Semester VI

Major Core IX - Immunology and Microbiology

Course Code: ZC1762

No. of hours/week	No. of credits	Total number of hours	Marks
6	5	90	100

Learning Objectives

1. To enable the students to become aware of the microbes around us and also to know about the processes involved in the elimination of invading microbes by the defense system of our body.
2. To provide proficiency in basic microbiological and immunological skills.

Course Outcomes

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	dentify the major components of the immune system at organ and cellular level.	PSO - 1	R
CO - 2	discuss the types of immune response and mechanisms to eliminate antigens.	PSO - 1	U
CO - 3	culture and identify the microorganisms based on morphological and staining techniques.	PSO - 3	Ap
CO - 4	apply knowledge of microorganisms on common pathological diseases,	PSO - 5	R; Ap
CO - 5	develop skills to monitor and maintain food safety.	PSO - 4	Ap
CO - 6	design analytical and experimental tasks involving microbiology and immunology.	PSO - 3	Ap; An

Unit I **Immunity and Lymphoid organs**: History and scope. Types of immunity - Innate, acquired, passive and active. Primary and Secondary organs - Thymus, Bone marrow, Bursa of Fabricius, Spleen, Lymph node, Mucosa Associated Lymphoid Tissue. lymphoid and myeloid lineage. Cells of immune system (T cells and B cells, macrophages).

Unit II **Antigen and Antibodies:** Haemopoietic stem cells and haemopoiesis - Antigen. Immunogens, hapten and adjuvants. Immunoglobulin: Immunoglobulin classes, structure and functions of IgG. Antigen – Antibody reactions. Secondary antibody, purification of antibody using protein A/G.

Unit III **Immune Response:** Primary and secondary immune response, immunity to bacterial infections (humoral and cell-mediated immune response). Hypersensitivity: Allergens and types of hypersensitivity. Tumour immunology. Autoimmunity - Rheumatoid arthritis. Vaccines and Immunization schedule.

Unit IV **Microbiology:** History and scope. Whittaker's classification of microbes with two examples. Bacteria: structure of E. coli, bacterial growth curve, culture media, culture techniques – batch culture and continuous culture (chemostat and turbidostat). Virus: structure (TMV and T_4 phage) – reproduction of phages (lysogenic and lytic). Synthetic Biology.

Unit V **Food Microbiology:** Food poisoning, food spoilage and preservation. **Industrial microbiology**: Wine and Vinegar production. **Medical microbiology:** Bacterial diseases (Tuberculosis, Gonorrhea, Streptococcal dermal infection), viral diseases (AIDS, Chicken pox, Hepatitis B, Rabies), fungal diseases (Mycotoxicosis and Aspergillosis).

Text Book

Arumugam, N., Mani, A., Narayanan, L.M., Dulsy Fatima and Selvaraj, A.M. (2013). Immunology and Microbiology. Nagercoil: Saras publications.

Reference Books

1. Kuby, T. (1994). Immunology. New York: W.H. Freeman and Company.
2. Tizard, I.R. (1995). Immunology - an Introduction (4^{th} ed.). Philadelphia: Saunders College Publications.
3. Prescott, Lansing, M. John, P. Harley and Donald A. Klan (2005). Microbiology. New York: McGraw Hill Publishing Co. Ltd.
4. Pelczar, Michael J. E.C.S. Chan and Noel R. Krieg (2006). Microbiology. New York: Tata McGraw – Hill Publishing Co. Ltd.
5. Roger, Y. Stanier, John L. Ingraham, Mark L. Wheelis and Pager R. Painter (1988). General Microbiology. New Delhi: Macmillan India Ltd.
6. Jeffrey K. Actor (2011). Elsevier's Integrated Review Immunology and Microbiology E-Book: Online Access 2^{nd} Edition, Kindle Edition.

Semester VI

Major Core X - Evolutionary Biology
Course Code: ZC1763

No. of hours/week	No. of credits	Total number of hours	Marks
5	5	75	100

Learning Objectives

1. To discern the evolutionary significance of animals and origin of species.
2. To provide methods of investigating animal evolution, construction of phylogenetic trees and to get job in educational institutions and paleontological departments.

Course Outcomes

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	explain the concepts of evolution, origin of life, geological time scale and evidences of evolution.	PSO - 1	U
CO - 2	explain the theories of evolution, mechanism of speciation and extinction of organism.	PSO - 3	R
CO - 3	apply Hardy-Weinberg equilibrium in population genetics.	PSO -6	Ap; E
CO - 4	outline the major transitions in evolution, from the origin of life to hominid evolution.	PSO - 6	Ap
CO - 5	perform, analyse and report experimental observations in evolutionary biology.	PSO - 2	Ap; An

Unit I **Concepts and Evidences of Evolution**: Origin of life - Theories and experiments; Evidences in support of evolution – morphology and comparative anatomy, embryology, physiology and biochemistry, palaeontology. Geological time scale.

Unit II **Theories of Evolution:** Lamarckism, Neo-Lamarckism. Darwinism, Neo-Darwinism. Mutation theory of De Vries. Modern synthetic theory. Variation – types, sources – mutation, combination, hybridization, genetic drift, Founder's principle, polyploidy. Natural selection – Stabilizing, directional and disruptive selection.

Unit III Isolating mechanisms: Types, origin and evolution of isolating mechanisms, role of isolation in speciation. **Species Concept and Speciation:** Species, sibling species, sub species, demes. Species concept - morphological, genetic and biological. Speciation - Phyletic and true speciation, mechanism of speciation. Patterns of speciation – allopatric, sympatric, quantum and parapatric.

Unit IV Phylogenetic analysis: Tools for sequence alignment – BLAST, FASTA. Methods of phylogenetic analysis - phenetic and cladistic; phylogenetic trees, methods for determining evolutionary trees – maximum parsimony, distance and maximum likelihood.

Unit V Trends in Evolution, Mimicry and Colouration: Modes of evolution – micro, macro and mega evolution. Heterochrony - Paedomorphosis and Peramorphosis. Rate of evolution. Human Evolution – organic, cultural and future evolution. Mimicry and colouration. Extinction - types, causes and significance.

Text Book

Veer Bala Rastogi (2017). Organic Evolution (Evolutionary Biology) 13th ed. Delhi: Medtech Publishers.

Reference Books

1. Arora, M.P. (2003). Evolutionary Biology. Chennai: Himalaya Publishing House.
2. Sanjib Chattopadhyay (2012). LIFE: Evolution, Adaptation and Ethology. Kolkata: Books and Allied (P) Ltd.
3. Verma, P.S. and V.K. Agarwal (1998). Concept of Evolution. New Delhi: S. Chand and Company Ltd.
4. Verma, P.S. and V.K. Agarwal (1982). Principles of General Biology (Evolution). New Delhi: S. Chand and company Ltd.
5. Gladis Helen Hepsyba, S. and Hemalatha, C.R. (2009). Basic Bioinformatics. Chennai: MJP Publishers.
6. John Britto, A. (2011). Bioinformatics. Palayamkottai: St. Xavier' College.
7. Hooman H. Rashidi and Lukas K. Buehler (2000). Bioinformatics Basics: Application
8. in Biological Science and Medicine. USA: CRC Press.
9. Sanjib Chattopadhyay (2008). Evolution, Adaptation and Ethology. Kolkatta: Books and Allied Pvt. Ltd.

Semester VI

Major Elective IV – (a) Applied Zoology

Course Code: ZC1764

No. of hours/week	No. of credits	Total number of hours	Marks
5	4	75	100

Learning Objectives

1. To deepen the knowledge of students in general and applied areas of Zoology.
2. To provide employment and job opportunities in the public, private and government sector.

Course Outcomes

CO	Upon completion of this course the students will be able to:	SO ddressed	CL
CO - 1	apply the knowledge of animal husbandry in economic development.	SO - 5	U
CO - 2	dentify the kinds of bees and the methods of bee keeping.	SO - 8	U
CO - 3	Rear silkworms, harvest and market the cocoons.	SO - 9	Ap
CO - 4	apply skills and experience about the management of poultry and Dairy farming.	SO - 9	Ap
CO - 5	culture of economically important finfish and shell fishes.	SO - 8	Ap

Unit I **Apiculture:** Scope – classification and kinds of bees – bees and their society – life cycle of Apis indica – food of honey bees - relationship between plants and bees. Methods of bee keeping (primitive and modern) – Honey bee products: honey, bee wax, bee venom. **Lac culture** – scope – lac insect Laccifer lacca and its life cycle – processing of lac - lac products and importance.

Unit II **Sericulture:** Scope – Silk Road - CSB - Moriculture: varieties of mulberry, methods of propagation, harvesting of leaves – Common species of Silkworm– Life cycle of mulberry silkworm – Diseases of silkworm: pebrine, grasserie, sotto diseases, muscardine – pest of silkworm: uzifly. Rearing of silkworm – mounting – spinning - harvesting of cocoons – silk reeling and marketing.

Unit III Poultry Keeping: Scope – commercial layers and broilers - poultry housing - types of poultry houses – management of chick, growers, layers and broilers – debeaking - sexing in chicks - Nutritive value of egg. Diseases of poultry – Ranikhet, Fowl pox, Coryza, Coccidiosis, Polyneuritis – vaccination.

Unit IV Dairy Farming: Scope – Breeds of Dairy animals – Establishment of a typical Dairy farm – Management of cow (Newborn, calf, Heifer, milking cow) – Diseases (Mastitis, Rinder Pest, FMD). Nutritive value of milk - dairy products (Standard milk, skimmed milk, toned milk and fermented milk-curd, ghee, cheese) Pasteurization. Leather industry – scope – processing of skin.

Unit V Integrated Farming: Definition and Scope. Agri-based fish farming – paddy cum fish culture – Horticulture-cum-fish farming. Integrated bee keeping - Live-stock fish farming - Duck-cum fish culture, fish-cum poultry farming, fish cum dairy farming, goat-cum fish integration, fish cum pig farming - multi-trophic aquaculture – Livestock – Poultry – Fish - Horticulture.

Text Book

Arumugam, N., Murugan, T., Johnson Rajeshwar, J. and Ram Prabhu, R. **(**2011). Applied Zoology. Nagercoil: Saras Publications.

Reference Books

1. Vasantharaj David, B. (2004). General and Applied Entomology (2nd ed.). New Delhi: Tata McGraw-Hill Publishing Company Ltd.
2. Johnson, J. and Jeya Chandra, I. (2005). Apiculture. Marthandam: Olympic Grafix.
3. Tharadevi, C.S., Jayashree, K.V. and Arumugam, N. (2014). Bee Keeeping. Nagercoil : Saras Publications.Johnson, M. and Kesary, M. (2015). Sericulture (5th ed.). Marthandam: CSI Press.
4. Ganga, G. and Sulochana Chetty (1997). An Introduction to Sericulture. Delhi: Oxford and IBH Publishing Co. Pvt. Ltd.
5. Gnanamani, M.R. (2005). Profitable Poultry Farming. Madurai: J. Hitone Publications.
6. Shukla, G.S. and Upadhyay, V.B. (1998). Economic Zoology. Jaipur: Rastogi Publications.
7. John Moran (2005). Tropical Dairy Farming. Australia: Landlinks Press.
8. Uma Shankar Singh (2008). Dairy Farming. New Delhi: Anmol Publishers.

Semester VI

Major Elective IV – (b) Poultry Science

Sub. Code: ZC1765

No. of hours/week	No. of credits	Total number of hours	Marks
5	4	75	100

Learning Objectives

1. To make the students know about the rearing of poultry as a profitable self employment opportunity.
2. To apply entrepreneurial and teamwork skills in finding, evaluating and beginning the process of implementing new venture concepts.

Course Outcomes

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	explain different aspects of raising poultry for meat and eggs.	PSO - 5	U
CO - 2	construct and maintain poultry house and management ofpoultry animals.	PSO - 5	R; Ap
CO - 3	dentify the diseases and implement control measures.	PSO - 5	R
CO - 4	develop entrepreneurship skills and commercialize ndigenous poultry farming.	PSO - 9	Ap
CO - 5	provide consultancy service to the local community.	PSO - 8	Ap

Unit I Poultry industry in India: Commercial layers and broilers. Sexing in one day old chicks. Poultry housing: General principles of building poultry house. Deep litter system - dropping pit – feeders – waterers - nest boxes. Laying cages - Californian cages - management of cage birds.

Unit II Poultry manure: volume, composition and values. Nutritional content of eggs. Management of chicks, growers, layers and broilers. Lighting for chicks, growers, layers and broilers. Summer and winter management. Debeaking and Forced moulting.

Unit III **Poultry nutrition:** Protein and amino acid requirements for chicks, growers, layers and broilers - Symptoms of excessive dietary levels and deficiency. Carbohydrate and fat requirements for chicks, growers, layers and broilers - symptoms of excessive dietary levels and deficiency. Requirements of vitamins and inorganic minerals - deficiency symptoms.

Unit IV **Requirements of poultry feed:** Importance of feed additives in poultry feed. Preparation of supplementary feed for poultry – South Indian feed ingredients in relation to Metabolizable Energy (M.E) level, protein level, amino acid level, minerals (Ca & P) and fibre content. Mash for chick, grower, layer and broiler.

Unit V **Poultry diseases:** Causes, symptoms, transmission, treatment, prevention and control of viral diseases (Ranikhet disease, fowl pox, infectious bronchitis, avian leucosis complex and Gumboro disease), bacterial (Fowl typhoid, Paratyphoid, Pullorum, Fowl cholera, Coryza, Mycoplasmosis), fungal diseases (Aspergillosis and Aflatoxicosis), Parasitic disease (Coccidiosis, Nematode infection, Tape worm infections) external parasites: Ticks, mites and lice. Prophylactic approach to diseases, Homeopathy in poultry diseases.

Text Book

Gnanamani M.R. (2010). Modern Aspects of Commercial Poultry Keeping. Madurai: Deepam Publications.

Reference Books

1. Singh, K.S. and Panda, B. (1988). Poultry Nutrition. New Delhi: Kalyani Publishers.
2. Norris-Elye, L. C. R. (2005). Poultry Science. New Delhi: Biotech Books.
3. Colin G. Scanes, George Brant and Eugene Ensminger, M. (2004). Poultry Science (3rd ed.). New Jersey: Prentice Hall Publishers.
4. Nuhad J. Daghir (2008). Poultry Production in Hot Climates, London: CAB Internationl.
5. David E. Swayne (2012). The Diseases of Poultry (13th ed.). New Jersey: Wiley – Blackwell Publishers.
6. Chauhan, H.V.S. and Sushovan Roy (2007). Poultry Diseases - Diagnosis and Treatment. Hyderabad: New Age International Publishers.
7. Sreenivasaiah P.V. (2015). Textbook of Poultry. Delhi: Bio-Green Books.

Semester VI
Major Elective IV - (c) Pest Management
Sub. Code: ZC1766

No. of hours/week	No. of credits	Total number of hours	Marks
5	4	75	100

Learning Objectives

1. To provide awareness on various pests and their control measures.
2. To apply Integrated Pest Management strategies to resonate home based food products with the general public.

Course Outcomes

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	outline the pest groups affecting different agricultural crops and control measures.	PSO - 1	U
CO - 2	evaluate the control measures adopted for pests of household and stored products.	PSO - 3	E
CO - 3	select correct IPM in cropping systems with traditional and alternative control measures.	PSO - 3	Ap
CO - 4	analyze the impact of pesticides on environment and adopt better agricultural practices.	PSO - 4	An
CO - 5	pursue advanced programme in entomology and seek employment opportunities.	PSO - 5	Ap

Unit I **Introduction:** definition of pest – outline of pest groups affecting agricultural crops – population dynamics of pests – causes for pest out breaks. Pest control methods: cultural, chemical and biological - pesticides, precautions, safety devices - pesticide poisoning symptoms and first aid.

Unit II **Pesticides:** organochlorine, organosphorus and organocarbamates – **i**norganic and natural pesticides. Preparation of pesticides: formulations – packages, manufacture. Toxicity levels – LD_{50} values. Mode of action of pesticides.

Unit III **Pests of Agricultural importance:** bionomics and life cycles of any two pests of the following: **c**ereals (rice); oilseeds (coconut, groundnut); vegetables (brinjal); pulses; plantation crops (coffee); fruits (citrus) and pesticide formulations.

Unit IV **Household pests and Pests of stored products:** household pests (cockroaches, termites, silverfish, flies and mosquitoes) and their control measures. Rodents as pests – local rodents, life history, feeding habits, reproduction and behaviour – methods of rodent control. Stored grain pest (rice weevil, flour beetle, cigarette beetle).

Unit V **Mode of Pest Control:** Pesticide spraying appliances. Residual toxicity of pesticides – Environment degradation and its prevention. Biological control of pest – parasites, predators and pathogens – chemosterilants – pheromones - Bacculovirus-mediated pest control. Integrated pest management and its relevance to 21st century.

Text Book

Dhawan, A.K., Balwinder Singh, Manmeet B Bhullar (2012). Integrated Pest Management. Chennai: Scientific Publishers.

Reference Books

1. Nayar, Ananthakrishnan and David (1976). General and Applied Entomology. New Delhi: Tata McGraw Hill Publishers.
2. Metcalf and Flint (1973). Destructive and useful Insects (4th ed.). New Delhi: Tata McGraw Hill Publishers.
3. Roya, D.N. and Abrown, A.W. (1981). Entomology: Medical and Veterinary (3rd ed.).Bangalore: The Bangalore Printing and publishing company.
4. Cremlyn, R. (1979). Pesticides: Preparation and mode of Action. New Jersey: John Wiley & Sons Ltd.
5. Ignacimuthu, S. and B V David (2009). Ecofriendly Insect Pest Management. Delhi: Elite Publishing House Pvt Ltd (Ind).

Semester VI

Major Practical VI (Ecology and Toxicology & Evolutionary Biology)

Course Code: ZC17P6

(Conducted during Semester V & VI)

No. of hours/week	No. of credits	Total number of hours	Marks
4	2	60	100

Learning Objectives

1. To investigate the relationship between the organisms and their environment.
2. To know the phylogenetic relations of the animal phyla and their traits in understanding the evolutionary relationship.

Course Outcomes

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	analyse the quality of water samples.	PSO - 3	Ap ; An
CO - 2	examine and identify the zooplanktons.	PSO - 1	Ap
CO - 3	assess the evolutionary concepts through experiments.	PSO - 4	E
CO - 4	study the natural ecosystem and report.	PSO - 7	C; Ap

Ecology and Toxicology

1. Detection of transparency of water by Secchi disc.
2. Estimation of oxygen content of water samples.
3. Estimation of salinity of water samples.
4. Mounting of freshwater and marine planktons.
5. Analysis of producers and consumers in grass land.
6. Determination of 48 hours LC_{50} of a pesticide.
7. Study of natural ecosystem and field report of the visit (compulsory).

Museum specimens/ Slides/ Models/ Charts

Secchi disc, Mutualism (Hermit crab and Sea anemone), Commensalism (Echeneis and Shark), Parasitism (Sacculina on Crab), Cyclomorphosis (Daphnia).

Evolutionary Biology

1. Serial homology in prawn.
2. Prodigality of nature - Frog.
3. Mutant forms in Drosophila.
4. Observation of variation in finger prints.
5. Variations in the markings of Umbonium shells.
6. Demonstration of Natural selection on gene frequency using beads.
7. Demonstration of Genetic drift on gene frequency using beads.
8. Demonstration of DNA sequence alignment by BLAST and construction of cladogram.

Models / Charts / Specimen

Homology- fore limbs of vertebrates, Analogy - wings of animals, Vestigial organs, Nautiloid fossil, Limulus, Peripatus, Archaeopteryx, Darwin finches, Industrial melanism, Ancon sheep, Monarch and Viceroy butterfly, Stick insect, Krait and Lycodon

Semester VI
Major Practical VII (Biotechnology, Immunology and Microbiology)
Course Code: ZC17P7
(Conducted during Semester VI)

No. of hours/week	No. of credits	Total number of hours	Marks
4	2	60	100

Learning Objectives

1. To familiarize the students with various immunological and microbiological techniques.
2. To implement experimental protocols and adapt them to carry out using biotechnological techniques.

Course Outcomes

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	solate genomic DNA.	PSO - 3	Ap
CO - 2	perform quantitative, immunological and microbiological analysis.	PSO - 6	Ap
CO - 3	differentiate Gram positive and negative bacteria.	PSO - 3	An; Ap
CO - 4	dentify lymphoid organs in a vertebrate model.	PSO - 4	R
CO - 5	develop skills needed for future research in immunology, microbiology and biotechnology.	PSO - 6	Ap

Biotechnology

1. Isolation of genomic DNA.
2. Estimation of DNA by Diphenylamine (DPA) Method.
3. Estimation of BOD in Sewage.
4. Estimation of COD in sewage.
5. Immobilization of enzyme (Amylase/ Invertase/ Protease) using sodium alginate - Demonstration.
6. Polymerase Chain Reaction – Demonstration.
7. Production of Hybridoma and Monoclonal antibodies – Flow chart.
8. Isolation of B and T lymphocytes using kits.

Models/ Charts/ Photos

pBR 322, phage, SV40, Recombinant DNA, Electroporation unit, Southern blotting, RFLP, organ culture (Plasma clot method), Knockout mice, Dolly, Sanger's method of DNA sequencing, Biosensor, Callus, Explant, Micropropagation, Fermenter, rDNA, Human genome sequence, Penicillin, Biogas production.

Immunology & Microbiology

1. Dissection of Lymphoid organs of Rat (Virtual demonstration).
2. Cleaning and sterilization of glass wares and Preparation of culture media for microbes.
4. Serial dilution technique.
5. Examination of bacterial motility by Hanging drop technique.
6. Staining of bacteria – simple staining and gram staining.
7. Radial immuno diffusion.

Charts/ Models/ Instruments

Escherichia coli, TMV, T_4 phage, Bacterial growth curve, Chemostat, Autoclave, Hot air oven, Inoculation loop, Haemocytometer, Stage and Ocular micrometer.

	Content addressed with Local Needs
	Content addressed with NationalNeeds
	Content addressed with Regional Needs
	Content addressed with Global Needs

M.Sc. Syllabus (2017 Board)

Semester I

Core I - Biochemistry

Course Code: PZ1711

No. of hours/ week	No. of credits	Total number of hours	Marks
6	4	90	100

Objectives

1. To create awareness among the students about the structure and functions of biomolecules.
2. To provide knowledge in tackling more advanced and specialized biochemical techniques.

Course Outcomes

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	assess the relationship between chemistry, physics and biology.	PSO - 1	E
CO - 2	recognize the structure and functions of biomolecules.	PSO - 1	R
CO - 3	discuss basic principles of metabolism and associated metabolic diseases.	PSO - 7	U
CO - 4	demonstrate experiments and techniques related to biochemistry.	PSO - 2	Ap; An
CO - 5	gain employability in industrial, biomedical and research laboratories.	PSO - 9	Ap

UNIT I Atoms – Molecules – Chemical bonds – Primary bonds and secondary bonds – pH and Hydrogen ion concentration - Buffers – 'Henderson-Hasselbalch' equation – Buffer systems in blood - Mechanism of buffer action - Acid base balance – Regulation of acid base balance – Acidosis and Alkalosis. Water – Colligative properties - Water turnover and balance - Electrolyte balance – Dehydration and Water intoxication.

UNIT II **Carbohydrates:** Classification, structure, properties of mono, oligo and polysaccharides and biological role of carbohydrates - Carbohydrate metabolism - glycogenesis, glycogenolysis, glycolysis, Krebs cycle, Electron transport and Oxidative phosphorylation, Energetics of glucose metabolism - Pasteur effect–HMP shunt - gluconeogenesis – glyoxylate pathway – Cori cycle – Regulation and hormonal control of carbohydrate metabolism – glycogen storage diseases – blood sugar level – Glycosuria - Glucose tolerance test – Diabetes.

UNIT III **Proteins:** Classification, structure, Ramachandran plot, Properties and biological role. Amino acids - classification, structure and properties – Metabolism of proteins - deamination, transamination– transmethylation and decarboxylation of amino acids – glycogenic and ketogenic amino acids – Formation and transport of ammonia - glucose-alanine cycle - Ornithine cycle – Metabolism of Phenylalanine, Tyrosine and Tryptophan. Porphyrins.

UNIT IV

Lipids: Classification, structure and Biological role - Chylomicrons, VLDL, LDL, HDL - Lipid metabolism – Theories of oxidation of fatty acids – Oxidation of any one fatty acid and its bioenergetics (palmitic acid) – Ketogenesis - Biosynthesis of palmitic acid – Metabolism of cholesterol - lipid storage diseases – Role of liver in fat metabolism. Prostaglandins. Integration of carbohydrate, protein and lipid metabolism.

UNIT V **Nucleotide metabolism:** Biosynthesis and degradation of purines and pyrimidines**. Enzymes:** classification, nomenclature, enzyme kinetics, Michaelis - Menten constant, enzyme inhibition, mechanism of enzyme action, factors affecting enzyme activity, isozymes, coenzymes. **Vitamins:** Classification (fat soluble and water soluble), occurrence and biochemical role. **Detoxification:** Mechanism of detoxification (oxidation, reduction, conjugation) - cytochrome P 450 system.

Reference Books

1. Satyanarayana, U. & Chakrapani, U. (2013). Biochemistry **(**4th ed). India: Elsevier.
2. Chatterjea**,** M.N. & Rana Shinde (2012). Textbook of Medical Biochemistry **(**8th ed.). New Delhi: Jaypee Brothers Medical Publishers Pvt. Limited.
3. Vasudevan, D. M., Sree Kumari, S. & Kannan Vaidyanathan (2013). Textbook of Biochemistry for Medical Students (7th ed.). New Delhi: Jaypee Brothers Medical Publishers Pvt. Limited.
4. Nitin Jain, Jain, J.L. & Sunjay Jain (2014). Fundamentals of Biochemistry. S. Chand & Co. Ltd., New Delhi.
5. Jeremy M. Berg, John L. Tymoczko & Lubert Stryer (2006). Biochemistry (6th ed,). San Francisco: Freeman & Co. Publishers.
6. Ambika Shanmugam (2012). Fundamentals of Biochemistry for Medical Students (7th ed.). Published by Wolters Kluwer, India.
7. David L. Nelson & Michael M. Cox (2004). Lehninger Principles of Biochemistry (4th ed.). New York: W.H. Freeman and Company.

Semester I

Core II - Cell and Molecular Biology

Course Code: PZ1712

No. of Hours/ week	No. of Credits	Total Number of Hours	Marks
6	4	90	100

Objectives

1. To provide firm intellectual and basic knowledge on the structure and functions of biomembranes, cell organelles and molecules of eukaryotic cells.
2. Get employment in educational institutions and research laboratories.

Course Outcomes

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	recognize and describe the structural and functional organization of cell organelles.	PSO - 1	U

CO - 2	illustrate dna replication and trace the flow of genetic information from dna to protein, protein sorting and trafficking	PSO - 4	Ap
CO - 3	summarise the cell cycle and proteins involved in the regulation and molecular defects leading to cancer.	PSO - 5	U
CO - 4	identify signaling components and pathways.	PSO - 3	U
CO - 5	apply the principles and techniques of molecular biology for further education and employment.	PSO - 6	Ap

UNIT I **Cell Structure & Functions of cell organelles**: prokaryotic cells – structure. Plasma membrane: Structure and function - active transport and pumps- transport by transporter proteins – membrane potential. Cell – cell and cell – matrix interaction: Cell adhesion molecules: Selectin – Integrin – Cadherins. Calcium dependent and Calcium independent homophilic cell–cell adhesion. Tight junction, Gap junction – connexin. Extracellular matrix – Collagen and non–collagen components.

UNIT II **Cell Signaling**: Extra cellular signaling – signaling molecules and their receptors - Functions of cell surface receptors. Pathways of intracellular signal transduction: G protein coupled receptors – Cyclic AMP pathways - Receptor Tyrosine Kinases (RTKs) – Ras, Raf and MAP kinase pathway – second messengers – signaling from plasma membrane to nucleus.

UNIT III **Cell organelles and Nucleic acids:** Structure and functions of Nucleus, Mitochondria, Endoplasmic reticulum - Golgi complex and lysosomes. Cytoskeleton – structure and functions. Ribosomes and translation of genetic information - Types, structure and functions of RNA.

UNIT IV **Protein synthesis and transport**: DNA template – – Transcription – Translation – Post translation detection. Protein – Protein trafficking - sorting: Secretory and endocytic pathway – transport from endoplasmic reticulum to Golgi – Anterograde and retrograde transport – transport to lysosome – exocytosis – endocytosis. Membrane protein and secretory proteins.

UNIT V **Normal and abnormal cell growth and functions**: Cell cycle – Mitosis - Meiosis - Cyclin and Cyclin dependent kinases – Regulation of cyclin dependent kinases (cdk) – Cyclin activity. Biology of ageing – role of anti-oxidants and free radicals. Apoptosis – definition – mechanism and significance. Neoplastic transformation: cancer – proto-oncogenes – tumour suppressor genes.

Reference Books

1. Lodish, H. & Berk, A. (2016). Molecular Cell Biology (8th ed.). New York: W.H. Freeman and Company Limited Publication.
2. Gupta, P.K. (2014). Cell and Molecular Biology (4th ed.). New Delhi: Rastogi Publication.
3. Geoffrey M. Cooper & Robert E. Hausman (2013). The cell: A Molecular Approach (6th ed.). Massachusetts, USA: Sinauer Associates Publication.
4. Alberts B., Johnson. A., Lewis, J., Raff, M., Roberts, K. and Watter, P. (2008). Molecular Biology of the Cell (5th ed.). New York: Garland Science Publication.

4. De Robertis, E.D.P. (2011). Cell and Molecular Biology (8th ed.). New York: Lippincott Williams & Wilkins Publication.

Semester I

Core III - Culture and Capture Fisheries

Course Code: PZ1713

No. of hours/ week	No. of credits	Total number of hours	Marks
6	4	90	100

Objectives

1. To gain knowledge on the construction and maintenance of ponds for culture of different types of cultivable aquatic organisms and also to gain information on fishery management, fish processing, preservation techniques and parasites of fishes.
2. To raise aqua farming and extend it to the society.

Course Outcomes

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	acquire knowledge on different types of aquatic organisms and construction of ponds.	PSO - 6	U
CO - 2	formulate the nutritional requirement of fishes and develop the breeding techniques.	PSO - 4	C
CO - 3	explain the culture of finfish and shellfish and identify the diseases and control measures.	PSO - 6	U; Ap
CO - 4	gain knowledge on fishery genetics and transgenic fishes.	PSO - 7	U
CO - 5	identify fish resource, capture techniques and fish marketing.	PSO - 6	U
CO - 6	develop entrepreneurship skill by employing fish processing techniques.	PSO - 9	Ap

UNIT I Purpose and importance of aquaculture - basic qualification of candidate species - cultivable freshwater and marine fishes - global and Indian scenario of aquaculture. Construction and maintenance of fish farm: selection of site - lay-out and types of ponds - aquatic plants and their control - control of fish predators - liming - fertilization of ponds. Kinds of aquaculture - Integrated fish farming - Sewage fed fish culture - Pen and cage culture.

UNIT II **Nutrition and Breeding**: Nutritional requirements - Culture of fish feed organisms - phytoplankton (diatom), zooplankton (rotifers, cladocerans), Artemia, Tubifex. Artificial feed and feed formulation. Seed collection: Sex identification – collection, rearing and selection of brooders - induced breeding by hypophysation - ovaprim - transportation of fish seed.

UNIT III **Finfish culture**: Culture of Indian major carps, Tilapia and murrel. Ornamental fish culture and its prospectus. **Shell fish culture**: Culture of freshwater and marine prawns, lobsters, crabs, edible and pearl oysters. **Fish pathology**: Ectoparasites, Endoparasites, Bacterial, Viral and Fungal diseases, nutritional deficiency diseases.

UNIT IV **Fishery Genetics**: Chromosomes in fishes - chromosome set manipulation - gynogenesis and androgenesis - induced polyploidy. Chromosomal abnormalities - Sex determination in fishes - sex patterns - intrinsic and extrinsic factors in sex control and sex reversal. Transgenic fishes.

UNIT V Capture Fisheries: Inland fisheries (riverine, lakesterine and cold water fisheries) - Estuarine fisheries - Marine fisheries. Crafts and fishing gears - Common fishes of Kanyakumari - Fish spoilage and methods of fish preservation – Fish Marketing and co-operative societies in aquaculture. **Economic importance of fishes**: Food value and fish by-products.

Reference Books

1. Pillay, T.V.R. (1990). Aquaculture: Principles and Practices. England: Fishing News Books Ltd.
2. Khanna, S.S. (2005). An Introduction to fishes. Allahabad: Silverline Publications.
3. Pandey & Shukla (2005). Fish and Fisheries. Meerut: Rastogi Publications.
4. Jai Singh, P. (2008). Fishes of Kanyakumari – A Hand Book on the Study of Fishes (2nd ed.). Nagercoil: Tower Graphics Printer.
5. Bardach, J. (1972). Aquaculture. New York: Wiley-Interscience Publication.
6. Jhingran, V.G. (1991). Fish and Fisheries of India. New Delhi: Hindustan Publishing Co.
7. Schaperclaus (2001). Fish Diseases, Vol. I and II. New Delhi: Oxonian Private Ltd.
8. Ghosh, R. (2007). Fish Genetics and Endocrinology. New Delhi: Swastik Publishers.
9. Santhanam, R. (1990). Fisheries Science. New Delhi: Daya Publishing House.
10. Rath, R.K. (1993). Freshwater Aquaculture. Jodhpur: Scientific Publishers.
11. Schonder. S.L. (1980). Hypophysation in Indian Major Carp. Agra: Satish Book Enterprises.
12. Reddy, P.V.G.K., Ayyappan, S., Thampy, D.M. & Gopal Krishna (2005). Text book of Fish genetics and Biotechnology. New Delhi: Indian Council of Agricultural Research.

Semester I

Elective I – (a) Biosystematics and Biodiversity

Course Code: PZ1714

No. of hours/ week	No. of credits	Total number of hours	Marks
6	5	90	100

Objectives

1. To enable the students to know about the diversified forms in nature and also to identify the relationships among different species.
2. Get employability in Zoological Survey of India, Museum and Biodiversity conservation organizations.

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	evaluate the importance, application, and practice of systematic biology.	PSO - 1	U; Ap
CO - 2	outline the classification of animal kingdom.	PSO - 1	R; E
CO - 3	collect, identify, preserve zoological specimens and assign systematic position based on international code of zoological nomenclature.	PSO - 2	Ap; An
CO - 4	discuss the importance of biodiversity and its conservation.	PSO - 9	An; Ap
CO - 5	assess the biodiversity and use library resources in biological research.	PSO - 2	E; Ap

UNIT I Basic concepts of Biosystematics - Importance and applications of biosystematics - Stages of taxonomy – alpha, beta and gamma taxonomy. Newer trends in taxonomy: Morphological, embryological, ecological, behavioral, cytological, biochemical approaches, Numerical taxonomy and Molecular taxonomy.

UNIT II **Zoological classification**: Theories of classification, components of classification, Linnaean hierarchy. Outline classification of animal kingdom. Systematic position of Invertebrates (one example for each phylum) and Chordates (one example for each class). Concept of species: kinds of species concept, polytypic species, sub species and other infra specific groups. Super species.

UNIT III **Taxonomic collection**: Collecting ways, preservation of collected materials, curating, preparation of specimens and methods of identification. **Zoological Nomenclature**: International code of Zoological Nomenclature (ICZN) – rules of nomenclature. Typification, type and its kinds.

UNIT IV **Biodiversity and its conservation**: Importance of biodiversity. Human impact on biological diversity: habitat fragmentation – wild life and human conflict - loss of animal diversity - endangered wildlife species – special projects - IUCN red list - hot spots. Conservation of biodiversity: In situ and Ex situ conservation - management of germplasm. Conservation practices in India: Wildlife sanctuaries, national parks and biosphere reserves - Indian Board of Wildlife (IBWL) - wildlife protection laws – Trade laws (CITES).

UNIT V Biodiversity – Levels of diversity – species, genetic, ecosystem. Evaluation of Biodiversity indices: Shannon-Weiner index, Brillouin diversity index, Dominance index (Simpson and Margalef index), Evenness index, richness index, Similarity and dissimilarity index, Association index. Diversity and ecosystem process theory.

Reference Books

1. Kapoor, V.C. (2001). Practice of Animal Taxonomy (5th ed.). New Delhi: Oxford and IBH Publishing Co. Pvt. Ltd.
2. Simpson, G.G. (1969). Principles of Animal Taxonomy. New Delhi: Oxford and IBH Publishing Co.
3. Supriyo Chakraborty (2004). Biodiversity. Jaipur: Pointer Publishers.
4. Jordan, E.L. & Verma, P.S. (2001). Invertebrate Zoology. New Delhi: S. Chand and Company Ltd.
5. Jordan, E.L. and Verma, P.S. (2014). Chordate Zoology. New Delhi: S. Chand and Company Ltd.
6. Trivedi, P.C. and Sharma, K.C. (2003). Biodiversity Conservation. Jaipur: Avishekar Publishers.
7. Kotpal, R.L. (2014). Modern Text Book of Zoology, Invertebrates. Meerut, New Delhi: Rastogi Publications,
8. Kotpal, R.L. (2005). Modern Text Book of Zoology, Vertebrates (3rd ed.). Meerut, New Delhi: Rastogi Publications.
9. Ekambaranatha Ayyar, M. & Anantha Krishnan, T.N. (1985). Manual of Zoology, Volume I, Invertebrata. Chennai: Viswanathan Printers and Publisher Pvt. Ltd.
10. Ekambaranatha Iyyar, M. (1995). A Manual of Zoology, Volume II, Chordata. Chennai: Viswanathan Printers and Publisher Pvt. Ltd.
11. Kato, M. (2012). The biology of biodiversity. Tokyo: Springer – Verlag Publications.

Semester I
Elective I - (b) Cell Technology
Course Code: PZ1715

No. of hours/week	No. of credits	Total number of hours	Marks
6	5	90	100

Objectives

1. To apply certain biological techniques to observe and analyze cells and their constituents in health and disease.
2. To impart skills to perform histological and histochemical techniques and identify the types of cells and their products.

Course Outcomes

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	explain isolation, culture, harvest and preservation of cell.	PSO - 1	U
CO - 2	prepare tissues for microtechnique and identify stains to distinguish histological and histo-chemical preparations.	PSO - 6	R; Ap
CO - 3	apply differential staining technique for identification of diseases.	PSO - 4	Ap
CO - 4	analyse the applications of stem cell technology and tissue engineering.	PSO - 9	An
CO - 5	apply theoretical knowledge of cell manipulation techniques in research.	PSO - 4	Ap

UNIT I Cells as experimental models – microorganisms (*E. coli* and Yeast), invertebrates (*Caenorhabditits elegans* and *Drosophila melanogaster*), vertebrates (*Xenopus* and mice) - Isolation, culture, harvest and preservation of cells – cryopreservation of cells for later recovery- plasmolysis, hemolysis and cell fractionation.

UNIT II Tissue preparation for microtechnique – fixation – need, types and a good fixative – preparation of compound fixatives – physical and chemical effects of fixation – alternative methods of fixation- special treatment of mineralized tissue - processing – embedding and sectioning.

UNIT III Staining – definition of a stain – structure and classification of stains - principles and properties of staining – vital staining – metallic impregnation technique use of radiolabelled and Fluorescent dye. Stains: histological, acidophilic, basophilic and histochemical. Alizarin preparation. Significance of staining – Blood dyes.

UNIT IV Histochemistry – principles of commonly used histochemical techniques. Identification and demonstration of tissue components – proteins, carbohydrates, lipids, nucleic

acids, enzymes, pigments, amyloids. Differential staining in identification of pathogens and diagnosis of disease.

UNIT V Stem cell technology – Stem cells - properties, applications and current standings of the stem cell technology. Embryonic stem cell – adult stem cell – applications – Stem-cell plasticity, Regulators of pluripotency and differentiation of stem cell. Regenerative medicine – Current stem cell therapies - stem cells and ageing - clinical applications of hematopoietic stem cells from cord blood - treatment of neural diseases such as Parkinson's disease, Huntington's disease and Alzheimer's disease. Repair of damaged organs (liver and pancreas).

Reference Books

1. John R. Baker (1966). *Principles of Biological microtechnique - A study of fixation and dyeing.* Great Britain: Richard Clay and Company Pvt. Ltd.
2. Ramnik Sood (1994). *Medical Laboratory Technology* (4th ed.). New Delhi: Jaypee Brothers Medical Publishers Pvt. Ltd.
3. Gretchen, L.H. (1979). *Animal tissue techniques*. San Francisco: W.H. Freeman and Company.
4. Lodish, Berk, A., Zipursky, S.L., Matsudaira, P., Baltimaore, D. & Darnell, J. (2000). *Molecular Cell Biology.* San Francisco: W.H. Freeman and Company.
5. Joseph Panno (2006). *Stem cell research - Medical applications and ethical controversy*. USA: Checkmark Books Publication.
6. Shyamsundari, K & Hanumantha Rao (2007). *Histochemistry in focus: A source book of techniques and research needs.* Chennai: MJP Publishers.
7. Prakash, M. & Arora, C.K. (1998). *Microscopical methods in Encyclopaedia of laboratory techniques series.* New Delhi: Anmol Publication Pvt. Ltd.

Semester I

Practical I (Biochemistry, Cell and Molecular Biology and Culture and Capture Fisheries)

Course Code: PZ17P1

No. of hours/week	No of credits	Total number of hours	Marks
6	5	90	100

Objectives

1. To design and perform biochemical and cell biological experiments.
2. To provide laboratory skills to identify the aquatic organisms and the physico-chemical parameters for sustainable aquaculture.

Course Outcomes

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	estimate the biomolecules and demonstrate the bio-techniques.	PSO - 1	An
CO - 2	use the tools and techniques in cell biology.	PSO - 1	Ap
CO - 3	prepare temporary mounting of cell and tissues.	PSO - 1	Ap
CO - 4	assess the fish population and determine the age of fishes.	PSO - 2	Ap; E
CO - 5	identify the factors that challenge aquaculture.	PSO - 4,	An

Biochemistry

1. Colorimetry- verification of Beer-Lambert's law.
2. Determination of pH of the given sample using pH paper and pH meter.
3. Quantitative estimation of glucose (Blood/Tissue).
4. Quantitative estimation of protein.
5. Quantitative estimation of Total lipid (Blood/Tissue).
6. Quantitative estimation of ascorbic acid.
7. Quantitative estimation of blood urea.
8. Determination of salivary amylase activity in relation to temperature, pH and enzyme activity.
9. Chromatographic separation of amino acids.
10. Electrophoresis - SDS - PAGE (Demonstration).

Instruments/ Charts/ Models

Colorimeter, pH Meter, Centrifuge, Chromatogram, Electrophoretic unit

Cell and Molecular Biology

1. Isolation and observation of sub cellular organelles.
2. Observation of mitosis from onion root tip.
3. Observation of meiosis from grasshopper testis.
4. Observation of polytene chromosome from the salivary gland of
5. Chironomous larva.
6. Barr-body identification.
7. Observation of striated muscle fibre from the coxal muscle of cockroach.
8. Observation of adipocytes from the fat body of cockroach.
9. Haemolymph smear (Cockroach).
10. Blood smear (Human).

Spotters/ Slides:

Fluid mosaic model, Golgi complex, Cancer cell, Cadherins, Karyotype, Haemocytometer.

Culture and Capture Fisheries

1. Morphometry of a pond.
2. Estimation of fish population by Mark and Recapture method using beads.
3. Length- weight relationship of fish Oreochromis mossambicus.
4. Morphological features of penaeids and nonpenaeids.
5. Identification of aquatic weeds, insects and predators.
6. Sex identification in fishes and prawn.
7. Determination of age and growth in fishes (scales).
8. Fish pathology – White spot- Tail rot – Costiasis - Anchor worm- Saprolegnia
9. Taxonomic description of the following - Indian major carps: Catla catla, Labeo rohita, Cirrihinus mrigala. Exotic carp: Cyprinus caripio, Silver carp: Hypophthalmichthys molitrix. Grass carp: Ctenopharyngodon idella. Cat fishes: Clarius batrachus, Heteropneustes fossilis. Other cultivable fishes: Channa punctatus, Channa morulius. Prawns, lobsters, crabs and oysters.

1. Visit to a coastal / aquaculture research centre (report).

Semester II

Core IV - Biostatistics, Computer Applications and Bioinformatics

Course Code: PZ1721

No. of hours/ week	No. of credits	Total number of hours	Marks
6	4	90	100

Objectives

1. To enable the students to get the insight into statistical analysis of biological data with mathematical principles in collection and calculations in various biological experiments.
2. To develop skill in handling useful tools for automation of complex computer jobs, and making these tools accessible on the network from a Web browser.

Course Outcomes

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	choose appropriate sampling scheme and interpret biological data.	PSO - 2	U; R
CO - 2	formulate hypothesis and test the significance.	PSO - 4	Ap
CO - 3	apply the computer skills for biological data management and presentation.	PSO - 6	Ap
CO - 4	use database similarity search and retrieval tools in sequence analysis.	PSO - 8	C; Ap; An
CO - 5	develop skills in submitting molecular data to scientific community.	PSO - 9	U; Ap

UNIT I Population and sample in biological studies - variables - sampling methods. Types of biological data. Measurement scales - ratio scale, interval scale, ordinal scale, nominal scale - parameters and statistics. Accuracy and precision. **Data collection and presentation**: Tabulation - graphs - diagrams. Frequency distribution - histogram - frequency curves and Ogives. Measures of central tendency: types of mean, median, mode.

UNIT II **Measures of dispersion**: Range – quartile and percentile - mean deviation - standard deviation - coefficient of variation – skewness and kurtosis - standard error. **Distribution**: Binomial, Poisson and Normal. Parametric and non parametric tests. Hypothesis testing – single and two population mean - types of error (Type I and Type II) – Chi-square analysis – test for goodness of fit and homogenecity.

UNIT III Student's t-distribution - Analysis of variance (ANOVA): one way classification and two way classification (Factorial design). Probability: Addition theorem, multiplication theorem and conditional theorem. Permutation and combination. Correlation – types, methods of study and testing the significance. Regression: equations – regression lines – simple linear regression and testing its significance. Mathematical modeling in biology: types and applications.

UNIT IV Computer applications: Computer memory and storage devices (Hard disc, floppy disc, CD-ROM, DVD, Pendrive). Micrtosoft office - M.S. Power point. MS Excel and statistical function: Descriptive statistics – t –test, ANOVA, correlation, regression, Chi-square test, table and charts. Internet and E-Mail - viruses and worms. SPSS Package - usage and application.

UNIT V Bioinformatics: Scope – Biological data bases – Data base retrieval tools (Locus link, ENTREZ, Pubmed and SRS) – Nucleotide sequence data base (NCBI, EMBL) - Protein data base (SWISS-PROT). Data base similarity research tools (BLAST, FASTA). Biological sequence analysis: sequence alignment, pair-wise alignment and multiple sequence alignment (CLUSTALW). Protein structure visualizing tools (RasMol, Swiss PDB Viewer). Applications of bioinformatics tools.

Reference books

1. Gurumani, N. (2005). An Introduction to Biostatistics. Chennai: MJP Publishers.
2. Khan, I. & Khanum, A. (2014). Fundamentals of Biostatistics (3rd ed.): Hyderabad. Ukaaz Publications.
3. Zar, J.H. (1984). Biostatistical Analysis (2nd ed.). London: Prentice-Hall International Inc.
4. Bailey, N.T.J. (1997). Statistical methods in Biology **(**3rd ed.). New York: Cam. University Press.
5. Sokal, R. & James, F. (1973). Introduction to Biostatistics. Tokyo, Japan: W.H. Freeman and Company Ltd.
6. Daniel, W.W. (1987). Biostatistics: A foundations for Analysis in the Health Sciences. New York: John Wiley & Sons.
7. Gupta, S.P. (1998). Statistical Methods. New Delhi: S. Chand and Company Ltd.
8. Banerjee, P.K. (2005). Introduction to Biostatistics. New Delhi: S. Chand and Company Ltd.
9. Attwood, T.K & Parry Smith, D.J. (2005). Introduction to bioinformatics. Delhi: Pearson Education Pvt. Ltd.
10. John De Britto, A. (2011). Bioinformatics. Sivakasi: Anto Art Craft Printers.
11. Kumaresan, V., Arumugam, N., Gopi, A., Meena, A. & Sundaralingam, R. (2008). Biostatistics, Computer Application and Bioinformatics. Nagercoil: Saras Publication.
12. Sundaralingam, R. & Kumaresan, V. (2008). Bioinformatics. Nagercoil: Saras Publication.

Semester II

Core V - Genetics and Evolution

Course Code: PZ1722

No. of hours/ week	No. of credits	Total number of hours	Marks
6	4	90	100

Objectives

1. To understand the principles of hereditary mechanisms at molecular level and to discern the evolutionary significance of animals.
2. To get employability in Genetic counseling units in hospitals and paleontological centers.

Course Outcomes

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	apply the principles of inheritance as formulated by mendel.	PSO - 2	U; Ap
CO - 2	identify the alterations in chromosome number and structure.	PSO - 7	R
CO - 3	explain the molecular and biochemical basis of genetic diseases.	PSO - 1	R
CO - 4	explain the key concepts in population, evolutionary and quantitative genetics	PSO - 1	U; An
CO - 5	discuss the mechanism of molecular evolution and origin of primates and hominids.	PSO - 5	U; R

UNIT I **Mendelian Genetics:** Mendelian principles (Dominance, segregation, independent assortment). Allelic and non-allelic interactions. Penetrance, expressivity and pleiotropism. Linkage and crossing over – types – mechanism – theories. Chromosome mapping - linkage maps, tetrad analysis, mapping with molecular markers, mapping by using somatic cell hybrids. LOD score linkage test. Polygenic inheritance. Heritability and its measurements. QTL mapping.

UNIT II **Molecular and Human Genetics**: Gene concept. Mutation – types and effects of gene mutation – mutagens – insertional mutagens. DNA damage and repair. Inter and Intra chromosomal aberrations. Ploidy - kinds – mechanism – significance. Human chromosomes, Karyotyping, Chromosomal banding and painting. Pedigree analysis. Inborn errors of metabolism: Disorders of amino acid metabolism (phenylketonuria, alkaptonuria, albinism), Disorders of nucleic acid metabolism (Gout, ADA deficiency), Disorders of carbohydrate metabolism (Pompe's, G_6PD deficiency), Disorders of lipid metabolism (Tay Sach's disease, Gaucher's disease), Hemoglobin disorders (sickle cell anemia, thalassemia).

UNIT III **Population Genetics and Evolution**: Mendelian populations - gene pool and gene frequencies - Hardy Weinberg law and genetic equilibrium. Calculation of gene frequencies for autosomal (dominant and recessive alleles, codominant alleles and multiple alleles) and sex-linked genes. Factors affecting Hardy Weinberg equilibrium – selection - heterozygous advantage – mutation – migration – random genetic drift – Founder's effect. Genetic load and death - neutralist hypothesis - genetic polymorphism.

UNIT IV **Molecular evolution**: Principle – methods of molecular evolution – nucleotide substitution (types and rates). Interpretation of variation in DNA sequence. Molecular clock. Origin of new gene functions – evolution of novel genes and proteins. Molecular phylogeny – phylogenetic tree – reconstruction of phylogenetic relationship – Distance Matrix approach and Parsimony based approach - kinds of molecular phylogenies – Universal Tree of Life. Phylogenetic and biological concept of species. Adaptive radiation. Isolating mechanisms. Modes of speciation (allopatry and sympatry).

UNIT V **Origin of higher categories**: Major trends in the origin of higher categories. Microevolution, macroevolution, megaevolution and co-evolution. Evolution rates, phyletic gradualism and punctuated equilibrium. Origin and Evolution of Primates: Evolution of Anthropoid Primates - The first hominids and origin of modern man - Bipedalism – communication – speech – language - altruism and morality. Evolution of culture.

Reference Books

1. Peter Snustad, D. & Michael J. Simmons (2009). Principles of Genetics (5th ed.). USA: John Wiley & Sons, Inc.
2. Eldon John Gardner, Michael J. Simmons & D. Peter Snustad (2005). Principles of Genetics (8th ed.). New Delhi: Wiley (India) Pvt. Ltd.
3. Monroe W. Strickberger (2015). Genetics (3rd ed.). India: Pearson Education.
4. Robert F. Weaver and Philip W. Hedrick (1989). Genetics. New York: W. M. C. Brown Publishers.
5. Emmanuel. C., Rev. Fr. Ignacimuthu, S. & Vincent, S. (2006). Applied Genetics. Chennai: MJP Publishers.
6. Hickey, G. I., Fletcher, H. L. & Winter, P. (2010). Genetics. New York: Taylor and Francis Group Publications.
7. Sanjib Chattopadhyay (2008). Evolution, Adaptation and Ethology. Kolkatta: Books and Allied Pvt. Ltd.
8. Maynard Smith, J. (1999). Evolutionary Genetics. England: Oxford University Press.
9. Monroe W. Strickberger (2000). Evolution (3rd ed.). Sudbery, Massachusetts: Jones and Bartlett Publishers.
10. Mark Ridley (1996). Evolution. England: Blackwell Science Ltd.
11. Arora, M. P. (2000). Organic Evolution. Mumbai: Himalaya Publish House.
12. Tomar, B.S. & Singh, S.P. (2000). Evolutionary Biology. Meerut: Rastogi Publications.
13. Ahuja, N. (2008). Evolution and Population Genetics. New Delhi: Pearl Books.
14. Savage, J.M. (1969). Evolution. New Delhi: Amerind Publishing Co. Pvt. Ltd.

Semester II
Core VI - Research Methodology
Course Code: PZ1723

No. of hours/ week	No. of credits	Total number of hours	Marks
6	4	90	100

Objectives

1. To enable the students to understand the working principles of bioinstruments and methodologies used in biological investigations and report writing.
2. To create self employment opportunities using the knowledge acquired.

Course Outcomes

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	demonstrate a broad range of research methodologies and their relevance to specific research problems.	PSO - 1	U
CO - 2	operate instruments like microscope, centrifuge, ph meter and spectrometer and perform experiments on histology, chromatography and electrophoretic techniques.	PSO - 2	Ap
CO - 3	use scientific methods to develop hypotheses, design and execute experiments by selecting the appropriate research techniques.	PSO - 4	Ap; An
CO - 4	conceptualize research processes, data presentation, report writing and publication in journals.	PSO - 5	Ap

UNIT I Microscope: Principle – Instrumentation, Types– bright field, dark field, phase contrast, interference, fluorescence, polarization, confocal, electron microscopes – scanning tunneling microscope, atomic force microscope, near field scanning optical microscope, magnetic force microscope. Photography – light – film – camera types – photomicrography.

UNIT II Centrifugation: Principle - Factors affecting sedimentation rate – Types and applications of centrifuges. pH meter: principle – electrodes – applications. Cryotechniques – cryopreservation. Cytotechnique: Whole mounts. Microtome: Rotary and Freezing microtome. Microtomy: Fixation – Dehydration – Clearing - Embedding - Sectioning – staining – mounting.

UNIT III Chromatography: Principle, types – paper, thin layer, column, gas and liquid chromatography – High Performance Liquid Chromatography – Ion exchange – Affinity chromatography. Electrophoresis: Principles, types – Paper and gel – Polyacrylamide gel, agarose gel, Iso electric focusing – Immunoelectrophoresis. Protein sequencing methods.

UNIT IV Spectrophotometer: principle, design and applications. Spectroscopy: principle- design- types- Atomic Absorption Spectroscopy, flame photometer, chemiluminometer, Nuclear Magnetic Resonance spectroscopy, FTIR spectrometry - Electron Spin Resonance, Magnetic Resonance Imaging – applications. Radio activity counters.

UNIT V Experimental design and Report writing: Essential steps in research – Literature collection – Review of literature – Research and discriminative reading – Bibliography- Index card – Literature citation – Plagiarism - Alphabet number system – Research report - Tables – Figures – Formatting and typing – Online literature collection – open access journals - Impact factor and Copy Right - Laboratory safety.

Reference Books

1. Veerakumari, L. (2006). Bioinstrumentation. Chennai: MJP Publishers.
2. Gurumani. N. (2006). Research Methodology for Biological Sciences. Chennai: MJP Publishers.
3. Robert L. Dryer & Gene F. Lata (1989). Experimental Biochemistry. New York: Oxford University Press.
4. Rana, S.V.S. (2002). Biotechniques. Meerut: Rastogi Publications.
5. Keith Wilson & John Walker (2000). Principles and Techniques of Practical Biochemistry (5^{th} ed.). United Kingdom: Cambridge University Press.
6. Marimuthu, R. (2008). Microscopy and Microtechnique. Chennai: MJP Publishers.
7. Ramnik Sood (2006). Medical Laboratory Technology. New Delhi: Jaypee Brothers Medical Publishers Pvt. Ltd.

Semester II

Elective II – (a) Developmental Biology
Course Code: PZ1724

No. of hours/ week	No. of credits	Total number of hours	Marks
6	5	90	100

Objectives

1. To enable the students to gain knowledge on the process by which a single cell, the zygote, multiply, differentiate and develop into an adult.
2. To gain employment at fertility centers in hospitals, health centers and cryopreservation units.

Course Outcomes

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	discuss basic concepts and develop knowledge on major developmental processes.	PSO - 1	U
CO - 2	explain the development of different organ and organ systems.	PSO - 6	R
CO - 3	analyse the mechanisms regulating developmental processes.	PSO - 7	U; An
CO - 4	evaluate the different technologies adopted in assisted reproduction.	PSO - 9	An; E
CO - 5	apply the concepts in new areas of developmental biology.	PSO - 8	Ap

UNIT I Historical perspectives and theories of embryology. Male reproductive system of a mammal, spermatogenesis, structure and function of sperm, factors influencing spermatogenesis, semen and seminal fluid**.** Female reproductive system of a mammal, female gonad**,** Oogenesis, ovulation, Regulation of ovulation. Vitellogenesis, types of eggs.

UNIT II **Fertilization and molecular aspects:** Mechanism of fertilization, theories of fertilization and post fertilization changes. Cleavage: Laws of cleavage, planes – patterns – chemical changes during cleavage. Cleavage and blastulation in chick and mammal. Cell lineage, Fate map of chick and mammal. Gradient theory. Morphogenetic pattern and fields.

UNIT III **Morphogenetic movements**: Gastrulation in chick and mammal. Germinal layers and their derivatives in vertebrates. Neurogenesis, Notogenesis, Development of mesoderm and coelom. **Organogenesis in vertebrates:** Central nervous system, eye, skin and its derivatives, heart, kidney, limbs, alimentary canal and its derivatives.

UNIT IV **Development of reproductive organs in man**: development and differentiation of testis, development of male genital ducts and accessory glands. Development and differentiation of ovary, development of female genital ducts and accessory glands. Infertility – causes and treatment, Assisted Reproductive Technology (ART), Family planning. Development of extra

embryonic membranes. Placentation in mammals.

UNIT V Embryonic induction in vertebrates – types –exogenous and endogenous. Theories of organizer or inductor, competence. Differentiation - characteristics and types, selective action of genes in differentiation. Teratogenesis and teratogens. Metamorphosis in insects and amphibians. Neoteny. Regeneration – regenerative ability in animals and mechanism. Asexual reproduction, Parthenogenesis and types.

Reference books

1. Balinsky, B. I. (1981). An Introduction to Embryology (5th ed.). Philadelphia: Holt-Saunders.
2. Wolpert, L. (2010). Principles of Development **(**4th ed.). United Kingdom: Oxford University Press.
3. Ronald W. Dudek & James D. Fix (2005). Embryology **(**3rd ed.). Philadelphia, USA: Lippincott Williams and Wilkins Publication.
4. Twyman, R. M. (2004). Developmental Biology. New Delhi: BIOS Scientific Publishers.
5. Verma, P. S. & Agarwal, V. K. (2014). Chordate Embryology: Developmental Biology. New Delhi: S. Chand & Company Ltd.
6. Gayatri Prakash (2007). Reproductive Biology. United Kingdom: Alpha Science International Ltd.

Semester II
Elective II - (b) Bioinformatics

Course Code: PZ1725

No. of hours/week	No. of credits	Total number of hours	Marks
6	5	90	100

Objectives

1. To understand the application of computer technology, to study and process the biological data.
2. To develop skills to use bioinformatics tools.

Course Outcomes

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	describe the basics of bioinformatics.	PSO - 1	U
CO - 2	explain bioinformatics tools and data bases.	PSO - 2	R
CO - 3	gain knowledge on sequence alignment and alignment programs.	PSO - 2	U
CO - 4	identify the tools for drug discovery, docking and molecular phylogeny.	PSO - 2	An
CO - 5	use bioinformatics tools for molecular data analysis and submission.	PSO - 3	Ap; An

UNIT I Introduction to Bioinformatics. Basics of computer and Information Technology – parts of a computer, memory and operating system, Internet, search engines. Genomics – structural, comparative and functional. Proteomics – expression, structural and functional. Types of sequences used in Bioinformatics – DNA sequences, RNA sequences, Protein sequences. Applications of Bioinformatics.

UNIT II **Bioinformatics Databases**: Types of databases. Biological databases: nucleotide sequence databases - GenBank, DDBJ, EMBL, NCBI; Protein sequence databases – SWISS-PROT, Uniprot, TrEMBL; Structure databases – PDB, NDB, PubChem, ChemBank, CSD; Bibliographic databases- MEDLINE, PUBMED. Database programs –DBMS and RDBMS. Data retrieval systems – SRS, ENTREZ and DBGET.

UNIT III **Sequence Analysis**: Sequence alignment and alignment programs; Comparison of two sequences – Dot Matrix analysis; Scoring schemes – PAM Matrices and BLOSUM Matrices; Dynamic programing – Needleman-Wunch algorithm, Smith-Waterman algorithm, BLAST and FASTA; Multiple Sequence Alignment, ClustalW; Storing alignments.

UNIT IV **Drug Designing**: Drug discovery process – drug target identification, target validation, Lead compound identification, Lead optimization, Docking (importance, mechanics of docking, docking sites), Quantitative structure-activity relationship. Preclinical and clinical development. Medical informatics: Hospital management and information system, computer based patient records, computer assisted surgical techniques, searching and retrieval of medical literature.

UNIT V **Phylogenetic analysis**: Molecular phylogenetic analysis; methods of phylogenetic analysis - phenetic and cladistic; phylogenetic trees, methods for determining evolutionary trees – maximum parsimony, distance and maximum likelihood; phylogenetic software resources. Programming for bioinformatics: IT fundamentals, operating systems, programming concepts, HTML, web technologies, common gateway interface.

Reference Books

1. Gladis Helen Hepsyba, S. & Hemalatha, C.R. (2009). *Basic Bioinformatics.* Chennai: MJP Publishers.
2. John De Britto, A. (2011). *Bioinformatics.* Sivakasi; Anto Art Craft Printers.
3. Sundaralingam, R. & Kumaresan, V. (2008). *Bioinformatics.* Nagercoil: Saras Publication.
4. Jin Xiong (2006). *Essential Bioinformatics.* USA: Cambridge University Press.
5. Hooman H. Rashidi & Lukas K. Buehler (2000). *Bioinformatics Basics: Application in Biological Science and Medicine.* New York: CRC Press.
6. Mohan Bansal, A.S. (2003). *Medical informatics – A primer.* New Delhi: Tata McGraw- Hill Publishing Company Ltd.

Semester II

Practical II (Biostatistics, Computer applications and Bioinformatics, Genetics and Evolution & Research Methodology)

Course code: PZ17P2

No. of hours/week	No of credits	Total number of hours	Marks
6	5	90	100

Objectives

1. To design an experimental problem and valuate critically with inferential biostatistics and necessary computer skills.
2. To understand the mechanism of heredity, evolution and population genetics.

Course Outcomes

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	collect, analyze and interpret data using statistical methods.	PSO - 1	Ap; An
CO - 2	compute data using ms excel and identify data bases using bioinformatic tools.	PSO - 2	Ap; E
CO - 3	compute and calculate gene frequencies for solving genetic issues.	PSO - 2	Ap; E
CO - 4	analyze the evolutionary concepts through experiments.	PSO - 2	An
CO - 5	perform whole mounting of specimen, histotechniques and adopt separation procedures using chromatography.	PSO - 4	Ap

Biostatistics, Computer applications and Bioinformatics

1. Collection of data - insect population in the campus.
2. Graphical representation of collected data.
3. Diagrammatic representation of collected of data.
4. Measures of central tendency: mean, median and mode.
5. Measures of dispersion- Standard deviation and standard error.
6. Correlation co-efficient – height - weight relationship, length and width of molluscan shells.
7. Study of probability using coin tossing with 2 and 3 coins and chi square test
8. Regression Analysis.
9. Test of significance (student's t-test).
10. Preparation of graph using M.S. Excel.

Charts/ Models

NCBI, SWISS-PROT and PubMed

Genetics and Evolution

1. Demonstration of monohybrid and dihybrid cross using beads.
2. Identification of sex and mutant forms of Drosophila.
3. Calculation of gene frequencies using Hardy-Weinberg equilibrium - ABO blood group.
4. Demonstration of natural selection using beads.
5. Demonstration of genetic drift using beads.
6. Analysis of variation in finger print patterns.
7. Study of homologous organs (fore limbs and hind limbs of vertebrates).
8. Study of analogous organs (wings of animals).
9. Adaptive radiation - beaks in Birds.

Specimens / Charts / Models / Photographs

Karyotype of syndromes, Pedigree chart, Fossils **(**Ammonite, Trilobite, Nautiloid fossil), Living fossil (Limulus, Peripatus), Connecting link (Archaeopteryx), leaf insect, stick insect.

Research Methodology

1. Whole mount preparation of five specimens.
2. Separation of amino acids using thin layer chromatography.
3. Sectioning and staining of a tissue.
4. Separation of pigments by column chromatography using plant extract (Demonstration).
5. Gel electrophoresis (Demonstration).

Instruments/ Charts/ Models

Phase contrast microscope, fluorescent microscope, pH meter, centrifuge, spectrophotometer, flame photometer, microtome, Chromatography column, electrophoretic apparatus, Index card.

Semester III
Core VII - Physiology
Course Code: PZ1731

No. of hours/ week	No. of credits	Total number of hours	Marks
6	4	90	100

Objectives

1.To impart knowledge on the structure and functions of various organs, organsystems and also to know about the associated disorders.

2.To get job in diagnostic centers, research and academic institutions.

Course Outcomes

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	describe the anatomy of different physiological systems at the tissue and cellular levels.	PSO - 1	U
CO - 2	evaluate the physiological functioning of different organs.	PSO - 2	E
CO - 3	analyze the physiological changes in relation to environmental conditions.	PSO - 7	Ap; An
CO - 4	identify different tissues related to anatomy and physiology from an evidence-based perspective.	PSO - 9	U
CO - 5	carry out physiological studies in the laboratory, interpret data and graphs and write a report.	PSO - 9	Ap; An

UNIT I **Nutrition**: types of nutrition and feeding mechanisms in animals. Digestion - Functional anatomy of the digestive system (human), Movements of gastrointestinal tract, Secretory functions of the alimentary tract and glands, Digestion and absorption. Metabolism of protein, carbohydrate and lipid. Balanced diet – Malnutrition - Energy balance – BMR. Gastrointestinal disorders: Gall stones, liver cirrhosis, gastritis, peptic ulcer and appendicitis.

UNIT II **Respiration and Homeostasis**: Respiratory organs and respiratory pigment in animals, Physiological anatomy of the respiratory system (human), Transport of respiratory gases, Regulation of respiration, Respiratory problems - bronchial asthma, pneumonia and pulmonary tuberculosis. Homeostasis: Osmoregulation - types and mechanism. Thermoregulation – classification, thermoregulatory mechanism in animals, aestivation and hibernation, Deep sea physiology, High altitude and space physiology, Effects of exposure to cold and heat. Bioluminescence – physiology and functions.

UNIT III **Circulation**: Components and functions of blood, Blood clotting. Haemopoiesis. Myogenic and neurogenic heart. Functional anatomy of human heart, Cardiac cycle, pacemaker, heart rate, Bradycardia and tachycardia, Regulation of cardio- vascular system. Blood pressure, sphygmomanometer, Electrocardiogram (ECG), Heart diseases (Atherosclerosis, coronary thrombosis and angina pectoris). Lymphatic system - organization, composition of lymph and functions.

UNIT IV **Neuro-muscular system**: Structure of the brain and neuron, Neurotransmitters, Synapse, Nerve impulse conduction, Reflex activity, Inborn and conditioned reflex actions, Electroencephalogram. Neural disorders - Meningitis and epilepsy. Types of muscle, structure and properties of skeletal muscle, Mechanism of muscle contraction, Neuromuscular junction. Sense organs - Structure and functions of skin, eye and ear.

UNIT V **Excretion and Reproduction**: Excretory organs in different groups of animals, Patterns of excretion, Structure and function of kidney (human), Nephron, Formation of urine, Micturition, Renal disorders – nephritis, renal calculi, Dialysis. Structure of testis and ovary (human), oestrus and menstrual cycle, ovulation, pregnancy, parturition and lactation, hormonal regulation of reproduction.

Reference Books

1. Sembulingam, K. and Prema Sembulingam (2013). Essentials of Medical Physiology (6th ed.). Bangalore: Jaypee Brothers Medical Publishers Pvt. Ltd.
2. Guyton and Hall (2010). Textbook of Medical Physiology (12th ed.). Philadelphia: John E. Hall, Saunders Elsevier.
3. Elaine N. Marieb (2003). Human Anatomy and Physiology (6th ed.). San Francisco: Daryl Fox publisher.
4. Sawant, K.C. (2011). Human Physiology. New Delhi: Wisdom Press/ Dominant Publishers and Distributors Pvt Ltd.
5. Sarada Subrahmanyam and Madhavankutty, K. (2001). Text Book of Human Physiology (6th ed.). New Delhi: S. Chand and Company Ltd.
6. William. S. Hoar (1984). General and Comparative Animal Physiology (2th ed.). Prentice Hall of India.
7. Prosser, C. L. (1991). Comparative Animal Physiology (4th ed.). United States: John Wiley and Sons Ltd.
8. Nielsen Knut Schmid (2007). Animal Physiology, Adaptation and Environment (5th ed.). New Delhi: Cambridge University Press.
9. Nagabushnam, R., Kadarkar, M.S. and Sarojini, R. (2002). Textbook of Animal Physiology. New Delhi: Oxford and IBH Publishing Company.
10. Sobti, R.C. (2008). Animal Physiology. New Delhi: Narosa Publishing House Pvt. Ltd.
11. Rastogi, S.C. (2007). Essentials of Animal Physiology (6th ed.). New Delhi: JBA Publishers.

Semester III
Core VIII - Immunology
Course Code: PZ1732

No. of hours/ week	No. of credits	Total number of hours	Marks
6	4	90	100

Objectives

1. To facilitate the students to understand and appreciate the defense functions of the immune system.
2. To develop the skill to determine the imunomodulatory strategies used to enhance or suppress the immune response.

Course Outcomes

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	explain the importance of innate immune response in providing adaptive immunity.	PSO - 1	U
CO - 2	know the evolution of immune molecules in different groups of animals.	PSO - 1	U
CO - 3	differentiate the types of hypersensitive allergic reactions by seeing the symptoms and duration and suggest the remedies.	PSO - 2	R; An
CO - 4	discuss the role of immune molecules in different diseases and organ transplantation.	PSO - 6	Ap
CO - 5	demonstrate detailed knowledge and understanding of immunology and the way it is applied in diagnostic and therapeutic techniques and research.	PSO - 9	U; Ap

UNIT I **Immune system in invertebrates and vertebrates**: Immunity - Innate and acquired, II, III and IV line of defense. Types – natural and artificial - active and passive immunity; Lymphoid organs and cells involved in immune response. Antigens and Immunoglobulins – characteristics, haptens, types. Immune Response: Humoral and Cell mediated immune response - primary and secondary immune response, importance of B cells in humoral immune response (antibody formation), factors influencing antibody formation. Immunological memory (Anamnesis). Immunization: immunization schedule and vaccines.

UNIT II **Major and minor histocompatibility complex**: MHC class I and II molecules, cellular distribution and regulation of MHC expression, MHC in immune responsiveness, MHC and susceptibility to infectious diseases. Minor histocompatibility (H) antigens. Immune effector mechanisms: Cytokines and their functions, Complement system – classical and alternate pathways, biological functions.

UNIT III **B and T cell**: B cells - Maturation, activation and differentiation - B cell receptor (BCR) - B cell co-receptor complex - signal transduction from B cell antigen receptor, major pathways of BCR signaling. T cells - maturation, activation and differentiation, T cell receptor (TCR), T cell co-receptor complex - formation of T and B cell conjugates, Co-stimulation in T cell response and signal transduction. Clonal anergy. Antigen processing and presentation – role of antigen presenting cells – cytosolic pathway and endocytic pathway.

UNIT IV **Immune system in health and diseases**: Tumour immunology - properties of tumour cells, causes of tumours, tumour antigens, immune response to tumour, immune surveillance, immunodiagnosis of tumour antigens, immuno therapy of tumour. Hypersensitivity: factors causing hypersensitivity, Type I, II, III, and IV reactions. Immunodeficiency - primary and secondary. Autoimmune diseases - characteristics, causes, classification, localized (Diabetes mellitus, Addison's disease) and systemic (systemic lupus erythematosus, rheumatoid arthritis). Immune response to infectious diseases and treatment - Protozoan disease (Malaria), Bacterial disease (Tuberculosis), Viral disease (AIDS).

UNIT V **Antigen-antibody interaction**: strength, affinity, avidity and cross reactivity. Complement fixation test - precipitation reaction in fluids and precipitin curve. Radial immunodiffusion and double immunodiffusion. Immunoelectrophoresis – counter and rocket electrophoresis. Agglutination reaction - hemagglutination, bacterial agglutination, coated particle agglutination, agglutination inhibition. Radio immuno assay - ELISA – Western blotting - Immunofluorescence - Flow cytometry. Transplantation: classification of grafts, mechanism of graft rejection, graft versus host reaction, immuno suppressive therapy during transplantation.

Reference Books

1. Goldsby, R.A., Kindt, T.J. and Osborne, B.A. (2007). Kuby's Immunology (6th ed.). New York: W.H. Freeman and Company.
2. Delves, P., Martin, S., Burton, D., Roitt I.M. (2006). Roitt's Essential Immunology (11th ed.). Oxford: Wiley-Blackwell Scientific Publication.
3. Ashim, K., Chakravarthy (2007). Immunology and Immunotechnology (2th ed.). Delhi: Saurabh Printers Pvt. Ltd.
4. Dasgupta, A. (1992). Modern Immunology (2th ed.). New Delhi: Jaypee Brothers Medical Publications Pvt. Ltd.
5. Gupta, S.K. (1991). Immunology perspectives in Reproduction and Infection. New Delhi: Oxford and IBH publication Co. Pvt. Ltd.
6. Hannigan, B.M., Moore, C.B.T. and Quinn, D.G. (2010). Immunology (2th ed.). India: Viva Book Pvt. Ltd.
7. Rao, C.V. (2006). Immunology (2th ed.). Chennai: Narosa Publishing House.
8. Murphy, K., Travers, P. and Walport, M. Garland (2008). Janeway's Immunobiology (7th ed.). New York: Science Publishers.

Semester III
Elective III – (a) General Endocrinology
Course Code: PZ1733

No. of hours/week	No. of credits	Total number of hours	Marks
6	5	90	100

Objectives

1. To learn how the endocrine system functions under normal circumstances, as well as the pathologies that arise when homeostasis fails.
2. To get job in clinical laboratory and endocrine research institutes.

Course Outcomes

CO	Upon completion of this course the students will be able to :	PSO addressed	CL
CO - 1	discuss the principles of endocrine system, hormonal communication and neuroendocrine mechanism in animals.	PSO - 1	U
CO - 2	explain the secretion and transportation of hormones to maintain homeostasis.	PSO - 10	U
CO - 3	apply the knowledge of endocrinology to understand hormone-related disorders.	PSO - 8	Ap
CO - 4	explain women related physiological processes such as menstruation, gestation and lactation	PSO - 3	Ap
CO - 5	correlate endocrine regulation of reproduction and metamorphosis in various invertebrates and vertebrates.	PSO - 5	Ap; An

UNIT I **Introduction:** Historical perspective and scope of endocrinology. Endocrine

methodologies - assay of hormones, surgical methods, radioisotope Chemical messengers - studies, pharmacologicalmethods, and replacement therapy and animal models for research. neurocrine, paracrine, autocrine, endocrine, pheromones and chalones.

UNIT II Neurosecretion and Neuroendocrine mechanisms: Neuroendocrine integration-evolution of regulatory mechanisms and endocrine control of neural function. Neuroendocrine mechanisms and functions in insects, crustaceans and non-arthropod invertebrates. Analogous neurosecretory systems of invertebrates and vertebrates. **UNIT III Endocrine glands and hormones:** Organization of the endocrine system - classification of hormones - structure, functions and patho-physiology of hypothalamus, pituitary, thyroid, parathyroid, adrenal, pancreas, gonads. Gastro-intestinal hormones.

UNIT IV Hormone synthesis and mechanism of Hormone action: Biosynthesis, storage and release of amine (catecholamines and thyroxine), protein (growth hormone and insulin) and steroid hormones (sex hormones). Mechanism of hormone action - receptors (membrane and cytosolic) - second messengers, signal transduction, termination of hormone activity. Pathophysiological correlates of hormone action. Endocrine disorders due to receptor number and function. Hormonal therapy.

UNIT V Endocrine Integration: Diffuse effect of hormones - Hormonal regulation of growth, development and metabolism, reproductive cycle and pregnancy, parturition and lactation, migration (birds and fishes), behavior and hibernation, neoplastic growth, colour change in vertebrates.

Reference Books

1. Mac E. Hadley and Jonathan Levine (2009). Endocrinology. India: Pearson Education (Singapore) Pvt. Ltd.
2. Aubrey Gorbman and Howard A. Bern (1974). A textbook of Comparative Endocrinology. Bombay: John Wiley and Sons, Inc. Wiley Eastern Pvt. Ltd.
3. Barrington, E.J.W (1975). An Introduction to General and Comparative Endocrinology, 5th Ed. London: Oxford University Press.
4. Donnell Turner, C. and Joseph T. Bagnara, W.B. (1976). General Endocrinology (6th ed.). Philadelphia: Saunders Company.
5. James Griffin and Sergio R. Ojeda (1988). Textbook of Endocrine Physiology. London: Oxford University Press.
6. Prakash S. Lohar (2005). Endocrinology: Hormones and Human Health. Chennai: MJP Publishers.

Semester III
Elective III – (b) Health Care
Course Code: PZ1734

No. of hours/week	No. of credits	Total number of hours	Marks
6	5	90	100

Objectives

1. To make the students realize the importance of the health of the body, develop a healthy personality so as to live a healthy and successful life.
2. To acquire independent employable skills in voluntary organizations or in health sectors.

Course Outcomes

CO	Upon completion of this course the students will be able to :	PSO addressed	CL
CO - 1	realize quality life and factors that determine health.	PSO - 5	U
CO - 2	dentify personal health problems and its remedies.	PSO - 8	R
CO - 3	gain knowledge on motherhood and childcare.	PSO - 8	U; Ap
CO - 4	describe mental and environmental health hazards.	PSO - 5	Ap
CO - 5	discuss alternative medicines and apply safety and first aid measures.	PSO - 5	An; Ap

UNIT I **Concept of health and well-being**: Definition – Physical, mental, social and positive health – Quality of life. Determinants of health: Heredity – Environment – Lifestyle – Socio-economic conditions – Health services. Nutrition and Health: Nutrients that provide energy – Carbohydrates – Lipids – Proteins. Nutrients that regulate: Vitamins – Minerals – Water. Healthy diet – Food guide Pyramid – Snacking – Vegetarian diet – Fast food.

UNIT II **Personal Health Care**: Protecting skin – common skin problems – Dry Skin, Acne, Dermatitis, Psoriasis, skin infections – skin cancer - caring for the skin. Hair – General care, cleaning tips, preventing hair loss, Anti dandruff strategies. Teeth – Common dental problems – General care of teeth – Dental check up. Eye – Common eye problems – Eye diseases – General care of eyes – Vision check up. Ear – general care – do's and don’ts.

UNIT III **Maternal and Child Health**: Motherhood – pregnancy confirmation test – Prenatal care – Intra natal care – problems during pregnancy – Miscarriage and stillbirth – premature birth – labor and delivery - Family planning. Child health: Care of the newborn – Feeding – Nutritional guidelines - Care of the under-five (Toddler and Preschool).

UNIT IV **Environmental and Mental Health**: Mental health: Characteristics – Types: Schizophrenia – Manic depressive psychoses – Paranoia – Neurosis – Personality and character disorders. Environmental health: health in the home environment – pollution at home – diseases. Safety at home: Fall – Fires – Poisoning – Electrical hazards - Safety in road (Auto mobile – Pedestrian) - Disaster management (Severe weather condition – Flood- Lightning – Cyclone – Earthquake - Landslides- Tsunami).

UNIT V **Alternative medicine and First aid**: Naturopathy – Homeopathy- Ayurveda – Unani – Siddha. First aid: First aid procedures for dehydration – heart attack – fractures and dislocation, burns – bleeding – poisoning – electric shocks – drowning.

Reference Books

1. Park, K. (1995). Park's Textbook of preventive and social medicine. Jabalpur: M/S Banarsidas Bhanot Publishers.
2. Getchell, Pippin and Varnes (2006). Perspectives on Health. USA: D C Heath & Co.
3. Lakshmana Sarma and Swami Nathan. S. (1960). Speaking of nature cure – Regain, retain and improve health the drugless way. New Delhi: Sterling Publications Pvt. Ltd.
4. Tom Sanders and Peter (2004). Emery Molecular basis of human nutrition. London: Taylor and Francis Publishers.

Semester III

Practical III (Physiology and Immunology)

Course Code: PZ17P3

No. of hours/week	No of credits	Total number of hours	Marks
4	4	60	100

Objectives

1. To design experiments and apply it in physiological research.
2. To understand the various immune-techniques and apply in immunological experiments.

Course Outcomes

CO	Upon completion of this course the students will be able to :	PSO addressed	CL
CO - 1	gain knowledge on the functioning of organ and organ systems.	PSO - 1	U
CO - 2	demonstrate the effect of abiotic factors on the physiology of the systems through experiments.	PSO - 2	Ap; An
CO - 3	identify the immune cells in a blood smear.	PSO - 1	R
CO - 4	demonstrate immune-techniques on antigen-antibody interaction.	PSO - 10	Ap

Physiology

1. Effect of temperature on heartbeat of Freshwater Mussel and calculation of Q_{10}.
2. Effect of temperature on salivary amylase activity and calculation of Q_{10}.
3. Effect of pH on salivary amylase activity.
4. Salt loss and salt gain in a freshwater fish.
5. Examination of excretory products of fish, bird and mammals.
6. Survey of digestive enzymes in Cockroach.
7. Counting of blood cells using haemocytometer.
8. Haemolysis of blood – Demonstration.
9. Observation of haemin crystals in blood.
10. Estimation of haemoglobin (any method).

Charts/ Slides/ Models/ Bookplates/ Instruments: EEG, ECG, Conditional reflex, Skeletal muscle, Kymograph, Sphygmomanometer, Intestine, Nervous tissue, Liver, Lungs, Heart, Kidney.

Immunology

1. Dissection of Lymphoid organs of a vertebrate (Demonstration).
2. Histology of lymphoid organs (Chart / CD).
3. Identification of various types of immune cells in peripheral blood smear.
4. Separation and preparation of cellular antigen (RBC and bacteria).
5. Methods of immunization- Intravenous, intraperitoneal and subcutaneous routes.
6. Methods of blood collection and serum preparation.
7. Antigen antibody interaction: Blood typing and Haemagglutination.

8. ELISA test (Demonstration).
9. Radial immunodiffusion.
10. Double immunodiffusion.

Spotters

Immunoelectrophoretic apparatus, Semi dry blotting apparatus, Counter current immunoelectrophoresis (chart), Rocket immunoelectrophoresis (chart).

Semester III

PG - Self-Learning Course

Life Science for Competitive Examinations – I

Course Code: PZ17S1

No of credits	Marks
2	100

Objectives

1. To enable the students to gather information on various topics in biology.
2. To face competitive examinations like UGC – CSIR, NET and other similar examinations.

UNIT I

Molecules and their interaction relevant to Biology:

A. Structure of atoms, molecules and chemical bonds.

B. Composition, structure and function of biomolecules (carbohydrates, lipids, proteins, nucleic acids and vitamins).

C. Stabilizing interactions (Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction, etc.).

D. Principles of biophysical chemistry (pH, buffer, reaction kinetics, thermodynamics, colligative properties).

E. Bioenergetics, glycolysis, oxidative phosphorylation, coupled reaction, group transfer, biological energy transducers.

F. Principles of catalysis, enzymes and enzyme kinetics, enzyme regulation, mechanism of enzyme catalysis, isozymes.

G. Conformation of proteins (Ramachandran plot, secondary structure, domains, motif and folds).

H. Conformation of nucleic acids (helix (A, B, Z), t-RNA, micro-RNA).

I. Stability of proteins and nucleic acids.

J. Metabolism of carbohydrates, lipids, amino acids nucleotides and vitamins.

UNIT II

Cellular Organization:

A. Membrane structure and function (Structure of model membrane, lipid bilayer and membrane protein diffusion, osmosis, ion channels, active transport, membrane pumps, mechanism of sorting and regulation of intracellular transport, electrical properties of membranes).

B. Structural organization and function of intracellular organelles (Cell wall, nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, chloroplast, structure & function of cytoskeleton and its role in motility).

C. Organization of genes and chromosomes **(**Operon, unique and repetitive DNA, interrupted genes, gene families, structure of chromatin and chromosomes, heterochromatin, euchromatin, transposons).

D. Cell division and cell cycle (Mitosis and meiosis, their regulation, steps in cell cycle, regulation and control of cell cycle).

E. Microbial Physiology (Growth yield and characteristics, strategies of cell division, stress response)

Fundamental Processes:

A. DNA replication, repair and recombination (Unit of replication, enzymes involved, replication origin and replication fork, fidelity of replication, extrachromosomal replicons, DNA damage and repair mechanisms, homologous and site-specific recombination).

B. RNA synthesis and processing (transcription factors and machinery, formation of initiation complex, transcription activator and repressor, RNA polymerases, capping, elongation, and termination, RNA processing, RNA editing, splicing, and polyadenylation, structure and function of different types of RNA, RNA transport).

C. Protein synthesis and processing (Ribosome, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, genetic code, aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase, and translational proof-reading, translational inhibitors, Post- translational modification of proteins).

D. Control of gene expression at transcription and translation level (regulating the expression of phages, viruses, prokaryotic and eukaryotic genes, role of chromatin in gene expression and gene silencing).

UNIT III

Cell Communication and Cell Signaling:

A. Host parasite interaction Recognition and entry processes of different pathogens like bacteria, viruses into animal and plant host cells, alteration of host cell behavior by pathogens, virus-induced cell transformation, pathogen-induced diseases in animals and plants, cell-cell fusion in both normal and abnormal cells.

B. Cell signaling Hormones and their receptors, cell surface receptor, signaling through G-protein coupled receptors, signal transduction pathways, second messengers, regulation of signaling pathways, bacterial and plant two-component systems, light signaling in plants, bacterial chemotaxis and quorum sensing.

C. Cellular communication Regulation of hematopoiesis, general principles of cell communication, cell adhesion and roles of different adhesion molecules, gap junctions, extracellular matrix, integrins, neurotransmission and its regulation.

D. Cancer

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

F. Innate and adaptive immune system Cells and molecules involved in innate and adaptive immunity, antigens, antigenicity and immunogenicity. B and T cell epitopes, structure and

function of antibody molecules. generation of antibody diversity, monoclonal antibodies, antibody engineering, antigen-antibody interactions, MHC molecules, antigen processing and presentation, activation and differentiation of B and T cells, B and T cell receptors, humoral and cell-mediated immune responses, primary and secondary immune modulation, the complement system, Toll-like receptors, cell-mediated effector functions, inflammation, hypersensitivity and autoimmunity, immune response during bacterial (tuberculosis), parasitic (malaria) and viral (HIV) infections, congenital and acquired immunodeficiencies, vaccines.

UNIT IV

Developmental Biology:

A. Basic concepts of development: Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting; mutants and transgenics in analysis of development
B. Gametogenesis, fertilization and early development: Production of gametes, cell surface molecules in sperm-egg recognition in animals; embryo sac development and double fertilization in plants; zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals; embryogenesis, establishment of symmetry in plants; seed formation and germination.
C. Morphogenesis and organogenesis in animals : Cell aggregation and differentiation in Dictyostelium; axes and pattern formation in Drosophila, amphibia and chick; organogenesis – vulva formation in Caenorhabditis elegans, eye lens induction, limb development and regeneration in vertebrates; differentiation of neurons, post embryonic development- larval formation, metamorphosis; environmental regulation of normal development; sex determination.
D. Morphogenesis and organogenesis in plants: Organization of shoot and root apical meristem; shoot and root development; leaf development and phyllotaxy; transition to flowering, floral meristems and floral development in Arabidopsis and Antirrhinum.
E. Programmed cell death, aging and senescence.

UNIT V

System Physiology – Plant:

A. Photosynthesis - Light harvesting complexes; mechanisms of electron transport; photoprotective mechanisms; CO_2 fixation-C3, C4 and CAM pathways.
B. Respiration and photorespiration – Citric acid cycle; plant mitochondrial electron transport and ATP synthesis; alternate oxidase; photorespiratory pathway.
C. Nitrogen metabolism - Nitrate and ammonium assimilation; amino acid biosynthesis.
D. Plant hormones – Biosynthesis, storage, breakdown and transport; physiological effects and mechanisms of action.
E. Sensory photobiology - Structure, function and mechanisms of action of phytochromes, cryptochromes and phototropins; stomatal movement; photoperiodism and biological clocks.
F. Solute transport and photoassimilate translocation – uptake, transport and translocation of water, ions, solutes and macromolecules from soil, through cells, across membranes, through xylem and phloem; transpiration; mechanisms of loading and unloading of photoassimilates.
G. Secondary metabolites - Biosynthesis of terpenes, phenols and nitrogenous compounds and their roles.

H. Stress physiology – Responses of plants to biotic (pathogen and insects) and abiotic (water, temperature and salt) stresses.

System Physiology – Animal:

A. Blood and circulation - Blood corpuscles, haemopoiesis and formed elements, plasma function, blood volume, blood volume regulation, blood groups, haemoglobin, immunity, haemostasis.

B. Cardiovascular System: Comparative anatomy of heart structure, myogenic heart, specialized tissue, ECG – its principle and significance, cardiac cycle, heart as a pump, blood pressure, neural and chemical regulation of all above.

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

D. Nervous system - Neurons, action potential, gross neuroanatomy of the brain and spinal cord, central and peripheral nervous system, neural control of muscle tone and posture.

E. Sense organs - Vision, hearing and tactile response.

F. Excretory system - Comparative physiology of excretion, kidney, urine formation, urine concentration, waste elimination, micturition, regulation of water balance, blood volume, blood pressure, electrolyte balance, acid-base balance.

G. Thermoregulation - Comfort zone, body temperature – physical, chemical, neural regulation, acclimatization.

H. Stress and adaptation

I. Digestive system - Digestion, absorption, energy balance, BMR.

J. Endocrinology and reproduction - Endocrine glands, basic mechanism of hormone action, hormones and diseases; reproductive processes, gametogenesis, ovulation, neuroendocrine regulation

Reference Books

1. Vijay N. Waghmare (2004). Life sciences for NET/SLET exams of UGC-CSIR. Maharashtra: Mudra Publication.
2. Dr. A P Singh & Kumar Pushkar (2010). CSIR-UGC NET/JRF/SLET Life Sciences (Paper I & II). New Delhi: Upkar Publishers.
3. Arun Chaudhary, B. L., Chaudhary and Kailash Choudhary (2007). CSIR/NET Life Sciences. New Delhi: New Age Publishers.
4. Kumar Pranav Mina Usha (2011). CSIR-JRF-NET: Life Sciences Fundamentals and Practice (Part - I). New Delhi: Pathfinder Academy.
5. Ashish Nagesh, Quaisher J. Hossain, Prashant Kumar (2012). UGC-CSIR NET (JRF & LS) Life Science. Chennai: Arihant Publishers.
6. Rupendra Singh (2014). CSIR NET/JRF Life Sciences (4th ed.). Lucknow: Catalyst Center of Excellence Pvt. Ltd.
7. Pramod Singh (2014). Trueman's UGC CSIR-NET Life Sciences. New Delhi: Danika Publishing Company.
8. RPH (2014). CSIR-UGC NET Life Science (Popular Master Guide): Life Sciences, RPH Editorial Board.
9. Pranav Kumar (2013). MCQs Life Sciences – Biotechnology (3rd ed.). New Delhi: Pathfinder Academy.

Semester IV
Core IX - Microbiology
Course Code: PZ1741

No. of hours/ week	No. of credits	Total number of hours	Marks
6	4	90	100

Objectives

1. To know about the microbes in and around us and recognize their role in industrial production of valuable products, environmental management, biomining and also about the diseases caused by them.
2. To provide careers in industries, clinical laboratories, agricultural establishments, research institutes and Universities.

Course Outcomes

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	explain the structure, distribution, classification and life cycle of microorganisms.	PSO - 1	U
CO - 2	culture microbes by selecting appropriate culture media.	PSO - 2	R; Ap
CO - 3	explain the role of microbes in food industries and environmental cleaning.	PSO - 7	R
CO - 4	identify the microbial pathogen and preventive measures.	PSO - 9	Ap
CO - 5	develop microbiological laboratory skills applicable to clinical research.	PSO - 10	Ap

UNIT I **Introduction**: History and scope, classification of microorganisms, Whittaker's five kingdom classification, three domain classification. Virus - General properties, structure of viruses, viral taxonomy, bacteriophages, reproduction of DNA and RNA phages, temperate bacteriophages and lysogeny, cytocidal infections and cell damage, persistent, latent and slow virus infections. Cultivation of viruses and purification assays. Viruses and cancer. Viroids and prions.

UNIT II **Bacteria**: Classification, Bergey's system of bacterial classification, Bacterial morphology and fine structure of Escherichia coli. Bacterial nutrition - Common nutrient requirements, Nutritional classes, Uptake of nutrients. Bacterial growth and measurement of growth - Influence of environmental factors on growth, Synchronous growth, Continuous culture, Chemostat and turbidostat. Types of culture media - Pure culture and methods of isolating pure cultures (streak plate technique and pour-plate technique).

UNIT III **Industrial Microbiology**: Fermentation and microbes - fermenter and types of fermenters (air-lift fermenter and stirred tank fermenter). Production of microbial products - alcohol (ethanol), antibiotics (penicillin), vitamin B_2 and Vitamin B_{12}. Biofertilizers - steps for preparing bacterial biofertilizers, mass cultivation of Cyanobacteria and Azolla, production of

mycorrhizal fungi and VAM fungi. Bacterial insecticides – Pseudomonas species and Bacillus species. Food spoilage and food preservation.

UNIT IV Environmental Microbiology: Drinking water and microbiological analysis of water purity - Coliform test, Most Probable Number (MPN) test, and Membrane Filter (MF) test. Purification of water. Sewage treatment – small scale, large scale (primary, secondary and tertiary) treatment. Biogas production – solubilization, acetogenesis and methanogenesis. Microbial leaching – copper and uranium leaching. Biodegradation of petroleum and xenobiotics.

UNIT V Antimicrobial agents: classification, Drug administration, determination of antimicrobial activity, mechanism of antimicrobial agents, effectiveness of antimicrobial drugs, drug resistance, drug dosage, antibacterial drug (penicillin), antifungal drug (nystatin), antiviral drug (amantadine). Current problems of antibiotic resistance in man. Microbes and diseases - Gnotobiotic animals, distribution of normal micro biota of the human body, Mechanism of microbial pathogenesis, Nosocomial infections. Protozoan diseases - Malaria and Amoebiasis. Fungal diseases - Mycotoxicosis and Aspergillosis. Bacterial diseases - Air borne diseases – Meningitis and Streptococcal pneumonia. Food and water borne diseases - Cholera and Typhoid. Soil borne diseases - Tetanus and Anthrax. Sexually transmitted and contact diseases – Gonorrhea and Syphilis. Viral diseases - Ebola, Hepatitis-B, Rabies and AIDS.

Reference Books

1. Dubey R.C. and Maheswari, D.K. (2010). A textbook of Microbiology (3rd ed.). 3rd Ed. New Delhi: S. Chand and Co.
2. John L. Ingraham and Catherine A. (2004). Introduction to Microbiology. UK: Inhgraham Thomson Books / Cole.
3. Pelzar, Chan and Krieg (2006). Microbiology. New Delhi: Tata McGraw Hill Publishing Company Ltd.
4. Joanne Willey, Linda Sherwood, Chris Woolverton (2013). Prescott's Microbiology (9th ed.). New York: WCB McGraw Hill Co.
5. Vijaya Ramesh, K. (2004). Environmental Microbiology. Chennai: MJP Publishers.
6. Powar, C.B. and Daginawala, H.F. (2008). General Microbiology, Vol. 2. Chennai: Himalaya Publishing House.
7. Singh, R.P. (2007). General Microbiology. New Delhi: Kalyani Publishers.

Semester IV

Core X - Ecobiology

Course Code: PZ1742

No. of hours/ week	No. of credits	Total number of hours	Marks
6	4	90	100

3. Objectiv

es

1. To provide the opportunity for students to develop a deep understanding of various aspects of the environment and apply that knowledge to current environmental issues and for wise environmental management.
2. To work productively with those within and beyond the academy on interdisciplinary

Course Outcomes

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	explain the interaction of organisms with the physical and biological environment.	PSO - 1	U
CO - 2	compare the differences in the structure and function of different types of ecosystems.	PSO - 1	U
CO - 3	assess the human population increase with respect to anthropological activities and environmental impact.	PSO - 2	E; An
CO - 4	formulate hypotheses and test them by designing appropriate experiments, analyze, interpret data and report	PSO - 3	C; An; E
CO - 5	use scientific knowledge of ecology to evaluate contemporary social and environmental issues.	PSO - 5	Ap; E
CO - 6	participate in environmental protection and conservation.	PSO - 3	Ap

UNIT I **Introduction**: Scope of Ecobiology and need for public awareness. **Ecosystem**: Concepts of ecosystem – structure and functions. Energy flows – single channel energy model, Y - shaped energy flow models. Productivity - Primary production, secondary production, measurement of primary productivity. **Habitat ecology**: freshwater, marine, estuarine, mangrove and terrestrial.

UNIT II **Population**: Structure and regulation, growth form, population fluctuations, population processes. Life table - diagrammatic and conventional life tables, Life history strategies. **Community**: Concept, basic terms, community structure, composition and stratification. Ecological niche, Ecotone and Edge effect, Ecotype. **Ecological succession**: types, general process, Concept of climax.

UNIT III **Environment in action**: Climatic factors (climate, precipitation, temperature, light, oxygen, carbon dioxide and pH), topographic factors, edaphic factors (soil formation, soil profile, soil organisms), biotic factors (symbiosis, commensalism, parasitism and competition). **Biological cloc**k: biological rhythms and mechanism of biological clock. **Natural resource ecology**: Concept and classification of resource, mineral resource, land resource, forest resource, water resource, energy resource (conventional and non-conventional).

UNIT IV **Biogeochemical cycles**: water cycle, carbon cycle, nitrogen cycle, sulphur cycle and phosphorous cycle. **Biogeography**: patterns of distribution (continuous, discontinuous, endemic), descriptive zoogeography, zoogeographical regions of the world. Dynamic biogeography (dispersal dynamics, dispersal pathways, migration, ecesis). **Natural Disasters**: Floods, earthquakes, cyclones, landslides, Tsunami, Mitigation and Disaster Management. **Urbanization**: Possible advantages of urbanization – problems, solutions. Remote sensing and its applications.

UNIT V **Pollution ecology**: Causes, effects and control measures of air pollution, water pollution, soil pollution, noise pollution, thermal pollution, nuclear hazards. Green House Gas emission and climate change. **Waste management**: solid, liquid and gaseous wastes. e-wastes. **Toxicology**: Biomagnification and bioaccumulation, toxicants, classification, toxicity (LC_{50} and LD_{50}), mode of action.

Reference Books

1. Eugene P. Odum, Murray Barrick, Gary W. Barret (2005). Fundamentals of Ecology (5th ed.). UK: Brooks/Cole Publishers.
2. Begon and Mortimer (1992). Population Ecology. Delhi: UBS Publishers.
3. Kormondy, Edward, J. (1994). Concept of Ecology. Delhi: Prentice Hall of India Pvt. Ltd.
4. Sharma, P.D. (1999). Ecology and Environment. Meerut: Rastogi Publications.
5. Dash, M.L. (1996). Fundamentals of Ecology. New Delhi: Tata McGraw Hill Publishing Company Ltd.
6. Trivedi, P.C. and Sharma, K.C. (2003). Biodiversity Conservation. Jaipur: Avishekar Publishers.
7. Trivedi, R.N. (1993). Textbook of Environmental Sciences. New Delhi: Anmol Publications Pvt. Ltd.
8. Shukla, S.K. and Srivastava, P.R. (1992). Water Pollution and Toxicology. New Delhi: Common-Wealth Publishers.
9. Subramanian, M.A. (2004). Toxicology: Principles and methods. Chennai: MJP Publishers.
10. Verma, P.S. and Agarwal V. K. (1986). Principles of Ecology. New Delhi: S. Chand & Co. Pvt. Ltd.

Semester IV

Core XI - Biotechnology and Nanobiology

Course Code: PZ1743

No. of Hours/ week	No. of Credits	Total Number of Hours	Marks
6	4	90	100

Objectives

1. To enable the students to understand the essence of biotechnology and become aware of the advances in Nanobiology.
2. To develop skill of technical proficiency in genetic manipulation to try to improve agricultural production, pharmaceutical products, medical treatment, or mitigation of environmental pollution.

Course Outcomes

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	explain the basic concepts of gene cloning and the importance of dna sequencing in biotechnological intervention.	PSO - 1	U
CO - 2	demonstrate cell culture techniques and prepare protocol to perform experiments.	PSO - 2	U; Ap
CO - 3	identify the progression of biotechnology in different areas like medicine, agriculture, environmental sustainability and forensics.	PSO - 2	R
CO - 4	apply the knowledge of genetically modified organism in bioremediation.	PSO - 4	Ap; An; C
CO - 5	outline the basic concepts of nanotechnology, its applications and threat to the environment.	PSO - 9	U
CO - 6	communicate the concepts of biotechnology and develop research skills.	PSO - 4	Ap

UNIT I **Gene cloning**: Basic steps of gene cloning, restriction and modifying enzymes, linkers and adaptors, cloning and expression vectors, construction of chimeric DNA, nucleic acid probes, DNA libraries, polymerase chain reaction, molecular markers, DNA sequencing, synthesis of oligonucleotides. Human Genome Project.

UNIT II **Animal Biotechnology**: Primary culture and cell lines, pleuripotent stem cell lines, tissue engineering. In vitro fertilization and embryo transfer in animals; gene transfer methods. Primary explantation techniques – organ and embryo culture – transgenic animals and the knockouts. Biotechnology and aquaculture - ploidy induction, gynogenesis and androgenesis.

UNIT III **Medical Biotechnology**: Hybridoma technology and Monoclonal antibodies – Applications of biotechnology in medicine, Vaccines, diagnostics and forensics. Gene therapy – Pharmacogenomics. **Enzyme biotechnology**: Isolation and purification of enzymes, uses of enzymes in industries, immobilization of enzymes and their uses, Biosensors. Terminator and traitor technology. Intellectual Property Rights.

UNIT IV **Industrial and Environmental Biotechnology**: Production of metabolites - Downstream processing and in situ recovery of products, microbial biotransformation, microbial biomass production (SCP). Bioremediation and phytoremediation - Genetically engineered microorganisms (GEMs) - treating oil spills, detection of pesticide in soil and their degradation, sequestering heavy metals. Biomining and Biofuels.

Unit V **Nanomaterials**: Types and properties, DNA and protein nanoarrays, biosystems (microbes) as nanofactories. Application of nanotechnology - medical diagnostics, imaging and drug delivery, agro-practices and food related nanoproducts, cosmetics, contact lenses and dental implants. Nanotechnological approaches for environmental remediation, prevention of contamination, environment maintenance and quality enhancement. Risks and threats of nanoparticles in environment.

Reference Books

1. Gupta P.K. (2009). Elements of Biotechnology. Meerut: Rastogi Publications.
2. Singh B.D. (2003). Biotechnology - Expanding Horizons. Chennai: Kalyani Publishers.
3. Satyanarayana V. (2004). Biotechnology. Kolkata: Books and Allied (P) Ltd.
4. Dubey R.C. (2006). A Text Book of Biotechnology (4^{th} ed.). New Delhi: S. Chand and Co. Ltd.,
5. Rema L.P. (2006). Applied Biotechnology. Chennai: MJP publishers.
6. Prakash S. Lohar, (2012). Biotechnology. Chennai: MJP publishers.
7. Madhuri Sharon, Maheshwar Sharon, Sunil Pandey and Goldie Oza (2012). Bio-Nanotechnology: Concepts and Applications. New Delhi: Ane Books Pvt. Ltd.
8. Vinod Labhasetwar and Diandra. L. Leslie-Pelecky (2007). Biomedical applications of Nanotechnology. New Jersey: Wiley Publications.
9. Jo Anne Shatkins (2008). Nanotechnology: Health and Environmental Risks. New York: CRC Press.
10. Y.S. Raghavan (2010). Nanostructures and Nanomaterials: Synthesis properties and applications. New Delhi: Arise Publishers and distributors.
11. Parthasarathy, B.K. (2007). Nanotechnology in Life Science. New Delhi: Isha Books.
12. Rakesh K. Yadav (2009). Investing in Nanotechnology. New Delhi: Mangalam Publications.

Semester IV
Elective IV – (a) Parasitology
Course Code: PZ1744

No. of Hours/ week	No. of Credits	Total Number of Hours	Marks
6	5	90	100

Objectives

1. To enable the students to be aware of the cosmopolitan distribution of parasites and vectors and their control measures.
2. To obtain job in clinical laboratories and health departments.

Course Outcomes

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	explain the basic biology and lifecycle of parasites including epidemiology, diagnosis and treatment.	PSO - 1	U
CO - 2	recognize morphological characteristics for identification of parasites and their developmental stages.	PSO - 2	R
CO - 3	identify appropriate techniques and develop basic skills for detection of parasites.	PSO - 3	U; R
CO - 4	critically analyze, interpret and discuss factual information on parasites.	PSO - 2	Ap; An
CO - 5	analyze the medical and public health aspects of human parasitic infections.	PSO - 5	An
CO - 6	seek employment in veterinary hospitals, clinical and research laboratories.	PSO - 3	Ap

UNIT I **Introduction**: Historical perspectives - taxonomy and classification of parasites – origin and evolution of parasitism - host parasite relationship, classification of parasites and hosts– transmission of parasites – Parasitic zoonoses – pathogenesis - clinical manifestations of parasitic diseases.

UNIT II **Protozoan parasites**: Introduction and classification. Intestinal Amoeba - Pathogenic free living amoeba – Intestinal flagellates – Trypanosomiasis, Leishmaniasis, Balantoidiasis, Malaria, Isosporiasis, Toxoplasmosis, Cryptosporidiosis, Pneumocytosis. Protozoans of minor medical importance.

UNIT III **Helminth parasites**: Trichiuriasis, Trichinellosis, Strongyloidiosis, Ascariasis, Enterobiosis, Filariasis, hook worm diseases, Dracunculiasis, Onchocerciasis, Loiosis – Larva migrants. Nematodes of lesser medical importance - Diphyllobothriasis, Taeniasis, Echinococcosis, Sparganosis, Schistosomiasis, Fascioliosis, Fasciolopsiasis, Paragonimiasis, Clonorchiasis, Trematodes of minor medical importance.

UNIT IV **Parasitic Insects**: Prevalence, transmission and control of parasitic infections. Parasitic infection in compromised host. Applied Parasitology: Eosinophilia in parasitic infections, Nosocomial parasitic infections. Evasion and parasitic mode of life –

morphological, biochemical and ethological adaptations. Quality assurance and laboratory safety.

UNIT V Diagnostic methods in parasitology: Microscopical examination of blood, stool, urine, sputum and biopsy material for parasites – general rules for microscopical examination. Cultural examination - preparation of media – techniques for cultivation of E. histolytica, Leishmania, Plasmodium. Immunodiagnostic methods – ELISA, AGD, IHA, IFAT, CFT, DAT, IB, WB, BF, DFAT. Molecular characterization of stage specific antigen nucleotide probes for diagnosis of protozoan diseases.

Reference Books

1. Cheng, C.T. (1964). The Biology of Animal Parasites. Tokyo: Toppan Company Ltd.
2. Chatterjee, K.D. (1981). Parasitology. Calcutta: Chatterjee Medical Publishers.
3. Rajesh Karyakarte and Ajit Damle (2008). Medical Parasitology (2nd ed.). Kolkata: Books and Allied (P) Ltd.
4. Ichhpujani R.L. and Rajesh Bhatia (2002). Medical Parasitology. New Delhi: Jaypee printers.
5. Patvaik, B.D. (2001). Parasitic Insects. Delhi: Dominant Publishers and Distributors.
6. Jones, A.W. (1976). Introduction to Parasitology. Boston, USA: Addison-Wesley Publishing Company.
7. Subah, C.P. (2001). Textbook of Medical Parasitology. Chennai: All India publishers and Distributors.

Semester IV

Elective IV – (b) Medical Entomology

Course Code: PZ1745

No. of hours/week	No. of credits	Total number of hours	Marks
6	5	90	100

Objectives

1. To identify medically important arthropods by their general morphology and important characteristics, to describe their biology, ecology and geographical distribution, their roles in transmission of diseases and nuisance to public health and to describe and apply control methods for arthropod vectors.
2. To propose effective control measures to eradicate vector borne diseases and seek employment opportunities in health centers.

Course Outcomes

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	identify the medically important arthropods by their general morphology and important characteristics.	PSO - 1	R ; U
CO - 2	describe the biology, ecology and geographical distribution of medically important pests and their role in transmission of diseases.	PSO - 2	U
CO - 3	outline the biology of tropical parasites and vectors and the	PSO - 2	Ap

	relationship between parasites and their hosts.		
CO - 4	assess the immunological approaches in the control of parasitic infections.	PSO- 2	E
CO - 5	enumerate strategies for prevention and care of vector borne disease.	PSO - 1	Ap; E

UNIT I **Introduction**: Fundamentals and scope of medical entomology - insects of medical importance: filth breeding insects, venomous insects, parasites of vertebrates, blood sucking insects, insects affecting physiology.

UNIT II **Life cycle of human parasitic insects**: Lice, fleas, mosquitoes, house flies and tsetse fly. Immunity to human parasites - host-parasitic relationships - ecological adaptive features among human parasitic insects.

UNIT III **Vector entomology**: Scope - vector borne diseases - mechanism of transmission in human beings - mechanical, biological and myiasis - common vector insects and their identification: mosquitoes, sand flies, black flies, house fly, tsetse fly, human flea and human louse. Hard and soft tick, trombiculid mite, itch mite and Cyclops.

UNIT IV **Medical importance and management**: Lice - body, head and pubic louse; fleas - flea nuisance, plague, flea-borne endemic typhus; mosquitoes - nuisance, malaria, filariasis, yellow fever, dengue; house flies - common and greater house fly - typhoid, dysentery, diarrhea, cholera, amoebiasis, gastroenteritis; tsetse fly - Gambian and Rhodesian sleeping sickness.

UNIT V **Vector control**: Insecticides - use and consequences. Use of bio-control agents and bio-pesticides - bacillus and predatory fishes. National programmes related to vector borne diseases - malaria - N.M.E.P., N.M.C.P – filarial - N.F.C.P. - N.F.E.P.

Reference Books

1. Bruce F. Eldridge and John D. Edman (2004). Medical Entomology - A textbook of public health and veterinary probes caused by Arthropods. Netherlands: Kluwer Academic Publishers.
2. Lance A. Durden (2002). Medical and Veterinary Entomology (3rd ed.). Cambridge: Academic Press.
3. Service, M.W. (2004). Medical Entomology for Students (3rd ed.). United Kingdom: Cambridge University Press.
4. Walter Scott Patton and Francis William Cragg (2008). A textbook of Medical Entomology. Montana, USA: Kessinger Publishing Pvt. Ltd.

Semester IV
Practical IV (Microbiology, Ecobiology & Biotechnology and Nanobiology)
Course Code: PZ17P4

No. of hours/week	No of credits	Total number of hours	Marks
6	5	90	100

Objectives

1. To acquire and demonstrate competency in laboratory safety and in routine microbiological and biotechnological techniques.
2. To recognize and apply methodological approaches of Ecobiology.

Course Outcomes

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	isolate, culture, stain and identify bacteria and perform antibiotic sensitivity test.	PSO - 1	Ap
CO - 2	estimate the physico-chemical parameters of water samples.	PSO - 2	An; E
CO - 3	identify the producers and consumers of a pond ecosystem and measure the primary productivity.	PSO - 1	R; Ap
CO - 4	extract and quantify genomic dna.	PSO - 1	Ap
CO - 5	prepare commercial products by using biotechnological methods.	PSO - 9	C

Microbiology

1. Sterilization of glassware.
2. Preparation of culture media.
3. Isolation of bacteria from soil, air and water.
4. Serial dilution – pure culture of soil bacteria.
5. Observation of bacterial motility - hanging drop method.
6. Simple staining of bacteria.
7. Gram's staining of bacteria.
8. Negative staining of bacteria.
9. Methylene blue reductase test for testing the quality of milk.
10. Test for antibiotic sensitivity.

Slides/ Charts/ Models:

Streptococcus, Salmonella, Corynebacterium, Clostridium, Influenza virus, Rabies virus, Hepatitis-B, HIV, Entamoeba, Aspergillus, root nodules (Rhizobium), Azolla, Ocular and stage micrometer, Autoclave, Laminar air flow.

Ecobiology

1. Measurement of primary productivity (O_2 measurement method).
2. Sampling of animal population using the quadrat method.
3. Observation of life table in an insect.
4. Collection and identification of freshwater planktons.
5. Measurement of turbidity using Secchi disc.
6. Determination of LC_{50} of a pesticide.
7. Estimation of H_2S in water sample.
8. Estimation of salinity in water sample.
9. Estimation of CO_2 in water sample.
10. Study report of a pond ecosystem.

Specimen/ Chart/ Models

Commensalisms (Shark and Echeneis), Mutualism (Sea anemone and Hermit crab), Food chain, Food web, Conventional energy source (coal) and non-conventional energy source (wind mill).

Biotechnology and Nanobiology

1. Extraction of genomic DNA.
2. Estimation of DNA (DPA method).
3. Agarose gel electrophoresis in separation of DNA (démonstration only).
4. Polymerase chain reaction (démonstration only).
5. Bacterial culture and antibiotic sélection media.
6. Immobilization of yeast cells.
7. Préparation of wine.Estimation of éthanol content in wine.
8. Production of amylase by bacteria.

Flow charts/ Instruments/ Figures

Plasmid DNA isolation, Insulin production by rDNA Technology, Hybridoma production, Synthesis of DNA nanoarray, Southern blotting, Biosensor (glucometer), Air-lift bioreactor, Bucky balls, Dendrimers.

Semester IV
PG - Self-Learning Course
Life Science for Competitive Examinations – II
Course Code: PZ17S2

No of credits	Marks
2	100

Objectives

1. To enable the students to gather information on various topics in biology.
2. To face competitive examinations like UGC – CSIR, NET and other similar examinations.

UNIT I Inheritance Biology:

A. Mendelian principles: Dominance, segregation, independent assortment.
B. Concept of gene : Allele, multiple alleles, pseudoallele, complementation tests
C. Extensions of Mendelian principles: Codominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, penetrance and expressivity, phenocopy, linkage and crossing over, sex linkage, sex limited and sex influenced characters.
D. Gene mapping methods: Linkage maps, tetrad analysis, mapping with molecular markers, mapping by using somatic cell hybrids, development of mapping population in plants.
E. Extra chromosomal inheritance: Inheritance of Mitochondrial and chloroplast genes, maternal inheritance.
F. Microbial genetics: Methods of genetic transfers – transformation, conjugation, transduction and sex-duction, mapping genes by interrupted mating, fine structure analysis of genes.

G. Human genetics: Pedigree analysis, Lod score for linkage testing, karyotypes, genetic disorders.
H. Quantitative genetics: Polygenic inheritance, heritability and its measurements, QTL mapping.
I. Mutation: Types, causes and detection, mutant types – lethal, conditional, biochemical, loss of function, gain of function, germinal verses somatic mutants, insertional mutagenesis.
J. Structural and numerical alterations of chromosomes: Deletion, duplication, inversion, translocation, ploidy and their genetic implications.
K. Recombination: Homologous and non-homologous recombination including transposition.

UNIT II Diversity of Life forms:

A. Principles & methods of taxonomy:
Concepts of species and hierarchical taxa, biological nomenclature, classical & quantitative methods of taxonomy of plants, animals and microorganisms.
B. Levels of structural organization:
Unicellular, colonial and multicellular forms. Levels of organization of tissues, organs & systems. Comparative anatomy, adaptive radiation, adaptive modifications.
C. Outline classification of plants, animals & microorganisms:
Important criteria used for classification in each taxon. Classification of plants, animals and microorganisms. Evolutionary relationships among taxa.
D. Natural history of Indian subcontinent:
Major habitat types of the subcontinent, geographic origins and migrations of species. Common Indian mammals, birds. Seasonality and phenology of the subcontinent.
E. Organisms of health & agricultural importance:
Common parasites and pathogens of humans, domestic animals and crops.
F. Organisms of conservation concern:
Rare, endangered species. Conservation strategies.

UNIT III Ecological Principles:

A. The Environment: Physical environment; biotic environment; biotic and abiotic interactions.
B. Habitat and Niche: Concept of habitat and niche; niche width and overlap; fundamental and realized niche; resource partitioning; character displacement.
C. Population Ecology: Characteristics of a population; population growth curves; population regulation; life history strategies (*r* and *K* selection); concept of metapopulation – demes and dispersal, interdemic extinctions, age structured populations.
D. Species Interactions: Types of interactions, interspecific competition, herbivory, carnivory, pollination, symbiosis.
E. Community Ecology: Nature of communities; community structure and attributes; levels of species diversity and its measurement; edges and ecotones.

F. Ecological Succession: Types; mechanisms; changes involved in succession; concept of climax.

G. Ecosystem Ecology: Ecosystem structure; ecosystem function; energy flow and mineral cycling (C,N,P); primary production and decomposition; structure and function of some Indian ecosystems: terrestrial (forest, grassland) and aquatic (fresh water, marine, estuarine).

H. Biogeography: Major terrestrial biomes; theory of island biogeography; biogeographical zones of India.

I. Applied Ecology: Environmental pollution; global environmental change; biodiversity: status, monitoring and documentation; major drivers of biodiversity change; biodiversity management approaches.

J. Conservation Biology: Principles of conservation, major approaches to management, Indian case studies on conservation/management strategy (Project Tiger, Biosphere reserves).

UNIT IV Evolution and Behaviour:

A. Emergence of evolutionary thoughts

Lamarck; Darwin–concepts of variation, adaptation, struggle, fitness and natural selection; Mendelism; Spontaneity of mutations; The evolutionary synthesis.

B. Origin of cells and unicellular evolution:

Origin of basic biological molecules; Abiotic synthesis of organic monomers and polymers; Concept of Oparin and Haldane; Experiment of Miller (1953); The first cell; Evolution of prokaryotes; Origin of eukaryotic cells; Evolution of unicellular eukaryotes; Anaerobic metabolism, photosynthesis and aerobic metabolism.

C. Paleontology and Evolutionary History:

The evolutionary time scale; Eras, periods and epoch; Major events in the evolutionary time scale; Origins of unicellular and multi cellular organisms; Major groups of plants and animals; Stages in primate evolution including Homo.

D. Molecular Evolution:

Concepts of neutral evolution, molecular divergence and molecular clocks; Molecular tools in phylogeny, classification and identification; Protein and nucleotide sequence analysis; origin of new genes and proteins; Gene duplication and divergence.

E. The Mechanisms:

Population genetics – Populations, Gene pool, Gene frequency; Hardy-Weinberg Law; concepts and rate of change in gene frequency through natural selection, migration and random genetic drift; Adaptive radiation; Isolating mechanisms; Speciation; Allopatricity and Sympatricity; Convergent evolution; Sexual selection; Co-evolution.

F. Brain, Behavior and Evolution:

Approaches and methods in study of behavior; Proximate and ultimate causation; Altruism and evolution-Group selection, Kin selection, Reciprocal altruism; Neural basis of learning, memory, cognition, sleep and arousal; Biological clocks; Development of behavior; Social communication; Social dominance; Use of space and territoriality; Mating systems, Parental investment and Reproductive success;

Parental care; Aggressive behavior; Habitat selection and optimality in foraging; Migration, orientation and navigation; Domestication and behavioral changes.

Applied Biology:

A. Microbial fermentation and production of small and macro molecules.

B. Application of immunological principles, vaccines, diagnostics. Tissue and cell culture methods for plants and animals.

C. Transgenic animals and plants, molecular approaches to diagnosis and strain identification.

D. Genomics and its application to health and agriculture, including gene therapy.

E. Bioresource and uses of biodiversity.

F. Breeding in plants and animals, including marker – assisted selection

G. Bioremediation and phytoremediation

H. Biosensors

UNIT V Methods in Biology:

A. Molecular Biology and Recombinant DNA methods:

a) Isolation and purification of RNA, DNA (genomic and plasmid) and proteins, different separation methods.

b) Analysis of RNA, DNA and proteins by one and two dimensional gel electrophoresis, Isoelectric focusing gels.

c) Molecular cloning of DNA or RNA fragments in bacterial and eukaryotic systems.

d) Expression of recombinant proteins using bacterial, animal and plant vectors.

e) Isolation of specific nucleic acid sequences

f) Generation of genomic and cDNA libraries in plasmid, phage, cosmid, BAC and YAC vectors.

g) In vitro mutagenesis and deletion techniques, genes knock out in bacterial and eukaryotic organisms.

h) Protein sequencing methods, detection of post translation modification of proteins.

i) DNA sequencing methods, strategies for genome sequencing.

j) Methods for analysis of gene expression at RNA and protein level, large scale expression, such as micro array based techniques

k) Isolation, separation and analysis of carbohydrate and lipid molecules

l) RFLP, RAPD and AFLP techniques

B. Histochemical and Immunotechniques:

Antibody generation, Detection of molecules using ELISA, RIA, western blot, immunoprecipitation, flowcytometry and immunofluorescence microscopy, detection of molecules in living cells, in situ localization by techniques such as FISH and GISH.

C. Biophysical Method:

Molecular analysis using UV/visible, fluorescence, circular dichroism, NMR and ESR spectroscopy Molecular structure determination using X-ray diffraction and NMR, Molecular analysis using light scattering, different types of mass spectrometry and surface plasma resonance methods.

D. Statisitcal Methods:

Measures of central tendency and dispersal; probability distributions (Binomial, Poisson and normal); Sampling distribution; Difference between parametric and non-parametric statistics; Confidence Interval; Errors; Levels of significance; Regression and Correlation; t-test; Analysis of variance; X2 test;; Basic introduction to Muetrovariate statistics, etc.

E. Radiolabeling techniques:

Detection and measurement of different types of radioisotopes normally used in biology, incorporation of radioisotopes in biological tissues and cells, molecular imaging of radioactive material, safety guidelines.

F. Microscopic techniques:

Visualization of cells and subcellular components by light microscopy, resolving powers of different microscopes, microscopy of living cells, scanning and transmission microscopes, different fixation and staining techniques for EM, freeze-etch and freeze- fracture methods for EM, image processing methods in microscopy.

G. Electrophysiological methods:

Single neuron recording, patch-clamp recording, ECG, Brain activity recording, lesion and stimulation of brain, pharmacological testing, PET, MRI, fMRI, CAT.

H. Methods in field biology:

Methods of estimating population density of animals and plants, ranging patterns through direct, indirect and remote observations, sampling methods in the study of behavior, habitat characterization: ground and remote sensing methods.

Reference Books

1. Vijay N. Waghmare (2004). *Life sciences for NET/SLET exams of UGC-CSIR.* Maharashtra: Mudra Publication.
2. Dr. A P Singh & Kumar Pushkar (2010). *CSIR-UGC NET/JRF/SLET Life Sciences (Paper I & II).* New Delhi: Upkar Publishers.
3. Arun Chaudhary, B. L., Chaudhary and Kailash Choudhary (2007). *CSIR/NET Life Sciences*. New Delhi: New Age Publishers.
4. Kumar Pranav Mina Usha (2011). *CSIR-JRF-NET: Life Sciences Fundamentals and Practice (Part - I).* New Delhi: Pathfinder Academy.
5. Ashish Nagesh, Quaisher J. Hossain, Prashant Kumar (2012). *UGC-CSIR NET (JRF & LS) Life Science*. Chennai: Arihant Publishers.
6. Rupendra Singh (2014). *CSIR NET/JRF Life Sciences* (4th ed.). Lucknow: Catalyst Center of Excellence Pvt. Ltd.
7. Pramod Singh (2014). *Trueman's UGC CSIR-NET Life Sciences.* New Delhi: Danika Publishing Company.
8. RPH (2014). *CSIR-UGC NET Life Science (Popular Master Guide): Life Sciences,* RPH Editorial Board.
9. Pranav Kumar (2013). *MCQs Life Sciences – Biotechnology* (3rd Ed.). New Delhi: Pathfinder Academy.

M.Sc. Syllabus (2020 Board)

Semester I

Core I – Biochemistry

Course Code: PZ2011

No. of hours/ week	No. of credits	Total number of hours	Marks
6	4	90	100

Objectives

1. To impart knowledge on chemical structure, functions and metabolic process of biomolecules in living system.
2. To develop analytical and communicative skills to conduct experiments and interpretthe results.

Course Outcomes

CO	pon completion of this course the students will be able to:	PSO addressed	L
CO - 1	efine structure and types of chemical bonds in biomolecules uch as hydrogen ions, water, protein, carbohydrate, lipid, ucleotides, enzymes and vitamins.	PSO - 1	R
CO - 2	xplain the fate of biomolecules in different metabolic pathways.	PSO - 1	U
CO - 3	pply cognitive, technical and creative skills to pursue higher udies and employability in industrial, biomedical and research boratories.	PSO - 4	p
CO - 4	nalyse biomolecules in biological systems and relate deficiency isorders.	PSO - 3	n
CO- 5	esign biochemical experiments and publish the results through ffective written and oral communication after drawing accurate onclusions.	PSO - 2	E

UNIT I (Ref. 1, 2, 3) **Basic concepts of biochemistry**: Scope. Atoms - molecules - chemical bonds - primarybonds and secondary bonds - pH and Hydrogen ion concentration - buffers - 'Henderson-Hasselbalch' equation - buffer systems in blood - mechanism of buffer action - acid basebalance - regulation of acid base balance - acidosis and alkalosis. Water – colligative properties - water turnover and balance - electrolyte balance - dehydration and waterintoxication.

UNIT II (Ref. 1, 2, 3) **Carbohydrates:** Classification, structure, properties of mono, oligo and polysaccharides and biological role of carbohydrates - Carbohydrate metabolism - glycogenesis, glycogenolysis, glycolysis, Krebs cycle, Electron transport and Oxidative phosphorylation, Energetics of glucose metabolism - Pasteur effect–HMP shunt - gluconeogenesis - glyoxylate pathway - Cori cycle - Regulation and hormonal control of carbohydrate metabolism - glycogen storage diseases - blood sugar level - Glycosuria - Glucose tolerance test - Diabetes.

UNIT III (Ref. 1, 2, 3) **Proteins:** Classification, structure, Ramachandran plot, properties and biological role. Amino acids - classification, structure and properties - metabolism of proteins - deamination, transamination - transmethylation and decarboxylation of amino acids -glycogenic and ketogenic amino acids - formation and transport of ammonia - glucose- alanine cycle - Ornithine cycle - metabolism of phenylalanine, tyrosine and tryptophan. Porphyrins.

UNIT IV (Ref. 4, 5, 6) **Lipids**: Classification, structure and biological role - chylomicrons, VLDL, LDL, HDL - Lipid metabolism - theories of oxidation of fatty acids - oxidation of any one fatty acid andits bioenergetics (palmitic acid) -ketogenesis - biosynthesis of palmitic acid - metabolism of cholesterol - lipid storage diseases - role of liver in fat metabolism. Prostaglandins.Integration of carbohydrate, protein and lipid metabolism.

UNIT V (Ref. 4, 5, 6) **Nucleotide, Enzymes and Vitamins:** Biosynthesis and degradation of purines and pyrimidines**.** Enzymes: classification, nomenclature, enzyme kinetics, Michaelis - Menten constant, enzyme inhibition, mechanism of enzyme action, factors affecting enzyme activity, isozymes, coenzymes. Vitamins: Classification (fat soluble and water soluble), occurrence and biochemical role. Detoxification: mechanism of detoxification (oxidation, reduction, conjugation) - cytochrome P450 system.

Textbook

Ambika Shanmugam (2012). *Fundamentals of Biochemistry for Medical Students,*

(7th ed.). Published by Wolters Kluwer. Madras: Navabharat Offest Works. Satyanarayana, U. and Chakrapani, U. (2013). *Biochemistry* **(**4th ed). India: Elsevier.

Reference Books

1. Chatterjea**,** M.N. andRanaShinde (2012). *Textbook of Medical Biochemistry* **(**8th ed.). New Delhi: Jaypee Brothers Medical Publishers Pvt. Limited.
2. Vasudevan, D. M., SreeKumari, S. andKannanVaidyanathan (2013). *Textbook of Biochemistry for Medical Students* (7th ed.). New Delhi: Jaypee Brothers Medical Publishers Pvt. Limited.
3. Nitin Jain, Jain, J.L. and Sunjay Jain (2014). *Fundamentals of Biochemistry*. New Delhi: S. Chand & Co. Ltd.
4. Jeremy M. Berg, John L. Tymoczko and Lubert Stryer (2006). *Biochemistry* (6th ed.). SanFrancisco: Freeman & Co. Publishers.
5. David L. Nelson and Michael M. Cox (2004). *Lehninger Principles of Biochemistry* (4th ed.). New York: W.H. Freeman and Company.
6. Victor W. Rodwell, David A. Bender, Kathleen M. Botham, Peter J. Kennelly, P. Anthony Weil (2018).*Harper's Illustrated Biochemistry* (31st ed.) New York: McGraw-Hill Education.

Semester I

Core II - Ecobiology

Course Code: PZ2012

o. of hours/ week	o. of credits	otal number of hours	Marks
6	4	90	100

Objectives

1. To impart knowledge on ecosystem, population, community, environmental pollutions and natural resources.
2. To develop the skill to sensitize environmental issues and work productively withinand beyond the academy for sustainable environment.

Course Outcomes

CO - 1	efine various laws of ecology, components of ecosystem, haracteristics and dynamics of population and community, natural sources and environmental pollutants.	SO - 1	R
CO - 2	assify different types of ecosystem, habitat, environmental factorsand terpret the population processes, ecological succession, iological clock, biogeochemical cycles, biogeography, natural isasters and causes of pollution.	SO - 1	U
CO - 3	evelop cognitive, technical and creative skills which enable students r life-long learning and participate in environmental protection and onservation activities for sustainable environment nd gain employability.	SO - 3	Ap
CO - 4	nalyse the nature of ecosystem, habitat, population, community, atural resources and environmental pollutions.	SO - 2	An
CO - 5	ssess the environmental issues like population explosion, rbanization, depletion of natural resources, pollution and waste anagements.	SO - 2	E
CO - 6	rmulate hypotheses and test them by designing appropriate xperiments, analyze, interpret the data and communicate the results rough effective written and oral communication.	SO - 4	C

UNIT I(Ref. 1, 5)

Ecosystem and Habitat ecology: Scope of Ecobiology Environmental concepts – laws and limiting factors. The environment – physical factors (climatic factors,topographic factors, edaphic factors), biotic factors and their interactions (symbiosis, commensalism, parasitism and competition- prey-predator interactions - Scramble and contest competition). Ecosystem: Concepts of ecosystem – structure and functions. Energy flow – single channel energy model, Y - shaped energy flow models. Productivity – Primary production, secondary production,

measurement of primary productivity. Homeostasis of the ecosystem.Habitat ecology: freshwater, marine, estuarine, terrestrial and desert.

UNIT II (Ref.1, 2, 3, 10)

Population and Community: Population - structure and regulation, growth form, population fluctuations, population processes, life history strategies - diagrammatic and conventional life tables.Concept of Metapopulation. Community - basic terms, communitystructure, composition and stratification. Ecological niche, Ecotone and Edge effect, Ecotype.Ecological succession - types, general process, concept of climax.

UNIT III (Ref. 1, 6, 7, 11, 12)

Biogeochemical cycles: water cycle, carbon cycle, nitrogen cycle, sulphur cycle and phosphorous cycle. **Natural resource ecology**: classification of resource, mineral resource, land resource, forest resource, water resource, energy resource- conventional and non-conventional.**Remote sensing**: physical basis – information extraction – role in ecological research.**Natural Disaster Management**: Floods, earthquakes, cyclones, landslides, Tsunami, Mitigation and Disaster Management.

UNIT IV (Ref. 1, 9, 11, 12)

Biogeography: patterns of distribution (continuous, discontinuous, endemic), descriptive zoogeography, zoogeographical regions of the world. Dynamic biogeography (dispersal dynamics, dispersal pathways, migration, ecesis). **Biodiversity**: Importance, Human impact on biodiversity, Endangered wildlife species - special projects in India - IUCN red list - hot spots.Levels of diversity - species, genetic, ecosystem. GIS and satellite imaging in biodiversity assessment. Biodiversity indices**:** Shannon-Weiner index, Simpson index, Similarity and dissimilarity index, Association index. Conservation of species: *In situ* and *Ex situ*- Wildlife sanctuaries, national parks and biosphere reserves - Indian Board of Wild Life (IBWL) - National Board for Wild Life (NBWL) - Wild Life Conservation Laws and Trade Laws (CITES) in India.

UNIT V (Ref. 1, 4, 7, 11)

Pollution ecology: Green House gas emission and Global warming. Impact of chemicals on biodiversity - Pesticides and fertilizers in agriculture. Bio-indicator and biomarkers of environment. Carbon footprint, Carbon sink. Waste management: solid, liquid and gaseous wastes. e-wastes. Toxicology: Biomagnification and bioaccumulation, toxicants, classification, toxicity (LC50 and LD50), OECD Test Guidelines for the Chemicals (420, 423), mode of action of toxicants. **Urbanization**: Possible advantages of urbanization – problems, solutions – satellite villages- biovillages. Environmental ethics.Central and State Pollution Control Boards. Environmental auditing, Environmental impact assessment, Legislations for environmental Protection.

Textbook

Eugene P. Odum, Murray Barrick, Gary W. Barret (2005). *Fundamentals of Ecology* (5thed.). UK: Brooks/Cole Publishers.

Trivedi, P.C. and Sharma, K.C. (2003).*Biodiversity Conservation*. Jaipur: Avishekar Publishers.

Reference Books

1. Sharma, P.D. (2017). *Ecology and Environment* (13th ed.). Meerut: Rastogi Publications.
2. Begon and Mortimer (1992).*Population Ecology.* Delhi: UBS Publishers.
3. Dash, M.L. (1996). *Fundamentals of Ecology.* New Delhi: Tata McGraw Hill Publishing Company Ltd.
4. Subramanian, M.A. (2004). *Toxicology: Principles and methods.* Chennai: MJP Publishers.
5. Tyler Miller, G. (2004).*Environmental Sciences* (10thed.).Thomson Brooks,Chennai: ChennaiMicroprint Pvt. Ltd.
6. Prabu, PC.,Udayasoorian and G. Balasuramanian (2009). *An Introduction to Ecology and Environmental Science*. Delhi: Avinash Paperbacks.
7. Biswarup Mukherjee (2011). *Environmental Biology and Toxicology*. Faridabad: Silver LinePublications.
8. Benny Joseph (2005). *Environmental Studies* (2nded.).Delhi: Tata McGraw Hill Companies.
9. Bhatia, A.L. (2010). *Textbook of Environmental Biology*. New Delhi: I.K. International Publishing House Pvt. Ltd.
10. AnupamPandey (2012). Population Ecology. New Delhi: I.K. Discovery Publishing House Pvt. Ltd.
11. Ignacimuthu S.J. (2012). *Environmental Studies.*Chennai: MJP Publishers.
12. SupriyoChakraborty (2004). *Biodiversity.* Jaipur: Pointer Publishers.

Semester I

Core III - Structure and Function of Invertebrates

Course Code: PZ2013

No. of hours/ week	No. of credits	Total number of hours	Marks
5	3	75	100

Objectives

1. To provide knowledge on the functional aspects of systems of invertebrates on a comparative basis.
2. To empower students with skills to comprehend the taxonomical and physiological functions of vital systems in invertebrates.

Course Outcomes

CO	pon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	cognise the organisation of coelom, mode of locomotion, utrition, respiration, excretion and significance of larval forms f invertebrates.	PSO - 1	R
CO - 2	omprehend the systematic position and physiological functions f vital systems in invertebrates.	PSO - 4	U
CO - 3	pply the cognitive skills to pursue higher studies and mployability relevant fields.	PSO - 3	Ap
CO - 4	xplore the structure and functions of vertebrates.	PSO - 2	An

UNIT I (Ref.2, 5, 7)

Principle of Animal taxonomy: Species concept. International code of zoological nomenclature - Taxonomic procedures. New trends in taxonomy - Animal collection, handling and preservation. Organization of coelom - Acoelomates -Pseudocoelomates- Coelomates. Protostomia and Deuterostomia.

UNIT II (Ref.1, 2, 3)

Locomotion and Nutrition: Pseudopodia – Flagella and ciliary movement in protozoa - hydrostatic movement in Coelenterata, Annelida and Echinodermata. Nutrition and digestion - patterns of feeding and digestion in lower metazoan – Filter feeding in polychaeta, Mollusca and Echinodermata.

UNIT III (Ref.1, 2, 3, 4)

Respiration and Excretion: Organs of respiration - gills, lungs and trachea -respiratory pigments - Mechanism of respiration. Excretion – organs of excretion - coelom, coelomoducts, nephridia and Malpighian tubules – mechanisms of excretion and osmoregulation.

UNIT IV (Ref.1, 2, 3, 4)

Nervous system: Primitive nervous system - Coelenterata and Echinodermata, Advance nervous system - Annelida, Arthropoda (crustacean and insects) and Mollusca (Cephalopoda). Endocrine organs in Invertebrates.

UNIT V (Ref.1, 2, 3)

Invertebrata larvae and Minor Phyla: Larval forms of free living invertebrates - Larval forms of parasites- Strategies and evolutionary significance of larval forms. Minor Phyla (structural features and affinity) - significance -organization and general characters.

Textbook

Jordan, E.L. and Verma, P.S. (2010).*Invertebrate Zoology***.**New Delhi: S. Chand & Co. Ltd.

Reference Books

1. Kotpal, R.L. (2004). *Modern Textbook of Zoology- Invertebrates* **(**9th ed.). Meerut: RastogiPublications.
2. Ayyar, E.K. and Ananthakrishnan, T.N. (1995). *Manual of Zoology, Vol. I (Invertebrata),Part I & II.* Madras: S. Viswanathan Printers and Publishers Pvt. Ltd.
3. Dhami, P.S. and Dhami, J.K. (1979). *Invertebrate Zoology*.Ram Nagar, New Delhi: S. Chand & Co. Ltd.
4. Jan, A. Pechenik (2002). *Biology of Invertebrates* (4th ed.). New Delhi: Tata McGraw-HillPublishing Company Ltd.
5. George Gaylord Simpson (2018). *Principles of Animal Taxonomy*. India: Scientific Publishers.
6. Lal, S.S. (2004). *A Text Book of Practical Invertebrate Zoology*.Meerut: Rastogi Publications.
7. Kapoor, V.C. (2019). *Theory and Practice of Animal Taxonomy and Biodiversity* (8th ed.).New Delhi: Oxford and IBH Publishers.
8. Barrington, E.J.W. (1969). *Invertebrate Structure and Function*. Great Britain. Thomas Nelson and Sons Ltd.

Semester I

Core IV - Comparative Anatomy of Chordates

Course Code: PZ2014

No. of hours/ week	No. of credits	Total number of hours	Marks
5	3	75	100

Objectives

1. To provide the knowledge of origin, structure and function of different organ system ofvertebrates.
2. To develop the skills to analyse the anatomy of vertebrates and its significance.

Course Outcomes

CO	pon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	entify the morphology and anatomy of major groups of ertebrates.	PSO - 1	R
CO - 2	terrelate the development of integuments, circulatory system, spiratory system , skeletal system, sense organs and nervous ystem.	PSO - 1	U
CO - 3	pply the cognitive skills to pursue higher studies and gain mployability in academic and research institutions.	PSO - 3	Ap
CO - 4	nalyse the anatomy of different groups of vertebrates.	PSO - 4	An

UNIT I (Ref. 1, 2, 8)

Protochordates: Origin of Chordata. Chordate characters - classification of protochordata- general characteristics, development and affinities of Hemichordata, Urochordata, Chephalochordata.

UNIT II (Ref. 1, 2)

Vertebrate Integument: Origin and classification of vertebrates. Vertebrate integument and its derivatives- development, general structure and functions of skin and its derivatives - glands, scales, horns, claws, nail, hoofs, feathers and hairs.

UNIT III (Ref. 1, 2, 6)

Circulation and Respiration: General plan of circulation in various groups - blood - evolution of heart - evolution of aortic arches and portal systems. Respiratory system - characters of respiratory tissue- internal and external respiration - comparative account of respiratory organs.

UNIT IV (Ref. 1, 2, 6)

Skeletal and Urinogenital system: Skeletal system - form, function, body size and skeletal elements of the body - comparative account of jaw suspensorium, vertebral column - limbs and girdles. Evolution of urinogenital system in vertebrate series.

UNIT V (Ref. 1, 2, 6)

Sensory and Nervous system:Sense organs - simple receptors - organs of olfaction, taste and hearing- lateral line system - electroreception. Nervous system - comparative anatomy of thebrainin relation to its functions - comparative anatomy of spinal cord - nerves - cranial, peripheraland autonomous nervous system.

Textbook

Jordan, E.L. and Verma, P.S. (2011). *Chordate Zoology*. New Delhi: S. Chand and CompanyLtd.

Reference Books

1. EkambaranathaAyyar, M. and Ananthakrishnan, T.N. (1995).*A Manual of Zoology, Volume II(Part I & II)*.Chennai: S. Viswanathan Pvt. Ltd.
2. Kotpal, R. L. (2014). *Modern text book of Zoology – Vertebrates* **(**3rded.). Meerut: RastogiPublications.
3. Kingsley, J.S. (2016). *Outlines of Comparative Anatomy of Vertebrates*. Allahabad: Central BookDepot.
4. Milton Hilderbrand (1998). *Analysis of vertebrate structure*. (5thed.). New York: John Wiley and SonsInc.
5. Dhami P.S. and Dhami J.K. (1972).*Chordate Zoology*. New Delhi: S. Chand and CompanyLtd.
6. Kardong, K. (2002). *Vertebrates: Comparative Anatomy, Function and Evolution.* Chennai:Tata McGraw Hill Publishing Company Ltd.
7. Young, J. Z. (2004). *The Life of Vertebrates* (3rd ed.). London: Oxford University Press.
8. Verma P.S. (2010).*A manual of Practical Zoology Chordates*.New Delhi: S. Chand & Co.Ltd.

Semester I
Elective I (a) - Animal Husbandry

Course Code: PZ2015

No. of hours/ week	No. of credits	Total number of hours	Marks
4	3	60	100

Objectives

1. To gain knowledge on livestock management and construction of farms.
2. To develop skills on livestock farming and extend it to the society.

Course Outcomes

CO	pon completion of this course the students will be able to:	PSO addressed	L
CO - 1	cquire knowledge on Livestock resources, construction and anagement of Livestock farms.	PSO - 1	
CO - 2	entify the breeds and stages of livestock.	PSO - 1	
CO - 3	nalyse the ethical laws formulated by the Animal Welfare oard.	PSO - 4	n
CO - 4	evelop entrepreneurial skills and gain employability in animal rms and research laboratories.	PSO - 3	p

UNIT I (Ref: 1, 2, 5, 7)

Livestock farming (Ruminants I): Prospects of livestock industry in India. Introduction and scope of cattle farming.Housing systems- selection of site, layout and design.Selectionof cattle - important exotic and indigenous breeds and their characteristics. Fodder production and preservation of green fodder.Management and feeding practices of calves, heifers, pregnant, lactating and dry animals, bulls and working animals.Cattle Diseases. Parasites – ecto and endo parasites.

UNIT II (Ref: 1, 2, 3, 4, 5, 6, 7)

Livestock farming (Ruminants II): Breeds of sheep and goat. Important economic traits for meat, milk and fibre. Management and feeding practices during different stages of growth and production (milk, meat and wool). Breeding schedule and management of ram and buck. Weaning and fattening of lambs and kids. Methods of milking and precautions.Factors affecting quality and quantity of milk production and milk products.

UNIT III (Ref: 1, 2, 5, 7)

Livestock (Non ruminants): Scope of swine farming. Importantexotic and indigenous breeds and their characteristics.Housing and feeding of swine. Management of different categories of swine: pregnant sows, pig-lets, growing stock, lactating sows. Horses, donkeys and mules: feeding, Foaling and care of newborn.Care of race horses and preparing horses for show.

UNIT IV (Ref: 1, 2, 5)

Laboratory and Pet animal management: Handling, weighing, sexing and weaning of laboratory animals (rat and rabbit). Marking for identification, Feeding schedule. Prophylactic measures and Hygienic care. Handling of dogs and pet birds - Feeding practices and care of young ones. Grooming and bathing of dogs. Marketing.

Unit V (Ref: 1, 8, 9, 10, 11, 12)

Animal welfare: Animal welfare and ethics - role and current status of Animal Welfare Board of India and other welfare organizations. Common offences against animals - Prevention of Cruelty to Animals (PCA) Act, 1960.Functions of Animal ethics committee (CPCSEA). Livestock Importation Act - Evidence, liability and insurance.

Textbook

Mathialagan, P. (2007).*Textbook of Animal Husbandry and Livestock Extension*. (3rded.).Lucknow: International Book Distributing Co.

Reference Books / Web link

1. Tarit Kumar Banrjee (2016). *Applied Zoology*. London: New Central Agency (P) Ltd.
2. SupritiSarkar, GautamKundu, KorakKantiChaki. (2016). Introduction to Economic ZoologyLondon: New Central Agency (P) Ltd.
3. Nagendra S. Pawar. (2008). *Applied Zoology*.New Delhi: Adhyayan Publishers.
4. Sukumar De. (2005). *Outlines of Dairy Technology*.New Delhi: Oxford University Press. 5.Williamson. G and Payne. J. A. (1978). *An introduction to Animal Husbandry in the Trophics*.London: Longman Group Limited.
5. Whyte. R. O. (1968). *Land, Livestock and Human Nutrition in India*. Delhi: UBS Publishers.
6. Cole. H. H. (1966). *Introduction to Livestock Production*. London: Freeman and Company.
7. https://www.oxfordscholarship.com.
8. http://www.awbi.in/about.html
9. https://indiacode.nic.in
10. https://www.nacenkanpur.gov.in
11. https://nacenkanpur.gov.in

Semester I

Elective I (b) - Health Care

Course Code: PZ2016

No. of hours/week	No. of credits	Total number of hours	Marks
4	3	60	100

Objectives

1. To make the students realize the importance of the health of the body, develop a healthy personality so as to live a healthy and successful life.
2. To acquire independent employable skills in voluntary organizations or in health sectors.

Course Outcomes

CO	pon completion of this course the students will be able :	PSO addressed	L
CO - 1	ɔell quality life and factors that determine health.	SO - 4	R
CO - 2	utline the concept of health and well-being, personal ealth care, maternal and child health, environmental and ental health, alternative medicine and first aid.	SO - 3	
CO - 3	ake use of the different aspects of health and well-beingin ay to day life.	SO - 3	p
CO - 4	xamine personal health problems and its remedies.	SO - 1	n

UNIT I(Ref.4)

Concept of health and well-being:Definition - Physical, mental, social and positive health - Quality of life. Determinants of health: Heredity - Environment - Lifestyle - Socio-economic conditions - Health services. Nutrition and Health: Nutrients that provide energy - Carbohydrates - Lipids - Proteins. Nutrients that regulate: Vitamins - Minerals - Water. Healthy diet - Food guide Pyramid - Snacking - Vegetarian diet - Fast food.

UNIT II(Ref.2)

Personal Health Care:Protecting skin - common skin problems - Dry Skin, Acne, Dermatitis, Psoriasis, skin infections – skin cancer - caring for the skin. Hair - General care, cleaning tips, preventing hair loss, Anti dandruff strategies. Teeth - Common dental problems - General care of teeth - Dental checkup. Eye - Common eye problems - Eye diseases - General care of eyes - Vision checkup. Ear - general care - do's and don’ts.

UNIT III(Ref. 2)

Maternal and Child Health:Motherhood - pregnancy confirmation test - Prenatal care - Intra natal care - problems during pregnancy - Miscarriage and stillbirth - premature birth -labor and delivery - Family planning. Child health: Care of the newborn - Feeding - Nutritional guidelines - Care of the under-five (Toddler and Preschool).

UNIT IV(Ref.2)

Environmental and Mental Health:Mental health: Characteristics - Types: Schizophrenia - Manic depressive psychoses - Paranoia - Neurosis - Personality and character disorders. Environmental health: health in the home environment - pollution at home - diseases. Safety at home: Fall - Fires - Poisoning - Electrical hazards - Safety in road (Auto mobile - Pedestrian) - Disaster management (Severe weather condition - Flood- Lightning - Cyclone - Earthquake – Landslides- Tsunami).

UNIT V(Ref. 1, 3, 5)

Alternative medicine and First aid:Naturopathy - Homeopathy- Ayurveda - Unani - Siddha. First aid: First aid procedures for dehydration - heart attack - fractures and dislocation, burns - bleeding - poisoning - electric shocks - drowning.

Reference Books

1. Park, K. (1995). *Park's Textbook of preventive and social medicine*. Jabalpur: M/S BanarsidasBhanot Publishers.
2. Getchell, Pippin and Varnes (2006). *Perspectives on Health*. USA: D C Heath & Co.
3. LakshmanaSarma and Swami Nathan. S. (1960). *Speaking of nature cure – Regain,retain and improve health the drugless way*. New Delhi: Sterling Publications Pvt. Ltd.
4. Tom Sanders and Peter (2004). *Emery Molecular basis of human nutrition*. London:Taylor and Francis Publishers.
5. Eva Roman (2008). *First aid*. New Delhi: Indiana Publishing House.

Semester II

Core V - Biostatistics, Computer Applications and Bioinformatics

Course Code: PZ2021

No. of hours/ week	No. of credits	Total number of hours	Marks
6	4	90	100

Objectives

1. To enable the students to collect and use the data to derive inferences in various biologicalexperiments.
2. To develop analytical skills of statistics and draw valid conclusions in research.

Course Outcomes

CO	Upon completion of this course the students will be able to :	PSO addressed	L
CO - 1	call different biological data, methods of collection, processing nd retrieval tools in sequence analysis.	PSO - 1	
CO - 2	xplainmeasures of dispersion,significance of data and soft wares pplied in biostatistics and biological databases.	PSO - 2	
CO - 3	halyze the data and interpret the results manually or by using oftware.	PSO - 2	n
CO - 4	pply statistical and bioinformatics tools in research and gain mployability in Research and Development organizations.	PSO - 3	p
CO - 5	evaluate biological data and critically analyse the research findings.	PSO - 4	
CO - 6	rmulate hypothesis, solve problems and present data to the cientific community.	PSO - 4	

UNIT I (Ref. 1, 2, 7, 9)

Data collection and presentation: Population and sample in biological studies - variables - sampling methods. Types of biological data. Measurement scales - ratio scale, interval scale, ordinal scale, nominal scale - parameters and statistics. Accuracy and precision.Data collection and presentation: Tabulation - graphs - diagrams. Frequencydistribution - histogram - frequency curves and Ogives. Measures of central tendency: types of mean, median, mode.

UNIT II (Ref. 1, 2, 7, 8, 9)

Measures of dispersion: Range - quartile and percentile - mean deviation - standard deviation - coefficient of variation -skewness and kurtosis - standard error. Distribution: Binomial, Poisson and Normal. Parametric and non-parametric tests. Hypothesis testing - single and two population mean - types of error (Type I and Type II) - Chi-square analysis-test for goodness of fit and homogenecity.

UNIT III (Ref. 1, 2, 7, 8, 9)

Analysis of Data: Student's *t*-distribution - Analysis of variance (ANOVA): one way classification and two way classification (Factorial design). Probability: Addition theorem, multiplication theorem and conditional theorem. Permutation and combination.Correlation - types, methods of study and testing the significance. Regression: equations – regression lines - simple linear regression and testing its significance. Mathematical modeling in biology: types and applications.

UNIT IV

Computer applications: Micrtosoft office - M.S. Power point. MS Excel. Statistical function: Descriptive statistics -*t*-test, ANOVA, correlation, regression, Chi-square test, table and charts. Viruses and worms.Statistical Packages: SPSS, Minitab, Sigmaplot, Originpro (Brief account).

UNIT V (Ref. 10)

Bioinformatics: Scope - Biological data bases - Data base retrieval tools (Locus link, ENTREZ, Pubmed and SRS) - Nucleotide sequence data base (NCBI, EMBL) - Protein data base (Protein data bank-PDB). Data base similarity research tools (BLAST, MSA). Biological sequence analysis: sequence alignment, pair-wise alignment and multiple sequence alignment.Protein structure visualizing tools (RasMol, Swiss PDB Viewer).Applications of bioinformatics tools.

Textbooks

Gurumani, N. (2005). *An Introduction to Biostatistics.* Chennai: MJP Publishers.

Attwood, T.K and Parry Smith, D.J. (2005).*Introduction to bioinformatics.*Delhi: Pearson Education Pvt. Ltd.

Reference books

1. Pillai, R.S.N. and V.Bagavathi (2016).S*tatistics Theory and Practice* (8thed.).NewDelhi: S. Chand PublishingCompany Ltd.
2. Khan, I. andKhanum, A. (2014). *Fundamentals of Biostatistics* (3rd ed.): Hyderabad. UkaazPublications.
3. Zar, J.H. (1984). *BiostatisticalAnalysis*(2nded.). London: Prentice-Hall InternationalInc.
4. Bailey, N.T.J. (1997). *Statistical methods in Biology* **(**3rded.). New York: Cam.University Press.
5. Sokal, R. and James, F. (1973). *Introduction to Biostatistics.* Tokyo, Japan: W.H.Freeman and Company Ltd.
6. Daniel, W.W. (1987). *Biostatistics: A foundations for Analysis in the Health Sciences*.New York: John Wiley &Sons.
7. Gupta, S.P. (1998). *Statistical Methods.* New Delhi: S. Chand and Company Ltd.
8. Banerjee, P.K. (2005). *Introduction to Biostatistics.*New Delhi: S. Chand and Company Ltd.
9. Pranab Kumar Banerjee (2009).*Introduction to Biostatistics*, New Delhi: S. Chandand Company Ltd.
10. Ignacimuthu, S. (2013) *Basic Bioinformatics* (2nded.)New Delhi: Narosa PublishingHouse.

Semester II

Core VI - Cell and Molecular Biology

Course Code: PZ2022

No. of Hours/ week	No. of Credits	Total Number of Hours	Marks
6	4	90	100

Objectives

1. To provide knowledge on the structure and functions of bio-membranes, cell organelles and signaling pathways.
2. To avail employment in educational institutions and research laboratories.

Course Outcomes

CO	pon completion of this course the students will be able to:	PSO addressed	L
CO - 1	cognize the structural and functional organization of plasma embrane, cell organelles, cell receptors, protein synthesis and bnormal cell growth.	SO - 1	
CO - 2	lustrate cellular organization and changes occurring in cells.	SO - 1	
CO - 3	nalyse the prokaryotic and eukaryotic cells, flow of genetic formation from DNA to protein, cell signaling and regulation of ell cycle.	SO - 2	n
CO - 4	valuate the changes in the cells, cell cycle and proteins involved the regulation and apoptosis.	SO - 4	
CO - 5	pply the principles and techniques of molecular biology for search and employment.	SO - 3	p

UNIT I (Ref. 1, 4)

Cell Structure and Functions of cell organelles: prokaryotic and eukaryotic cells - structure. Plasma membrane: Structure and function. Active transport and pumps- transport by transporter proteins - membrane potential.Tight junction, Gap junction. Cytoskeleton - Microfilaments, intermediate filaments and microtubules. Extracellular matrix - Collagen and non-collagen components.

UNIT II (Ref. 4, 5)

Cell organelles and Nucleic acids: Structure and functions of Nucleus: Nuclear pores, Nucleolus. Mitochondria, Ribosomes, Endoplasmic reticulum (ER): Rough and SmoothER - Golgi complex - lysosomes. DNA and RNA: Types, structure and functions.

UNIT III (Ref. 1, 2, 3).

Signaling pathways: Cell adhesion molecules - Extra cellular signaling – signaling molecules and their receptors - Pathways of intracellular signal transduction: G protein coupled receptors - Cyclic AMP pathways - Receptor Tyrosine Kinases (RTKs): Ras, Raf and MAP kinase pathway - second messengers - signaling from plasma membrane to nucleus.

UNIT IV (Ref. 1, 6)

Protein synthesis and transport: Transcription and Translation in Prokaryotes and Eukaryotes.

Gene regulation - positive and negative, Protein trafficking - sorting - transport from endoplasmic reticulum to Golgi, transport to lysosome - exocytosis - endocytosis. Membrane protein and secretory proteins.

UNIT V (Ref. 1, 3)

Normal and abnormal cell growth: Cell cycle - Mitosis - Meiosis. Regulation of cell cycle: Cyclin and Cyclin dependent kinases. Apoptosis - mechanism and significance. Molecular aspects of cancer, proto-oncogenes - oncogenes, tumour suppressor genes.

Textbook

Lodish, H. and Berk, A. (2016).*Molecular Cell Biology* (8th ed.). New York: W.H.Freeman and Company Limited Publication.

Reference Books

1. Gupta, P.K. (2014). *Cell and Molecular Biology* (4th ed.). New Delhi: Rastogi Publication.
2. Geoffrey M. Cooper and Robert E. Hausman (2013). *The cell: A Molecular Approach*
3. (6thed.). Massachusetts, USA: Sinauer Associates Publication.
4. Pranav Kumar and Usha Mina (2018). *Life Sciences – Fundamentals and Practice I.*
5. (4th ed.). New Delhi: Pathfinder Publication.
6. Powar C.B. (2010). *Cell Biology*. Hyderabad: Himalaya Publisher.
7. Alberts B., Johnson. A., Lewis, J., Raff, M., Roberts, K. and Watter, P. (2008).
8. *Molecular Biology of the Cell* (5th ed.). New York: Garland Science Publication.
9. De Robertis, E.D.P. (2011). *Cell and Molecular Biology* (8th ed.). New York:Lippincott Williams & Wilkins Publication.

Semester II

Core VII - Developmental Biology

Course Code: PZ2023

No. of hours/ week	No. of credits	Total number of hours	Marks
5	4	75	100

Objectives

1. To enable the students to gain knowledge on the process by which a zygote, multiplies, differentiates and develops into an adult.
2. To gain employment in fertility centers, hospitals and health centers.

Course Outcomes

CO	pon completion of this course the students will be able to:	PSO addressed	L
CO - 1	iscuss basic concepts and developmental processes of different rgan systems and techniques in reproductive biology.	PSO - 1	
CO - 2	istinguish the embryonic structures, origin and development of rgan systems.	PSO - 1	
CO - 3	halyse the regulating mechanisms of developmental processes nd identify deformities.	PSO - 2	n
CO - 4	pply knowledge to pursue higher studies and gain mployability in biological research laboratories.	PSO - 3	p

UNIT I (Ref. 1, 2, 5)

Reproductive system: Historical perspectives and theories of embryology. Sexual and asexual reproduction - Parthenogenesis and types.Male reproductive system of a mammal, spermatogenesis, structure and function of sperm, semen and seminal fluid.Female reproductive system of a mammal, oogenesis, ovulation, vitellogenesis, types of eggs.

UNIT II(Ref. 1, 2, 3)

Fertilization and molecular aspects: Mechanism of fertilization, theories of fertilization. Cleavage: Laws - planes - patterns - chemical changes during cleavage. Cleavage and blastulation in chick and mammal.Cell lineage, fate map of chick and mammal.

UNIT III(Ref. 1, 2, 4)

Morphogenetic movements and Organogenesis in chick and mammals: Gastrulation - germinal layers and their derivatives, neurogenesis, notogenesis, development ofmesoderm and coelom. Organogenesis: eye, skin and its derivatives, heart, kidney, limbs, alimentary canal and its derivatives.

UNIT IV(Ref. 1, 3, 6)

Development of reproductive organs in man: development and differentiation of testis, development of male genital ducts and accessory glands. Development and differentiation of ovary, development of female genital ducts and accessory glands.Teratogenesis and teratogens.Infertility - causes and treatment, development of extra embryonic membranes.Placentation in mammals.

UNIT V (Ref. 1, 3, 5)

Embryonic induction, Metamorphosis and Regeneration: Embryonic induction in vertebrates - types - exogenous and endogenous. Theories of organizer or inductor, competence. Differentiation - characteristics and types, selective action of genes in differentiation. Metamorphosis in insects and amphibians.Neoteny. Regeneration - regenerative ability in animals and mechanism.

Text Book

Balinsky, B. I. (2012). *An Introduction to Embryology* (5th ed.). Philadelphia: CengageLearning Publishers.

Reference books

1. Jain, P.C. (2017). *Elements of Developmental Biology (Chordate Embryology).* New Delhi: Vishal publishing Co.
2. Wolpert, L. (2010). *Principles of Development* **(**4th ed.). United Kingdom: Oxford University Press.
3. Ronald W. Dudek and James D. Fix (2005). *Embryology* **(**3rd ed.). Philadelphia, USA: Lippincott Williams and Wilkins Publication.
4. Chattopadhyay, S. (2017). *An Introduction toDevelopmental Biology* (2nd ed.). Kolkata: ArnbhaSen, Books and allied (P) Ltd.
5. Twyman, R. M. (2004). *Developmental Biology*. New Delhi: BIOS ScientificPublishers.
6. Verma, P. S. and Agarwal, V. K. (2014). *Chordate Embryology: DevelopmentalBiology*. New Delhi: S. Chand and Company Ltd.
7. Gayatri Prakash (2007). *Reproductive Biology*. United Kingdom: Alpha ScienceInternational Ltd.
8. Sastry, K.V. and Shukla, V. (2003). *Developmental Biology* (1st ed.). New Delhi: Rastogi publications.

Semester II

Core VIII - Research Methodology

Course Code: PZ2024

o. of hours/ week	No. of credits	otal number of hours	arks
5	4	75	00

Objectives

1. To enable the students to understand the working principles of bio-instruments andmethodologies used in biological investigations.
2. To enhance report writing skills and create self-employment opportunities.

Course Outcomes

CO	pon completion of this course the students will be able :	PSO addressed	L
CO - 1	utline the principles and working mechanism of laboratory quipments and research techniques.	PSO - 1	
CO - 2	xplain laboratory or field procedures, methods, and strumentation for biological studies.	PSO - 1	
CO - 3	nalyze scientific methods to develop hypotheses, design and xecute experiments by selecting the appropriate research chniques.	PSO - 2	n
CO - 4	onceptualize research processes, data presentation, report riting and publication in journals.	PSO - 3	p
CO - 5	valuate scientific ideas and design experiments to address edical, social and environmental problems.	PSO - 4	

UNIT I (Ref. 1, 2)

Microscope: Principle - types - interference, fluorescence, confocal, electron microscopes scanning tunneling microscope, atomic force microscope, near field scanning optical microscope, magnetic force microscope. Photomicrography.

UNIT II (Ref. 1, 2, 5)

Centrifugation: Principle - factors affecting sedimentation rate - Types and applications of centrifuges. Cryotechniques- cryopreservation. **Cytotechnique**: Whole mounts. Microtome: Rotary and Freezing microtome. Microtomy: Fixation - dehydration - clearing- embedding - sectioning - staining - mounting.

UNIT III (Ref. 3, 4, 5)

Chromatography: Principle, types - gas and liquid chromatography - High Performance Liquid Chromatography - Ion exchange - Affinity chromatography. **Electrophoresis**:Principles, types - gel - Polyacrylamide gel, agarose gel, Blotting techniques,Iso electric focusing - Immunoelectrophoresis. Protein sequencing methods.

UNIT IV (Ref. 3, 4, 5)

Spectroscopy: principle, types - UV-Visible Spectroscopy, Atomic Absorption Spectroscopy, flame photometer, chemiluminometer, Nuclear Magnetic Resonance spectroscopy, FTIR spectrometry - Electron Spin Resonance, Magnetic Resonance Imaging - applications. Radio activity counters.

UNIT V (Ref. 6, 7)

Experimental design and Report writing: Essential steps in research - Literature collection - Review of literature - Bibliography - Literature citation - Research report - Tables - Figures - Formatting and typing - Online literature collection - open access journals - Predatory journals - Impact factor - Citation index- H-index- Plagiarism - Copy Right - Patent.

Textbooks

Veerakumari, L. (2006). *Bioinstrumentation.*Chennai: MJP Publishers.

Gurumani, N. (2006).*Research Methodology for Biological Sciences*.
Chennai: MJPPublishers.

Reference Books

1. Marimuthu, R. (2008). *Microscopy and Microtechnique*. Chennai: MJP Publishers.
2. Prakash, M. and C.K. Arora (1998). *Microscopical Methods*. New Delhi: AnmolPublications Pvt. Ltd.
3. Keith Wilson and John Walker (2018). *Principles and Techniques of Practical Biochemistry* (8th ed.). United Kingdom: Cambridge University Press.
4. Pranav Kumar (2018). *Fundamentals and Techniques of Biophysics and MolecularBiology*. New Delhi: Pathfinder publication.
5. RamnikSood (2006). *Medical Laboratory Technology*. New Delhi: Jaypee BrothersMedical Publishers Pvt. Ltd.
6. R. Paneerselvam. (2016). *Research Methodology.* New Delhi: PHI Learning Pvt. Ltd.
7. Gurumani. N. (2010).*Scientific thesis writing and paper presentation*. Chennai: MJPPublishers.

Semester II

Elective II (a) - Animal Behaviour and Chronobiology

Course Code: PZ2025

No. of hours/week	No. of credits	Total number of hours	Marks
4	3	60	100

Objectives

1. To acquaint students with deep understanding of Animal behaviour and Chronobiology.
2. To develop skills of animal watching and procure jobs in sanctuaries.

Course Outcomes

CO	pon completion of this course the students will be able :	PSO addressed	L
CO - 1	escribe animal behaviour, reflexes, biological rhythms and hronobiology.	PSO - 1	
CO - 2	ummarize the history of ethology, social behaviour in himals, organization of circadian system in multicellular himals.	PSO - 1	
CO - 3	lustrate the developing compassion towards animals, group election, altruism, predict biological clock system, circadian acemaker system in vertebrates.	PSO - 1	p
CO - 4	halyse the patterns of animal behaviour and complexity of iological clock system in vertebrates.	PSO - 3	n
CO - 5	ssess the relevance of biological clocks for human welfare nd taking decisions.	PSO - 4	

UNIT I(Ref. 1, 3, 4, 5, 6)

Introduction to Animal Behaviour: Principles of Animal Behaviour, Historicalperspectives of ethology, Approaches to animal behaviour. Ethogram - Methods andrecording of a behaviour. Innate behavior, Neurological basis of animal behaviour, hormonal control of behaviour.

UNIT II(Ref. 1, 4, 5, 7)

Patterns of Behaviour: Reflexes - types, reflex path, characteristics of reflexes. Orientation: Primary and secondary orientation, kinesis - orthokinesis, klinokinesis; taxis - tropotaxis, klinotaxis, menotaxis, mnemotaxis. Learning: Associative learning, classical and operant conditioning, Habituation and Imprinting. Memory - types of memory.

UNIT III(Ref. 1, 4, 5)

Social and Sexual Behaviour: Social Behaviour: Concept of Society; various modes of animal communication. Altruism; Insect's society with Honey bee as example; Foraging in honey bee and bee communication.Nesting behavior in birds.Sexual Behaviour: Mate choice, intra-sexual selection (male rivalry), inter-sexual selection (female choice), sexual conflict in parental care.

UNIT IV(Ref. 1, 6, 8, 9, 10)

Introduction to Chronobiology: Historical developments in chronobiology; Biological oscillation: the concept of average, amplitude, phase and period. Biological clocks: centraland peripheral biological clock, adaptive significance of biological clocks, Chronopharmacology, Chronomedicine, Chronotherapy.

UNIT V(Ref. 1, 2)

Biological Rhythm: types of biological rhythms: short- and long- term rhythms, Circadian rhythms - molecular biology of the circadian pacemaker system, Tidal rhythms and Lunar rhythms. Circannual rhythms, Photoperiod and regulation of seasonal reproduction of vertebrates, Role of melatonin.

Textbook

Agarwal, V.K. (2009). *Animal Behaviour* (*Ethology*). New Delhi: S. Chand and Company Ltd.

Reference Books / web link

1. Sanjib Chattopadhyay (2012). *LIFE: Evolution, Adaptation and Ethology*. Kolkata: Books and Allied (P) Ltd.
2. Chandrashekaran, M.K. (1985). *Biological Rhythms*.Madras Science Foundation.
3. Mohan P. Arora. (2016). *Animal Behavior*. Chennai: Himalaya Publishing House.
4. Auprey Manning and Mariam Stamp Dowkins (2012).*An Introduction to Animal behavior*. UK: Cambridge University Press.
5. Slatter P. J. B. (1985). *An Introduction to Ethology*. UK: Cambridge University Press.
6. Saha T. K. (2009). *An Introduction to Animal behaviour*. Delhi: Emkay Publications.
7. Machve K. K. (2016). *Evolution of Animal Behaviour*. Thiruvananthapuram: Manglam Publications.
8. http://www.apiindia.org/pdf/progress_in_medicine_2017/mu_75.pdf
9. https://www.pharmatutor.org/articles/chronopharmacology-overview
10. https://www.sciencedirect.com/topics/medicine-and-dentistry/chronotherapy

Semester II

Elective II (b) - Bioinformatics

Course Code: PZ2026

No. of hours/week	No. of credits	Total number of hours	Marks
4	3	60	100

Objectives

1. To understand the application of computer technology, to study and process biological data.
2. To develop skills to use bioinformatics tools.

Course Outcomes

CO	pon completion of this course the students will be able to:	PSO addressed	L
CO - 1	escribe the basics of bioinformatics.	PSO - 1	
CO - 2	hoose bioinformatics tools and data bases.	PSO - 1	
CO - 3	terpret sequence alignment and alignment programs.	PSO - 2	
CO - 4	entify the tools for drug discovery, docking and molecular hylogeny.	PSO - 3	n
CO - 5	se bioinformatics tools for molecular data analysis and ubmission.	PSO - 4	p

UNIT I (Ref. 1)

Introduction to Bioinformatics and databases: Introduction and definition, applications, Databases: Types of databases. Biological databases: nucleotide sequence databases - GenBank, DDBJ, EMBL, NCBI; Protein sequence databases - PDB, Uniprot, TrEMBL; NDB. Chemical databases; PubChem,ChemBank, CSD; Bibliographic databases- MEDLINE, PUBMED.

UNIT II (Ref. 1)

Sequence Analysis: Sequence alignment and alignment programs; Comparison of two sequences - Dot Matrix analysis; Scoring schemes - PAM Matrices and BLOSUM Matrices; Dynamic programming- Needleman-Wunch algorithm, Smith-Waterman algorithm, BLAST and FASTA; Multiple Sequence Alignment, ClustalW; Storing alignments.

UNIT III (Ref. 6, 7)

Drug Designing: Drug discovery process - drug target identification, target validation, Lead compound identification, Lead optimization, Docking (importance, mechanics of docking, docking sites), Quantitative structure-activity relationship. Preclinicaland clinical development.

UNIT IV (Ref. 1)

Phylogenetic analysis: Molecular phylogenetic analysis; methods of phylogenetic analysis - phenetic and cladistic; phylogenetic trees, methods for determining evolutionary trees - maximum parsimony, distance and maximum likelihood; phylogenetic software resources.

UNIT V (Ref. 1)

Genomics and Proteomics: Central dogma of molecular biology. Genomics - structural, comparative and functional. Proteomics - expression, structural and functional. Types of sequences used in Bioinformatics – DNA sequences, RNA sequences, Protein sequences.

Textbook

Rastogi, S. C. Mendiratta, N. and Rastogi, P. (2011).*Bioinformatics*. PHI Learning PrivateLimited, New Delhi.

Reference Books

1. Attwood, T.K. and Parry-Smith, D.J. (2006). *Introduction toBioinformatics*. DorlingKindersley Publication: Delhi.
2. Gladis Helen Hepsyba, S. and Hemalatha, C.R. (2009). *Basic Bioinformatics.* Chennai:MJP Publishers.
3. John De Britto, A. (2011). *Bioinformatics.* Sivakasi; Anto Art Craft Printers.
4. Sundaralingam, R. and Kumaresan, V. (2008). *Bioinformatics.* Nagercoil: SarasPublication.
5. Jin Xiong (2006). *Essential Bioinformatics.* UK: Cambridge University Press.
6. Hooman H. Rashidi and Lukas K. Buehler (2000). *Bioinformatics Basics: Applicationin Biological Science and Medicine.* New York: CRC Press.
7. Mohan Bansal, A.S. (2003). *Medical Informatics – A primer*. New Delhi: TataMcGraw- Hill Publishing Company Ltd.

Semester I

Practical I - Biochemistry and Ecobiology

Course Code: PZ20P1

No. of hours/week	No of credits	Total number of hours	Marks
4	4	60	100

Objectives

1. To design and perform biochemical experiments.
2. To understand the interaction between abiotic and biotic environment.

Course Outcomes Objectives

3. To design and perform biochemical experiments.
4. To understand the interaction between abiotic and biotic environment.

Course Outcomes

CO	pon completion of this course the students will be able :	PSO addressed	L
CO - 1	escribe the knowledge necessary for professional or cademic work in the field of biochemistry and ecology.	PSO - 1	
CO - 2	nalyse the biomolecules and physico-chemical parameters samples.	PSO - 2	n
CO - 3	evelop drawing and writing skills and design experiments.	PSO - 4	p
CO - 4	stimate the components of an ecosystem.	PSO - 2	

Biochemistry

1. Colorimetry- verification of Beer-Lambert's law.
2. Preparation of Acid & Alkali solutions and acid-base titration applying Henderson-HasselBalch' equation.
3. Preparation buffers of known pH and solutions of known molarity, normality,percentage, ppt, ppm.
4. Chromatographic separation of amino acids.
5. Quantitative estimation of glucose (Blood/ Tissue).
6. Quantitative estimation of protein (standard graph).
7. Quantitative estimation of total lipid (Blood/ Tissue).
8. Quantitative estimation of ascorbic acid.
9. Quantitative estimation of blood urea.
10. Determination of salivary amylase activity in relation to substrate applying Michaelis -Menten equation.

Instruments/ Charts/Models

Colorimeter, pH Meter, Centrifuge, Chromatogram, Electrophoretic unit

Ecobiology

1. Measurement of primary productivity (O_2 measurement method).
2. Sampling of animal population using quadrat method.
3. Observation of life table in an insect.
4. Collection and identification of freshwater planktons.
5. Measurement of turbidity using Secchi disc.
6. Estimation of LC_{50} of a pesticide.
7. Estimation of H_2S in water sample.
8. Estimation of salinity in water sample.
9. Estimation of CO_2 in water sample.
10. Study report of a pond ecosystem. Specimen/ Chart/ Models

Commensalism (Shark and *Echeneis*), Mutualism (Sea anemone and Hermit crab),Food chain, Food web, Conventional energy source (coal) and non-conventional energy source (wind mill).

Semester II

Practical II - Biostatistics, Computer applications and Bioinformatics&Cell and Molecular Biology

Course code: PZ20P2

No. of hours/week	No of credits	Total number of hours	Marks
4	4	60	100

Objectives

1. To design an experimental problem and evaluate critically with inferential biostatisticsand necessary computer skills.
2. To develop the skills involved in cell biology, histology and biomolecules separationtechniques.

Course Outcomes

CO	pon completion of this course the students will be able to:	PSO addressed	L
CO - 1	nalyze and interpret the collected data using statistical ethods manually and soft wares.	PSO - 1	n
CO - 2	valuate the biological samples applying research techniques.	PSO - 2	
CO - 3	evelop drawing and writing skills through record and design xperiments.	PSO - 2	p
CO - 4	esign biological experiments.	PSO - 2	

Biostatistics, Computer applications and Bioinformatics

1. Collection of biological data (Primary and Secondary).
2. Classification and representation (Graphical and Diagrammatic) of collected data.
3. Measures of dispersion- standard deviation and standard error.
4. Estimation of population by Mark and Recapture method using beads.
5. Correlation co-efficient – length and width of molluscan shells.
6. Study of probability using coin tossing with 2 and 3 coins and chi square test.
7. Regression Analysis.
8. Test of significance (student's *t*-test).
9. Preparation of graph using M.S. Excel.

10. Retrieval of DNA and protein sequence from NCBI.

11. Visualizing protein structure using RasMol.

Charts/ Models

NCBI, SWISS-PROT and PubMed

Cell and Molecular Biology

1. Isolation and observation of sub cellular organelles.
2. Observation of mitosis - onion root tip.
3. Observation of meiosis - grasshopper testis.
4. Observation of polytene chromosome - salivary gland of Chironomus larva.
5. Barr-body identification.
6. Observation of striated muscle fibre - coxal muscle of cockroach.
7. Observation of adipocytes - fat body of cockroach.
8. Haemolymph smear (Cockroach).
9. Whole mount preparation of a specimen.
10. Sectioning and staining of a tissue.

Spotters/ Slides

Fluid mosaic model, Golgi complex, Cancer cell, Cadherins, Karyotype, Haemocytometer

Semester III
Core IX - Physiology
Course Code: PZ2031

Hours/ Week	Credits	Total Hours	Marks
6	4	90	100

Objectives

1. To impart knowledge on the structure and functions of various organs, organ systemsand associated disorders.
2. To develop skills relevant for pursuing higher education and apply the knowledge intheir life.

Course Outcomes

CO	pon completion of this course the students will be ble to:	PSO addressed	CL
CO - 1	call the structure and functions of organ systems.	SO - 1	R
CO - 2	escribe the anatomy of different physiological systemsat e tissue and cellular levels.	SO - 1	U
CO - 3	arry out physiological studies in the laboratory, terpret data and graphs and write a report.	SO - 2	Ap
CO - 4	nalyze the physiological changes in relation to nvironmental conditions.	SO - 3	An
CO – 5	valuate the physiological functioning of different rgans.	SO - 4	E

UNIT I

Nutrition: types of nutrition and feeding mechanisms in animals. Digestion - Functional anatomy of the digestive system (human), Movements of gastrointestinal tract, Secretory functions of the alimentary tract and glands, Digestion and absorption. Metabolism of protein, carbohydrate and lipid. Balanced diet – Malnutrition - Energy balance – BMR. Gastrointestinal disorders: Gall stones, liver cirrhosis, gastritis, peptic ulcer and appendicitis.

UNIT II

Respiration and Homeostasis: Respiratory organs and respiratory pigment in animals, Physiological anatomy of the respiratory system (human), Transport of respiratory gases, Regulation of respiration, Respiratory problems - bronchial asthma, pneumonia and pulmonary tuberculosis. Homeostasis: Osmoregulation - types and mechanism. Thermoregulation – classification, thermoregulatory mechanism in animals, aestivation and hibernation, Deep sea physiology, High altitude and space physiology, Effects of exposure to cold and heat. Bioluminescence – physiology and functions.

UNIT III

Circulation: Components and functions of blood, Blood clotting. Haemopoiesis. Myogenic and neurogenic heart. Functional anatomy of human heart, Cardiac cycle, pacemaker, heart rate, Bradycardia and tachycardia, Regulation of cardio- vascular system. Blood pressure, sphygmomanometer, Electrocardiogram (ECG), Heart diseases (Atherosclerosis, coronary thrombosis and angina pectoris). Lymphatic system - organization, composition of lymph and functions.

UNIT IV

Neuro-muscular system: Structure of the brain and neuron, Neurotransmitters, Synapse, Nerve impulse conduction, Reflex activity, Inborn and conditioned reflex actions, Electroencephalogram. Neural disorders - Meningitis and epilepsy. Types of muscle, structure and properties of skeletal muscle, Mechanism of muscle contraction, Neuromuscular junction. Sense organs - Structure and functions of skin, eye and ear.

UNIT V

Excretion and Reproduction: Excretory organs in different groups of animals, Patterns of excretion, Structure and function of kidney (human), Nephron, Formation of urine, Micturition, Renal disorders – nephritis, renal calculi, Dialysis. Structure of testis and ovary (human), oestrus and menstrual cycle, ovulation, pregnancy, parturition and lactation, hormonal regulation of reproduction.

Reference Books

1. Sembulingam, K. & Prema Sembulingam (2013). *Essentials of Medical Physiology* 6th ed.). Bangalore: Jaypee Brothers Medical Publishers Pvt. Ltd.
2. Guyton & Hall (2010). *Textbook of Medical Physiology* (12th ed.). Philadelphia: John E. Hall, Saunders Elsevier.
3. Elaine N. Marieb (2003). *Human Anatomy and Physiology* (6th ed.). SanFrancisco: Daryl Fox publisher.
4. Sawant, K.C. (2011).*Human Physiology*. New Delhi: Wisdom Press/ DominantPublishers and Distributors Pvt Ltd.
5. SaradaSubrahmanyam&Madhavankutty, K. (2001). *Textbook of Human Physiology* (6th ed.). New Delhi: S. Chand and Company Ltd.
6. William. S. Hoar (1984). *General and Comparative Animal Physiology* (2thed.). Prentice Hall of India.
7. Prosser, C. L. (1991). *Comparative Animal Physiology* (4th ed.). United States:JohnWiley and Sons Ltd.
8. Nielsen Knut Schmid (2007). *Animal Physiology, Adaptation and Environment*
9. (5th ed.). New Delhi: Cambridge University Press.
10. Nagabushanam, R., Kadarkar, M.S. &Sarojini, R. (2002). *Textbook of AnimalPhysiology*. New Delhi: Oxford and IBH Publishing Company.
11. Sobti, R.C. (2008). *Animal Physiology*. New Delhi: Narosa Publishing HousePvt. Ltd.
12. Rastogi, S.C. (2007). *Essentials of Animal Physiology* (6th ed.). New Delhi: JBA Publishers.

Semester III

Core X - Genetics and Evolution

Course Code: PZ2032

Hours/ Week	Credits	Total Hours	Marks
6	4	90	100

Objectives

1. To enrich the knowledge on the principles of heredity at molecular level and to discernthe evolutionary significance.
2. To develop skills for assessing heritability, identifying genetic disorders andconstructing phylogenetic trees.

Course Outcomes

O	**pon completion of this course the students will be able :**	**PSO addressed**	**L**
O - 1	call the principles of inheritance, mutation, genetic isorders, genetic equilibrium and patterns of evolution.	SO - 1	
O - 2	escribe Linkage and crossing over, Gene concept, Hardy einberg law and gene frequency, principles and methods of olecular evolutionary studies.	SO - 1	U
O - 3	terpret the heritability and its measurements, molecular and iochemical basis of genetic diseases, gene frequencies of opulation, Universal Tree of Life, cultural evolution of man.	SO - 2	p
O - 4	nalyse the expressivity of genes, chromosome mapping, heritance of particular character through Pedigree chart, actors affecting Hardy Weinberg equilibrium and hylogenetic relationship.	SO - 3	n
O - 5	valuate allelic and non-allelic interactions, effects of utation, selection, migration, adaptation on Mendelian opulation.	SO - 4	

UNIT I

Mendelian Genetics: Mendelian principles (Dominance, segregation, independent assortment). Allelic and non-allelic interactions. Penetrance, expressivity and pleiotropism. Linkage and crossing over – types – mechanism – theories. Chromosome mapping - linkage maps, tetrad analysis, mapping with molecular markers, mapping by using somatic cell hybrids. LOD score linkage test. Polygenic inheritance. Heritability and its measurements. QTL mapping.

UNIT II

Molecular and Human Genetics: Gene concept. Mutation – types and effects of gene mutation – mutagens – insertional mutagens. DNA damage and repair. Inter and Intra chromosomal aberrations. Ploidy - kinds – mechanism – significance. Human chromosomes, Karyotyping, Chromosomal banding and painting. Pedigree analysis. Inborn errors of metabolism: Disorders of amino acid metabolism (phenylketonuria, alkaptonuria, albinism), Disorders of nucleic acid metabolism (Gout, ADA deficiency), Disorders of carbohydrate metabolism (Pompe's, G_6PD deficiency), Disorders of lipid metabolism (Tay Sach's disease, Gaucher's disease), Hemoglobin disorders (sickle cell anemia, thalassemia).

UNIT III

Population Genetics and Evolution: Mendelian populations - gene pool and gene frequencies - Hardy Weinberg law and genetic equilibrium. Calculation of gene frequencies for autosomal (dominant and recessive alleles, codominant alleles and multiple alleles) and sex-linked genes. Factors affecting Hardy Weinberg equilibrium – selection - heterozygous advantage – mutation – migration – random genetic drift – Founder's effect. Genetic load and death - neutralist hypothesis - genetic polymorphism.

UNIT IV

Molecular evolution: Principle – methods of molecular evolution – nucleotide substitution (types and rates). Interpretation of variation in DNA sequence. Molecular clock. Origin of new gene functions – evolution of novel genes and proteins. Molecular phylogeny – phylogenetic tree – reconstruction of phylogenetic relationship – Distance Matrix approach and Parsimony based approach - kinds of molecular phylogenies – Universal Tree of Life. Phylogenetic and biological concept of species. Adaptive radiation. Isolating mechanisms. Modes of speciation (allopatry and sympatry).

UNIT V

Origin of higher categories: Major trends in the origin of higher categories. Microevolution, macroevolution, megaevolution and co-evolution. Evolution rates, phyletic gradualism and punctuated equilibrium. Origin and Evolution of Primates: Evolution of Anthropoid Primates - The first hominids and origin of modern man - Bipedalism – communication – speech – language - altruism and morality. Evolution of culture.

Reference Books

1. Verma, P.S. &Agarwal, V.K. (2010).*Genetics* (9th ed.). New Delhi: S. ChandPublishing.
2. Verma, P.S. &Agarwal, V.K. (2004).*Cell Biology, Genetics, Molecular Biology, Evolution & Ecology.* New Delhi: S. Chand Publishing.
3. Peter Snustad, D. & Michael J. Simmons (2009).*Principles of Genetics* (5th ed.).USA: John Wiley & Sons, Inc.
4. Eldon John Gardner, Michael J. Simmons & D. Peter Snustad (2005). *Principles of Genetics*(8th ed.). New Delhi: Wiley (India) Pvt. Ltd.
5. Monroe W. Strickberger (2015). *Genetics* (3rd ed.). India: Pearson Education.
6. Robert F. Weaver and Philip W. Hedrick (1989).*Genetics*.New York: W. M. C.Brown Publishers.
7. Emmanuel. C., Rev. Fr. Ignacimuthu, S. & Vincent, S. (2006). *Applied Genetics*. Chennai: MJP Publishers.
8. Hickey, G. I., Fletcher, H. L. &Winter, P. (2010). *Genetics.* New York: Taylor and

Francis Group Publications.
9. Sanjib Chattopadhyay (2008). *Evolution, Adaptation and Ethology*.Kolkata: Books and Allied Pvt. Ltd.
10. Maynard Smith, J. (1999).*Evolutionary Genetics.* England: Oxford UniversityPress.
11. Monroe W. Strickberger (2000). Evolution (3rd ed.). Sudbery, Massachusetts:Jones and Bartlett Publishers.
12. Ledyard Stebbins (1971). *Processes of organic evolution.*
13. Mark Ridley (1996). *Evolution.* England: Blackwell Science Ltd.
14. Arora, M. P. (2000). *Organic Evolution.*Mumbai: Himalaya Publish House.
15. Tomar, B.S. & Singh, S.P. (2000). *Evolutionary Biology.* Meerut: RastogiPublications.
16. Ahuja, N. (2008). *Evolution and Population Genetics.* New Delhi: Pearl Books.
17. Savage, J.M. (1969). *Evolution.* New Delhi: Amerind Publishing Co. Pvt. Ltd.

Semester III

Core XI - Culture and Capture Fisheries

Course Code: PZ2033

Hours/ Week	Credits	Total Hours	Marks
6	4	90	100

Objectives

1. To impart knowledge on the construction, maintenance and management of cultivableorganisms in aqua farms.
2. To practice aqua farming and extend it to the society.

Course outcomes

O	pon completion of this course the students will be ableto	PSOs addressed	L
O - 1	call the culture of finfish, shellfish and their management.	SO - 1	
O - 2	escribe different types of aquatic organisms, construction of onds, nutrition and breeding in aquaculture.	SO - 1	
O - 3	late culture practices, breeding techniques, fish pathology, shery genetics.	SO - 2	p
O - 4	nalyse physico-chemical and nutritional factors for ptimizing aquaculture, fish marketing and preservation.	SO - 3	n
O - 5	ssess profitability of an established aqua farm.	SO - 4	

UNIT I

Purpose and importance of aquaculture - basic qualification of candidate species - cultivable freshwater and marine fishes - global and Indian scenario of aquaculture. Construction and maintenance of fish farm: selection of site - lay-out and types of ponds - aquatic plants and their control - control of fish predators - liming - fertilization of ponds. Kinds of aquaculture - Integrated fish farming - Sewage fed fish culture - Pen and cage culture.

UNIT II

Nutrition and Breeding: Nutritional requirements - Culture of fish feed organisms - phytoplankton (diatom), zooplankton (rotifers, cladocerans), Artemia, Tubifex. Artificial feed and feed formulation. Seed collection: Sex identification – collection, rearing and selection of brooders - induced breeding by hypophysation - ovaprim - transportation of fish seed.

UNIT III

Finfish culture: Culture of Indian major carps, Tilapia and murrel. Ornamental fish culture and its prospectus. **Shell fish culture**: Culture of freshwater and marine prawns, lobsters, crabs, edible and pearl oysters. **Fish pathology**: Ectoparasites, Endoparasites, Bacterial, Viral and Fungal diseases, nutritional deficiency diseases.

UNIT IV

Fishery Genetics: Chromosomes in fishes - chromosome set manipulation - gynogenesis and androgenesis - induced polyploidy. Chromosomal abnormalities - Sex determination in fishes - sex patterns - intrinsic and extrinsic factors in sex control and sex reversal. Transgenic fishes.

UNIT V

Capture Fisheries: Inland fisheries (riverine, lakesterine and cold water fisheries) - Estuarine fisheries - Marine fisheries. Crafts and fishing gears - Common fishes of Kanyakumari - Fish spoilage and methods of fish preservation – Fish Marketing and co-operative societies in aquaculture. **Economic importance of fishes**: Food value and fish by-products.

Reference Books

1. Pandey, K. &Shukla, J.P. (2005). *Fish and Fisheries*. Meerut: RastogiPublications.
2. Pillay, T.V.R. (1990). *Aquaculture: Principles and Practices.* England: Fishing News Books Ltd.
3. Jhingran, V.G. (1997). *Fish and Fisheries of India*. New Delhi: Hindustan PublishingCompany.
4. Santhanam, R. (1990). *Fisheries Science.* New Delhi: Daya Publishing House.
5. Khanna, S. S. & Singh, H. R. (2014). *A Text Book of Fish Biology andFisheries*.Delhi: Narendra Publishing House.
6. Ghosh, R. (2007). *Fish Genetics and Endocrinology*. New Delhi: SwastikPublishers.
7. Reddy, P.V., Ayyappan, G.K., Thampy, S., &Gopal Krishna, D.M. (2005). *Textbookof Fish genetics and Biotechnology*. New Delhi: Indian Council of Agricultural Research.
8. Jai Singh, P. (2008).*Fishes of Kanyakumari – A Hand Book on the Study ofFishes* (2nd ed.). Nagercoil: Tower Graphics Printer.
9. Schaperclaus, W. (2001). *Fish Diseases, Vol.I and II.* New Delhi: OxonianPrivate Ltd.
10. Santhanam, R., (2008). *A manual of Freshwater Aquaculture.* New Delhi: Oxfordand IBH Publishing Company, South Asia Books.
11. Khanna, S. S. (2005).*An Introduction to fishes*. Allahabad: Silver linePublications.
12. Santhanam, R. (2008). *A manual of Freshwater Aquaculture.* New Delhi:Oxford and IBH Publishing Company, South Asia Books.
13. Khanna, S.S. (2005). *An Introduction to fishes.* Allahabad: Silver linePublications.

Semester III

Elective III (a) - General Endocrinology

Course Code: PZ2034

Hours/ Week	Credits	Total Hours	Marks
4	3	60	100

Objectives

1. To impart knowledge on the function and the pathology of the endocrine system.
2. To develop skills for analysing clinical problems of the endocrine system and pursueresearch.

Course Outcomes

O	**pon completion of this course the students will be ble to:**	**SO ddressed**	**L**
O - 1	efine the concepts of endocrine system, hormones, iosynthesis and pathology.	PSO - 1	
O - 2	ssociate the role of the endocrine system in relation to omeostasis, growth, development, behaviour and nvironmental factors.	SO - 2	
O - 3	pply the knowledge of endocrine pathology to hormone- lated disorders.	PSO - 4	p
O - 4	nvisage women related physiological processes related endocrine glands and hormones.	PSO - 3	n
O - 5	orrelate endocrine regulation of growth, reproduction nd metamorphosis in various invertebrates and ertebrates.	PSO - 4	

UNIT I

Introduction: Historical perspective and scope of endocrinology. Endocrine methodologies - assay of hormones, surgical methods, radioisotope studies, pharmacological methods, and replacement therapy and animal models for research. Chemical messengers - neurocrine, paracrine, autocrine, endocrine, pheromones and chalones.

UNIT II

Neurosecretion and Neuroendocrine mechanisms: Neuroendocrine integration- evolution of regulatory mechanisms and endocrine control of neural function. Neuroendocrine mechanisms and functions in insects, crustaceans and non-arthropod invertebrates. Analogous neurosecretory systems of invertebrates and vertebrates.

UNIT III

Endocrine glands and hormones: Organization of the endocrine system - classification of hormones - structure, functions and patho-physiology of hypothalamus, pituitary, thyroid, parathyroid, adrenal, pancreas, gonads. Gastro-intestinal hormones.

UNIT IV

Hormone synthesis and mechanism of Hormone action: Biosynthesis, storage and release of amine (catecholamines and thyroxine), protein (growth hormone and insulin) and steroid hormones (sex hormones). Mechanism of hormone action - receptors (membrane and cytosolic) - second messengers, signal transduction, termination of hormone activity.

Pathophysiological correlates of hormone action. Endocrine disorders due to receptor number and function. Hormonal therapy.

UNIT V

Endocrine Integration: Diffuse effect of hormones - Hormonal regulation of growth, development and metabolism, reproductive cycle and pregnancy, parturition and lactation, migration (birds and fishes), behavior and hibernation, neoplastic growth, colour change in vertebrates.

Reference Books

1.Mac E. Hadley and Jonathan Levine (2009). Endocrinology. India: Pearson Education (Singapore) Pvt. Ltd.

2. Aubrey Gorbman and Howard A. Bern (1974). A textbook of Comparative Endocrinology. Bombay: John Wiley and Sons, Inc. Wiley Eastern Pvt. Ltd.
3. Barrington, E.J.W (1975). An Introduction to General and Comparative Endocrinology, 5th Ed. London: Oxford University Press.
4. Donnell Turner, C. and Joseph T. Bagnara, W.B. (1976). General Endocrinology (6th ed.). Philadelphia: Saunders Company.
5. James Griffin and Sergio R. Ojeda (1988). Textbook of Endocrine Physiology. London: Oxford University Press.
6. Prakash S. Lohar (2005). Endocrinology: Hormones and Human Health. Chennai: MJP Publishers.

Semester III

Elective III (b) – Forensic Biology

Course Code: PZ2035

Hours/ Week	Credits	Total Hours	Marks
4	3	60	100

Objectives

1. To emphasize the importance of scientific methods in crime detection.
2. To develop skills for disseminating information on the advancements in the field offorensic science.

Course Outcomes

CO	pon completion of this course the students will be ble to:	PSO addressed	L
CO - 1	call the fundamentals of forensic biology, psychology nd criminal profiling.	PSO - 1	
CO - 2	utline the use of scientific evidence in a legal context sing basic facts, fundamental principles and functionsof rensic science.	PSO - 2	
CO - 3	pply the knowledge gained on forensic, dermatoglyphic, erological and odontological techniques to render rensic service during real-time crime scenes.	PSO - 3	p
CO - 4	nalysefingerprints, personal identification evidence, bite arks and pug marks.	PSO - 3	n
CO - 5	valuate information to find strategies to resolve roblems in forensic biology.	PSO - 4	

UNIT I (Ref. 1, 2, 3)**(12 hrs.)**

Introduction to Forensic Biology: Concepts and scope, functions and historical aspects of forensic science. Importance, nature, location, collection and preservation of biological exhibits and crime scene investigation of biological evidence. Forensic dermatoglyphics - biological basis of fingerprints,formation of ridges, fundamental principles of fingerprinting, types of fingerprints, fingerprint patterns, automated fingerprint identification system.

UNIT II (Ref: 4, 5, 9, 10)**(12 hrs.)**

Forensic examinations: Forensic examination of hair - importance, nature, location, structure, growth phases of hair, collection, evaluation and tests for their identification. Forensic Serology - identification of body fluids, collection and preservation of blood evidence, distinction between human and non-human blood, semen - forensic significance of semen, composition and morphology of spermatozoa, collection, evaluation and tests for identification of semen. Composition and forensic significance of saliva, sweat, milk and urine.

UNIT III (Ref. 6, 7, 8) **(12 hrs.)**

Forensic Odontology: Structural variation, types of teeth - human and non- human teeth, determination of age from teeth, eruption sequence, dental anomalies, their significance in personal identification. Bite marks - forensic significance, collection and preservation of bite marks, photography and evaluation of bite marks, lip prints in forensic investigations.

UNIT IV (Ref. 1, 2, 6) **(12 hrs.)**

Forensic Entomology and Forensic Microbiology: Forensic Entomology - insects of forensic importance, collection of entomological evidence during death investigations. The role of aquatic insects in forensic investigations, insect succession on carrion and its relationship to determine time since death, factors influencing insect succession on carrion, its application to forensicentomology. Forensic Microbiology - types and identification of microbialorganisms of forensic significance.

UNIT V (Ref. 2, 6, 10) **(12 hrs.)**

Wildlife Forensics: Importance of Wildlife Protection Act-1972- Schedules in the protection of endangered species of flora and fauna. Identification of wildlife materials such as skin, fur, bones, nails, horn, teeth, plants, plant parts and products by conventional and modern methods. Identification of pug marksof various animals, DNA techniques in wildlife investigations.

Reference Books

1. S. Chowdhuri (1971). *Forensic Biology*. New Delhi: BPRD.
2. R. Saferstein (1993). *Forensic Science Handbook* (Vol. 3). New Jersey: Prentice Hall.
3. R.S. Ramotowski (2013). *Lee and Gaensleen's, Advances in Fingerprint Technology*
4. (3rd ed.). Boca Raton: CRC Press.

5. L. Stryer, (1988). *Biochemistry* (3rd ed.). New York: W.H. Freeman and Company.
6. R.K. Murray, D.K. Granner, P.A. Mayes and V.W. Rodwell, (1993).*Harper's Biochemistry.* Norwalk: APPLETON and Lange.
7. M. Bernstein (1997). *Forensic odontology in, Introduction to Forensic Sciences* (2nd ed.), W.G. Eckert (Editor). Boca Raton: CRC Press,
8. J. Dix (1999). *Handbook for Death Scene Investigations*. Boca Raton: CRC Press.
9. V.J. Geberth, (2006). *Practical Homicide Investigation.* Boca Raton CRC Press,
10. W.G. Eckert and S.H. James (1989).*Interpretation of Bloodstain Evidence at Crime Scenes*. Boca Raton: CRC Press.
11. G.T. Duncan and M.I. Tracey (1997). *Serology and DNA typing in, Introduction to Forensic Sciences* (2nd ed.), W.G. Eckert (Editor.). Boca Raton: CRC Press.

Semester III
PG Self-Learning Course

Life Science for Competitive ExaminationsCourse Code: PZ20S1

No of credits	Marks
2	100

Learning Objectives

1. To enable the students to gain knowledge on various fields of life sciences.
2. To face competitive examinations like UGC-CSIR, NET and other similar examinations.

Course Outcomes

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	recall the terms inMolecular Cell Biology, Developmental Biology, Taxonomy, Physiology, Inheritance, Ecology and Evolution.	PSO - 1	R
CO - 2	summarise related concepts of biology.	PSO - 4	U
CO - 3	apply the acquired knowledge in entry level services.	PSO - 2	Ap
CO - 4	analyse and interpret the concepts for research and higher education.	PSO - 3	An

UNIT I

Molecular Cell Biology: Membrane structure and function:Structure of cell membrane, lipid bilayer and membrane protein diffusion, osmosis, ion channels, active transport, membrane pumps, mechanism of sorting and regulation of intracellular transport, electricalproperties of membranes. Structural organization and function of intracellular organelles: Cell wall, nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, chloroplast, structure and function of

cytoskeleton and its role in motility. Organization of genes and chromosomes: Operon, unique and repetitive DNA, interrupted genes, gene families, structure of chromatin and chromosomes, heterochromatin, euchromatin, transposons. Cell division and cell cycle:Mitosis and meiosis, steps in cell cycle, regulation and control of cell cycle. DNA replication, repair and recombination: Unit of replication, enzymes involved replication origin and replication fork, fidelity of replication, extrachromosomal replicons, DNA damage and repair mechanisms, homologous and site-specific recombination. RNA synthesis and processing: transcription factors and machinery, formation of initiation complex, transcription activator and repressor, RNA polymerases, capping, elongation, and termination, RNA processing, RNA editing, splicing, and polyadenylation, structure and function of different types of RNA, RNA transport. Protein synthesis and processing: Ribosome, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, genetic code, aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase, and translational proof-reading, translational inhibitors, Post- translational modification of proteins. Control of gene expression at transcription and translation level: regulating the expression of phages, viruses, prokaryotic and eukaryotic genes, role of chromatin in gene expression and gene silencing.

UNIT II

Developmental Biology and Taxonomy: Basic concepts of development: Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting; mutants and transgenics in analysis of development. Gametogenesis, fertilization and early development: Production of gametes, cell surface molecules in sperm-egg recognition in animals; embryo sac development and double fertilization in plants; zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals; embryogenesis, establishment of symmetry in plants; seed formation and germination. Morphogenesis and organogenesis in animals: Cell aggregation and differentiation in *Dictyostelium*; axes and pattern formation in *Drosophila*, amphibia and chick; organogenesis – vulva formation in *Caenorhabditis elegans*, eye lens induction, limb development and regeneration in vertebrates; differentiation of neurons. Post embryonic development - larval formation, metamorphosis; regeneration, environmental regulation of normal development; sex determination. Programmed cell death, aging and senescence. Principles & methods of taxonomy: Concepts of species and hierarchical taxa, biological nomenclature, classical & quantitative methods of taxonomy of plants, animals and microorganisms. Levels of structural organization: Unicellular, colonial and multicellular forms. Levels of organization of tissues, organs & systems.Comparative anatomy, adaptive radiation, adaptive modifications.Outline classification of animals and microorganisms: Important criteria used for classification in each taxon. Classification of plants, animals and microorganisms.Evolutionary relationships among taxa.

Unit III

System Physiology – Animal: Blood and circulation: Blood corpuscles, haemopoiesis andformed elements, plasma function, blood volume, blood volume regulation, blood groups, haemoglobin, immunity, haemostasis. Cardiovascular System: Comparative anatomy of heart structure, myogenic heart, specialized tissue, ECG – its principle and significance, cardiac cycle, heart as a pump, blood pressure, neural and chemical regulation. Respiratory system:Comparison of respiration in different species, anatomical considerations, transport of gases, exchange of gases, waste elimination, neural and chemical regulation of respiration. Nervous system: Neurons, action potential, gross neuroanatomy of the brain and spinal cord, central and peripheral nervous system, neural control of muscle tone and posture. Excretory system:Comparative physiology of excretion, kidney, urine formation, urine concentration, waste elimination, micturition, regulation of water balance, blood volume, blood pressure, electrolyte balance, acid-base balance. Digestive system: Digestion, absorption, energy balance, BMR. Thermoregulation: Comfort zone, body temperature – physical, chemical, neural regulation, acclimatization. Stress and adaptation.Endocrinology and reproduction: Endocrine glands, basic mechanism of hormone action, hormones and diseases; reproductive processes, gametogenesis, ovulation,neuroendocrine regulation.

UNIT IV

Inheritance Biology: Mendelian principles: Dominance, segregation, independent assortment. Extensions of Mendelian principles: Codominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, penetrance and expressivity, phenocopy, linkage and crossing over, sex linkage, sex limited and sex influenced characters. Concept of gene: Allele, multiple alleles, pseudoallele, complementation tests. Gene mapping methods: Linkage maps, tetrad analysis, mapping with molecular markers, mapping by using somatic cell hybrids, development of mapping population in plants. Extra chromosomal inheritance: Inheritance of Mitochondrial and chloroplast genes, maternal inheritance. Microbial genetics: Methods of genetic transfers – transformation, conjugation, transduction and sex-duction, mapping genes by interrupted mating, finestructure analysis of genes. Human genetics: Pedigree analysis, Lod score for linkage testing, karyotypes, genetic disorders. Quantitative genetics: Polygenic inheritance, heritability and its measurements, QTL mapping. Mutation: Types, causes and detection, mutant types – lethal, conditional, biochemical, loss of function, gain of function, germinal verses somatic mutants, insertional mutagenesis. Structural and numerical alterations of chromosomes: Deletion, duplication, inversion, translocation, ploidy and their genetic implications. Recombination: Homologous and non-homologous recombination including transposition.

UNIT V

Ecology and Evolution: The Environment: Physical environment; biotic environment; biotic and abiotic interactions. Habitat and Niche: Concept of habitat and niche; niche width and overlap; fundamental and realized niche; resource partitioning; character displacement. Population Ecology: Characteristics of a

population; population growthcurves; population regulation; life history strategies (*r* and *K* selection); concept of metapopulation- demes and dispersal, interdemic extinctions, age structured populations. Community Ecology: Nature of communities; community structure and attributes; levels of species diversity and its measurement; edges and ecotones. Ecological Succession: Types; mechanisms; changes involved in succession; concept of climax. Ecosystem Ecology: Ecosystem structure; ecosystem function; energy flow and mineral cycling (C, N, P); primary production and decomposition; structure and function of some Indian ecosystems: terrestrial (forest, grassland) and aquatic (fresh water, marine, estuarine). Biogeography: Major terrestrial biomes; theory of island biogeography; biogeographical zones of India. Conservation Biology: Principles of conservation, major approaches to management, Indian case studies on conservation/management strategy (Project Tiger, Biosphere reserves).Emergence of evolutionary thoughts: Lamarck; Darwin - concepts of variation, adaptation, struggle, fitness and natural selection; Mendelism; Spontaneity of mutations; The evolutionary synthesis. Origin of cells and unicellular evolution: Origin of basic biological molecules; Abiotic synthesis of organic monomers and polymers; Conceptof Oparin and Haldane; Experiment of Miller (1953); The first cell; Evolution of prokaryotes; Origin of eukaryotic cells; Evolution of unicellular eukaryotes; Anaerobic metabolism, photosynthesis and aerobic metabolism. Paleontology and Evolutionary History: The evolutionary time scale; Eras, periods and epoch; Major events in the evolutionary time scale; Origins of unicellular and multi cellular organisms; Major groups of plants and animals; Stages in primate evolution including Homo.

Reference Books

1. Vijay N. Waghmare (2004). *Life sciences for NET/SLET exams of UGC-CSIR.*Maharashtra:Mudra Publication.
2. Dr. A P Singh and Kumar Pushkar (2010). *CSIR-UGC NET/JRF/SLET Life Sciences (Paper I & II).* New Delhi: Upkar Publishers.
3. ArunChaudhary, B. L., Chaudhary and KailashChoudhary (2007). *CSIR/NET Life Sciences*. New Delhi: New Age Publishers.
4. Kumar Pranav Mina Usha (2011). *CSIR-JRF-NET: Life Sciences Fundamentals and Practice (Part - I).* New Delhi: Pathfinder Academy.
5. AshishNagesh, Quaisher J. Hossain, Prashant Kumar (2012). *UGC-CSIR NET (JRF &LS) Life Science*. Chennai: Arihant Publishers.
6. Rupendra Singh (2014). *CSIR NET/JRF Life Sciences* (4thed.). Lucknow: Catalyst Center of Excellence Pvt. Ltd.
7. Pramod Singh (2014). *Trueman's UGC CSIR-NET Life Sciences.*NewDelhi:Danika Publishing Company.
8. RPH (2014). *CSIR-UGC NET Life Science (Popular Master Guide): Life Sciences,* RPH Editorial Board.

Semester IV

Core XII – Microbiology

Course Code: PZ2041

Hours/ Week	Credits	Total Hours	Marks
6	4	90	100

Objectives

1. To facilitate the students to understand the microbes and their significance.
2. To develop skills in microbial techniques relevant to industries, environment anddisease management.

Course Outcomes

CO	pon completion of this course the students willbe ble to:	SO ddressed	CL
CO - 1	escribe the structure, distribution and life cycle of icroorganisms and their role in human welfare.	PSO - 1	R
CO - 2	xplain culture techniques, growth, fermentation and icrobial products.	PSO - 2	U
CO - 3	pply the microbiological laboratory skills in clinical search, food industries and environmental anagement.	PSO - 3	Ap
CO - 4	nalyze beneficial and harmful microbes	PSO - 3	An
CO - 5	valuate the microbial importance and applications in arious fields.	PSO - 4	E

UNIT I

Introduction: History and scope, classification of microorganisms, Whittaker's five kingdom classification, three domain classification. Virus - General properties, structure of viruses, viral taxonomy, bacteriophages, reproduction of DNA and RNA phages, temperate bacteriophages and lysogeny, cytocidal infections and cell damage, persistent, latent and slow virus infections. Cultivation of viruses and purification assays. Viruses and cancer. Viroids and prions.

UNIT II

Bacteria: Classification, Bergey's system of bacterial classification, Bacterial morphology and fine structure of Escherichia coli. Bacterial nutrition - Common nutrient requirements, Nutritional classes, Uptake of nutrients. Bacterial growth and measurement of growth - Influence of environmental factors on growth, Synchronous growth, Continuous culture, Chemostat and turbidostat. Types of culture media - Pure culture and methods of isolating pure cultures (streak plate technique and pour-plate technique).

UNIT III

Industrial Microbiology: Fermentation and microbes - fermenter and types of fermenters (air-lift fermenter and stirred tank fermenter). Production of microbial products - alcohol (ethanol), antibiotics (penicillin), vitamin B_2 and Vitamin B_{12}. Biofertilizers - steps for preparing bacterial biofertilizers, mass cultivation of Cyanobacteria and Azolla, production of mycorrhizal fungi and VAM fungi. Bacterial insecticides – Pseudomonas species and Bacillus species. Food spoilage and food preservation.

UNIT IV

Environmental Microbiology: Drinking water and microbiological analysis of water purity - Coliform test, Most Probable Number (MPN) test, and Membrane Filter (MF) test. Purification of water. Sewage treatment – small scale, large scale (primary, secondary and tertiary) treatment. Biogas production – solubilization, acetogenesis and methanogenesis. Microbial leaching – copper and uranium leaching. Biodegradation of petroleum and xenobiotics.

UNIT V

Antimicrobial agents: classification, Drug administration, determination of antimicrobial activity, mechanism of antimicrobial agents, effectiveness of antimicrobial drugs, drug resistance, drug dosage, antibacterial drug (penicillin), antifungal drug (nystatin), antiviral drug (amantadine). Current problems of antibiotic resistance in man. Microbes and diseases - Gnotobiotic animals, distribution of normal micro biota of the human body, Mechanism of microbial pathogenesis, Nosocomial infections. Protozoan diseases - Malaria and Amoebiasis. Fungal diseases - Mycotoxicosis and Aspergillosis. Bacterial diseases - Air borne diseases – Meningitis and Streptococcal pneumonia. Food and water borne diseases - Cholera and Typhoid. Soil borne diseases - Tetanus and Anthrax. Sexually transmitted and contact diseases – Gonorrhea and Syphilis. Viral diseases - Ebola, Hepatitis-B, Rabies and AIDS.

Reference Books

1. Dubey R.C. &Maheswari, D.K. (2010).*A textbook of Microbiology* (3rd ed.).New Delhi: S. Chand and Co.
2. Joanne, M., Wiley Linda M., Sherwood Christopher J. &Woolverton. (2013). Prescott's Microbiology. America: McGraw-Hill International.
3. ArtiKapil. (2013). Anandanarayan&Paniker's textbook of Microbiology. Hyderabad:Universal Press.
4. John L. Ingraham & Catherine A. (2004).*Introduction to Microbiology*. UK:Ingraham Thomson Brooks /Cole.
5. Alcamo E. (2001). Fundamentals of Microbiology.6th Ed. New Delhi: Jones and Bartlett Publishers.Pelzar, Chan and Krieg (2006). *Microbiology*.New Delhi: Tata McGraw Hill Publishing Company. Ltd.
6. Vijaya Ramesh, K. (2004).*Environmental Microbiology*. Chennai: MJP Publishers.
7. Powar, C.B. and Daginawala, H.F. (2008). *General Microbiology*, Vol. 2. Chennai:Himalaya Publishing House.
8. Singh, R.P. (2007). *General Microbiology*. New Delhi: Kalyani Publishers.
9. Johri R.M., Snehlatha, Sandhya Sharma (2010). *A Textbook of Algae*. New Delhi:Wisdom Press.

Semester IV

Major Core XIII - Biotechnology and Nanobiology

Course Code: PZ2042

Hours/ Week	Credits	Total Hours	Marks
6	4	90	100

Objectives

1. To enable the students to understand the essence of biotechnology and becomeaware of the advances in Nanobiology.
2. To develop skills to apply biotechnological principles in research related togenetic manipulations, industrial and environmental biotechnology.

Course Outcomes

O	pon completion of this course the students will be ble to:	PSO addressed	L
O - 1	xplain the various techniques used in modern iotechnology.	SO - 1	
O - 2	utline the basic concepts of Biotechnology and anobiology, its application and threat to the society.	SO - 2	
O - 3	pply the biotechnological principles in research and dicial use of bio- and nanotechnology to solve societal roblems.	SO - 2	p
O - 4	nalyze the impact of biotechnological products and enetically modified organisms in bioremediation.	SO - 3	n
O - 5	valuate the function, gene modulation and their effectson nprovement of crops and animals after the applications f cloned genes.	SO - 4	
O - 6	esign simple experiments on biotechnology and ommunicate the results through publication.	SO - 3	

UNIT I

Gene cloning: Basic steps of gene cloning, restriction and modifying enzymes, linkers and adaptors, cloning and expression vectors, construction of chimeric DNA, nucleic acid probes, DNA libraries, polymerase chain reaction, molecular markers, DNA sequencing, synthesis of oligonucleotides. Human Genome Project.

UNIT II

Animal Biotechnology: Primary culture and cell lines, pleuripotent stem cell lines, tissue engineering. In vitro fertilization and embryo transfer in animals; gene transfer methods. Primary explantation techniques – organ and embryo culture – transgenic animals and the knockouts. Biotechnology and aquaculture - ploidy induction, gynogenesis and androgenesis.

UNIT III

Medical Biotechnology: Hybridoma technology and Monoclonal antibodies – Applications of biotechnology in medicine, Vaccines, diagnostics and forensics. Gene therapy – Pharmacogenomics. **Enzyme biotechnology**: Isolation and purification of enzymes, uses of enzymes in industries, immobilization of enzymes and their uses, Biosensors. Terminator and traitor technology. Intellectual Property Rights.

UNIT IV

Industrial and Environmental Biotechnology: Production of metabolites - Downstream processing and in situ recovery of products, microbial biotransformation, microbial biomass production (SCP). Bioremediation and phytoremediation - Genetically engineered microorganisms (GEMs) - treating oil spills, detection of pesticide in soil and their degradation, sequestering heavy metals. Biomining and Biofuels.

Unit V

Nanomaterials: Types and properties, DNA and protein nanoarrays, biosystems (microbes) as nanofactories. Application of nanotechnology - medical diagnostics, imaging and drug delivery, agro-practices and food related nanoproducts, cosmetics, contact lenses and dental implants. Nanotechnological approaches for environmental remediation, prevention of contamination, environment maintenance and quality enhancement. Risks and threats of nanoparticles in environment.

Reference Books

1. Gupta P.K. (2009). *Elements of Biotechnology.* Meerut: Rastogi Publications.
2. Singh B.D. (2003). *Biotechnology - Expanding Horizons.* Chennai: KalyaniPublishers.
3. Satyanarayana V. (2004).*Biotechnology.* Kolkata: Books and Allied (P) Ltd.
4. Dubey R.C. (2006). *A Textbook of Biotechnology* (4th ed.). New Delhi: S. ChandandCo. Ltd.
5. Rema L.P. (2006). *Applied Biotechnology.* Chennai: MJP publishers.
6. Prakash S. Lohar, (2012). *Biotechnology.*Chennai: MJP publishers.
7. Madhuri Sharon, Maheshwar Sharon, Sunil Pandey& Goldie Oza (2012). *BioNanotechnology: Concepts and Applications.* New Delhi: Ane Books Pvt.Ltd
8. VinodLabhasetwar&Diandra. L. Leslie-Pelecky (2007). *Biomedical applications of Nanotechnology.* New Jersey: Wiley Publications. Jo Anne Shatkins (2008). *Nanotechnology: Health and Environmental Risks.*New York: CRC Press.
9. Y.S. Raghavan (2010). *Nanostructures and Nanomaterials: Synthesis properties andapplications.* New Delhi: Arise Publishers and distributors.
10. Parthasarathy, B.K. (2007). *Nanotechnology in Life Science.* New Delhi: IshaBooks.
11. Rakesh K. Yadav (2009). *Investing in Nanotechnology.* New Delhi: Mangalam Publications.

Semester IV

Core IVX - Immunology

Course Code: PZ2043

Hours/ Week	Credits	Total Hours	Marks
5	4	75	100

Objectives

1. To facilitate the students to appreciate the defense functions of the immune system.
2. To develop the skill to determine the immunomodulatory strategies used to enhance orsuppress the immune response.

Course Outcomes

O	**pon completion of this course the students will be able :**	**PSO addressed**	**L**
O - 1	call the importance of immunity, immune response, MHC, CR and TCR, antigen –antibody interaction.	SO - 1	
O - 2	late the evolution of immune molecules in different groupsof nimals, immunodeficiency diseases and immunotechniques.	SO - 1	
O - 3	ake use of immunization schedules, differentiate the typesof ypersensitive allergic reactions and symptoms.	SO - 2	p
O - 4	nalyse the immune response in relation to toxicants, accines, tumour, and infectious diseases.	SO - 3	n
O - 5	valuate the role of immune cells and humoral factors in nmune response	SO - 3	
O – 6	redictimmuno-nano materials for immunodiagnostic, erapeutic techniques and research.	SO - 4	

UNIT I

Immune system in invertebrates and vertebrates: Immunity - Innate and acquired, II, III and IV line of defense. Types – natural and artificial - active and passive immunity; Lymphoid organs and cells involved in immune response. Antigens and Immunoglobulins – characteristics, haptens, types. Immune Response: Humoral and Cell mediated immune response - primary and secondary immune response, importance of B cells in humoral immune response (antibody formation), factors influencing antibody formation. Immunological memory (Anamnesis). Immunization: immunization schedule and vaccines. **UNIT II**

Major and minor histocompatibility complex: MHC class I and II molecules, cellular distribution and regulation of MHC expression, MHC in immune responsiveness, MHC and susceptibility to infectious diseases. Minor histocompatibility (H) antigens. Immune effector mechanisms: Cytokines and their functions, Complement system – classical and alternate pathways, biological functions.

UNIT III

B and T cell: B cells - Maturation, activation and differentiation - B cell receptor (BCR) - B cell co-receptor complex - signal transduction from B cell antigen receptor, major pathways of BCR signaling. T cells - maturation, activation and differentiation, T cell receptor (TCR), T cell co-receptor complex - formation of T and B cell conjugates, Co-stimulation in T cell response and signal transduction. Clonal anergy. Antigen processing and presentation – role of antigen presenting cells – cytosolic pathway and endocytic pathway.

UNIT IV

Immune system in health and diseases: Tumour immunology - properties of tumour cells, causes of tumours, tumour antigens, immune response to tumour, immune surveillance, immunodiagnosis of tumour antigens, immuno therapy of tumour. Hypersensitivity: factors causing hypersensitivity, Type I, II, III, and IV reactions. Immunodeficiency - primary and secondary. Autoimmune diseases - characteristics, causes, classification, localized (Diabetes mellitus, Addison's disease) and systemic (systemic lupus erythematosus, rheumatoid arthritis). Immune response to infectious diseases and treatment - Protozoan disease (Malaria), Bacterial disease (Tuberculosis), Viral disease (AIDS).

UNIT V

Antigen-antibody interaction: strength, affinity, avidity and cross reactivity. Complement fixation test - precipitation reaction in fluids and precipitin curve. Radial immunodiffusion and double immunodiffusion. Immunoelectrophoresis – counter and rocket electrophoresis.

Agglutination reaction - hemagglutination, bacterial agglutination, coated particle agglutination,agglutination inhibition. Radio immuno assay - ELISA – Western blotting - Immunofluorescence - Flow cytometry.

Transplantation: classification of grafts, mechanism of graft rejection, graft versus host reaction, immuno Suppressivtherapyduringtransplantation

Reference Books

1. Goldsby, R.A., Kindt, T.J. & Osborne, B.A. (2007). *Kuby's Immunology* (6thed.). New York: W.H. Freeman and Company.
2. Deves, P., Martin, S., Burton, D. &Roitt I.M. (2017). *Roitt's Essential Immunology* (13thed.). Oxford: Wiley-Blackwell Scientific Publication.
3. Ashim, K., Chakravarthy (2007). *Immunology and Immunotechnology* (2th ed.). Delhi: Saurabh Printers Pvt. Ltd.
4. Dasgupta, A. (1992). *Modern Immunology* (2th ed.). New Delhi: Jaypee BrothersMedical Publications Pvt. Ltd.
5. Gupta, S.K. (1991). *Immunology perspectives in Reproduction and Infection.*New Delhi: Oxford and IBH publication Co. Pvt. Ltd.
6. Hannigan, B.M., Moore, C.B.T. & Quinn, D.G. (2010). *Immunology* (2th ed.).India: Viva Book Pvt. Ltd.
7. Rao, C.V. (2006). *Immunology* (2th ed.). Chennai: Narosa Publishing House.
8. Murphy, K., Travers, P. and Walport, M. Garland (2008). *Janeway's Immunobiology* (7th ed.). New York: Science Publishers.
9. Dulsy Fathima and Arumugam, N. (2020). Immunology. Nagercoil: Saras Publications.

Semester IV

Core XV - Medical Laboratory Technology

Course Code: PZ2044

Hours/ Week	Credits	Total Hours	Marks
5	4	75	100

Objectives

1. To impart knowledge on laboratory principles, clinical analysis and safety measures inhandling samples.
2. To develop skills on laboratory investigations adopted in medical diagnosticlaboratories.

Course Outcomes

CO	pon completion of this course the students will be ble to:	PSO addressed	CL
CO - 1	utline the laboratory principles applied in diagnosis of isease and methods of biomedical waste disposal.	PSO - 1	R
CO - 2	xplain the type of specimens, collection and use of ppropriate diagnostic techniques.	PSO - 2	U
CO - 3	repare reagents, handle instruments and perform clinical nalysis.	PSO - 3	Ap
CO - 4	terpret and validate the results.	PSO - 4	An

UNIT I (Ref.1, 5)**(15 hrs.)**

Laboratory instruments and safety measures: Scope of Medical laboratory technology. Laboratory principles - Organization of clinical laboratory - Role of medical laboratory technician. Laboratory instruments: Common glass wares in clinical laboratory - Centrifuges - Water bath – Refrigerator – Autoclave - Hot air oven – Mixer – Laminar air flow – Microscope – Analyser –Spectrometer – Cell counter - Blood bank. Safety measures - Cleaning and sterilization methods -antiseptics and disinfectants - hospital and clinic borne infection and personnel hygiene.

UNIT II (Ref. 1, 2, 3, 5, 6)**(15 hrs.)**

Clinical sample collection, processing and storage: Specimen collection and processing of blood, urine and cerebrospinal fluid, separation of serum and plasma, Handling of specimens for testing, preservation and transport of specimen, factors affecting the clinical results, effect of storage on sample. Anticoagulants: EDTA, Di- potassium salts of EDTA, oxalate, sodium citrate and sodium fluoride. Techniques of sample processing: Throat Swab, Sputum, blood, urine, stool, pus, CSF, other body fluids, other swabs like from wounds, skin clipping, spore strips.

UNIT III (Ref.1, 2, 3, 5, 6, 7, 8)**(15 hrs.)**

Body fluid analysis: Physical, chemical and microscopical examination of cerebrospinal fluid, pleural fluid, synovial fluid. Haematological techniques - Haemoglobin estimation, Erythrocyte Sedimentation Rate, Differential count, Total Red Blood cell count, Total White blood cell count, Platelet count. Blood banking technology - Blood typing, collection and storage and plasma separation.Diagnosis of Covid-19.

UNIT IV (Ref. 1, 3, 5) **(15 hrs.)**

Histopathology: Introduction of histopathology, labelling and transportation of tissuespecimens, tissue processing- fixation, sectioning, staining and mounting, manual and automated method. Cryostat, frozen sections of fresh, fixed and unfixed tissue, freeze drying, rapid frozen sections and staining for emergency diagnosis.

UNIT V (Ref. 1, 2, 3, 7, 8)**(15 hrs.)**

Clinical sample analysis and biomedical waste management: Physical, chemical and microscopical examination of sputum, urine and stool. Routine examination of urine and their clinical significance. Pregnancy test. Semen: Sample collection and microscopic examination for count and morphology. Bio-medical waste – waste generation, segregation ,disposal. Management of Bio-medical Waste, Technologies for Treatment for BMW, Legal Aspects and Environment Concern. COVID

Reference Books

1. Mukerjee, K. L. & S. Ghosh, (2010). *Medical Laboratory Technology,* Volume I, II,III. New Delhi: McGraw Hill.
2. Sood. R. (2006).*Textbook of Medical Laboratory Technology*. New Delhi: Jaypee.
3. Rajan, S. (2012). *Manual for Medical Laboratory and Technology* (1st ed.). Chennai:Anjanaa Book House.
4. John Bernard Henry (2001). *Clinical diagnosis and management by laboratoryMethods* (20th ed.). Philadelphia: Saunders & Co.
5. Mary Vijaya, T., Mini, M.L., SunithaKumari, K. &Asha, K.R.T. (2003).*Practical Clinical Biochemistry Manual.*Kaliakkavilai: Rishi Publications.
6. Himadri Panda (2019). *Biomedical Waste Management, Recycling and Applications*(1st ed.). India: Discovery Publishing house Pvt. Ltd.
7. Najih A. Naser&Saleh A. Naser (1998).*Clinical Chemistry Laboratory Manual*.USA: Moshby Inc.
8. SabtiriSanyal (2000). *Clinical Pathology*. Delhi: Reed Elsevier India Pvt. Ltd.

Semester IV

Elective IV (a) - Parasitology

Course Code: PZ2045

Hours/ Week	Credits	Total Hours	Marks
4	3	60	100

Objectives

1. To enable the students to be aware of the cosmopolitan distribution ofparasites, vectors and their control measures.
2. To develop skills for employment in clinical laboratories and healthdepartments.

Course Outcomes

O	pon completion of this course the students will be ble to:	PSO addressed	L
O - 1	efine the basic biology and life cycle of parasites cluding epidemiology, diagnosis and treatment.	SO - 1	
O - 2	xplain morphological characters of parasites, evelopmental stages and their infestation.	SO - 1	
O - 3	entify appropriate techniques and develop basic skills for etection of parasites.	SO - 3	p
O - 4	halyse the medical and public health aspects of human arasitic infections.	SO - 2	n
O - 5	ompare the diagnostic methods of parasitic infestation in eterinary hospitals, clinics and research laboratories.	SO - 4	

UNIT I

Introduction: Historical perspectives - taxonomy and classification of parasites – origin and evolution of parasitism - host parasite relationship, classification of parasites and hosts– transmission of parasites – Parasitic zoonoses – pathogenesis - clinical manifestations of parasitic diseases.

UNIT II

Protozoan parasites: Introduction and classification. Intestinal Amoeba - Pathogenic free living amoeba – Intestinal flagellates – Trypanosomiasis, Leishmaniasis, Balantoidiasis, Malaria, Isosporiasis, Toxoplasmosis, Cryptosporidiosis, Pneumocytosis. Protozoans of minor medical importance.

UNIT III

Helminth parasites: Trichiuriasis, Trichinellosis, Strongyloidiosis, Ascariasis, Enterobiosis, Filariasis, hook worm diseases, Dracunculiasis, Onchocerciasis, Loiosis – Larva migrants. Nematodes of lesser medical importance - Diphyllobothriasis, Taeniasis, Echinococcosis, Sparganosis, Schistosomiasis, Fascioliosis, Fasciolopsiasis, Paragonimiasis, Clonorchiasis, Trematodes of minor medical importance.

UNIT IV

Parasitic Insects: Prevalence, transmission and control of parasitic infections. Parasitic infection in compromised host. Applied Parasitology: Eosinophilia in parasitic infections, Nosocomial parasitic infections. Evasion and parasitic mode of life – morphological, biochemical and ethological adaptations. Quality assurance and laboratory safety.

UNIT V

Diagnostic methods in parasitology: Microscopical examination of blood, stool, urine, sputum and biopsy material for parasites – general rules for microscopical examination. Cultural examination - preparation of media – techniques for cultivation of E. histolytica, Leishmania, Plasmodium. Immunodiagnostic methods – ELISA, AGD, IHA, IFAT, CFT, DAT, IB, WB, BF, DFAT. Molecular characterization of stage specific antigen nucleotide probes for diagnosis of protozoan diseases.

Reference Books

1. Cheng, C.T. (1964). *The Biology of Animal Parasites.* Tokyo: Toppan Company Ltd.
2. Chatterjee, K.D. (1981). *Parasitology.* Calcutta: Chatterjee Medical Publishers.
3. Rajesh Karyakarte&AjitDamle (2008).*Medical Parasitology* (2nd ed.). Kolkata: Books and Allied (P) Ltd.
4. Ichhpujani R.L. & Rajesh Bhatia (2002).*Medical Parasitology.* New Delhi: Jaypee printers.
5. Patvaik, B.D. (2001). *Parasitic Insects.* Delhi: Dominant Publishers and Distributors.
6. Jones, A.W. (1976). *Introduction to Parasitology.* Boston, USA: Addison-Wesley Publishing Company.
7. Subah, C.P. (2001). *Textbook of Medical Parasitology.* Chennai: All India publishers and Distributors.

Semester IV

Elective IV (b) - Applied Entomology

Course code: PZ2046

Hours/ Week	Credits	Total Hours	Marks
4	3	60	100

Objectives

1. To impart knowledge on insect diversity and economically important insects.
2. To develop skill to collect, identify and differentiate pests from productive insects and their management.

Course Outcomes

O	**pon completion of this course the students will be ble to :**	**PSO addressed**	**L**
O - 1	entify locally available insects, the pests of agriculture, omestic animals and public health, types of infestations nd their control measures.	SO - 1	
O - 2	istinguish the salient features of insects, beneficial sects, pests and their control measures.	SO - 1	
O - 3	emonstrate research and effective communication skills,to commend the application of safer pest control easures.	SO - 4	p
O - 4	nalyze the types, damages and loss caused by pests andtheir ffective control measures.	SO - 2	n
O - 5	esign an experiment to evaluate the effectiveness of ethods of pest control.	SO - 3	

UNIT I (Ref.1, 3, 5, 8, 9)**(12 hrs.)**

Insecta: Salient features of Class Insecta and orders - Orthoptera, Isoptera, Hemiptera, Diptera, Coleoptera, Lepidoptera, Dermaptera, Odonata, Neuroptera and Hymenoptera. Categories of pests (major and minor) – based on occurrence, types and level of infestation.Types of damage caused by insect pests to crops.Causes of pest outbreak.

UNIT II (Ref. 3, 4, 5, 6, 7)**(12 hrs.)**

Agricultural Entomology: Life history and control measures of agriculture crop pest – Cereal - Paddy(*Scirpophagaincertulas)*, Oil seeds - Coconut (*Oryctes rhinoceros*), Maize (*Chilopartellus*), Vegetables – Brinjal (*Leucinodes orbonalis),* Okra(*Eariasvitella*), Pulses (*Helicoverpaarmigera*), Fruits – Banana(*Odoiporuslongicollis),* Mango (*Ste Sitophilus oryzae*).

UNIT III (Ref. 2, 3, 4, 6)**(12 hrs.)**

Pests of Domestic Animals: Stable fly and cattle fly; Fowl - shaft louse and chicken flea; sheep and goat - head maggot and sheep ked. Insects associated with medical importance and management - head louse*Pediculushumanuscapitis*, mosquitoes - *Anopheles*, *Culex*, *Aedes*, flea - *Xenopsyllacheopis,* eye fly, sand fly, ticks, mites and bed bug. Insects associated with household insects - cockroaches, termites and silverfish.

UNIT IV (Ref. 2, 3, 4, 5)**(12 hrs.)**

Productive and beneficial insects: Types**,** Life cycle and economic importance - honey bees and Silkworms. Lac insects – lac cultivation, shellac.Biological control agents- Lacewings, ladybird beetles, *Trichogramma*.Pollinators, Weed killers, Scavengers, Insect as food and feed.Insects as biological indicators and experimental models. Cochineals - *Dactylopiuscoccus*. Medicinally important insects.

UNIT V (Ref. 6, 7, 8, 9)**(12 hrs.)**

Pest management: Assessment of pest status. Economic Injury Level, Pest Control - Chemical control - pesticides. Biological control - predator, parasites, biocides and microbial control. Recent trends in pest control - Pheromones, Attractants, Repellents, Antifeedants, Chemosterilants and chitin inhibitors. Host - plant resistance to insects, *Bt* cotton - concepts and application. Concepts of Biointensive Integrated Pest Management (BIPM) and biopesticides.

Reference Books

1. Ambrose, D.P (2017). *The Insects: Structure, Function and Biodiversity* (2nd ed.). Ludhiana: Kalyani Publishers.
2. Ambrose, D.P. (2017. *The Insects: Beneficial Harmful Aspects* (2nd ed.). Ludhiana: Kalyani Publishers.
3. David, B &Ananthakrishnan, T.N. (2016). *General and Applied Entomology* (2nd ed.).New Delhi: Tata McGraw hill publishing company Ltd., India.
4. Vasantharaj David, B. & Ramamurthy, VV. (2012). *Elements of Economic Entomology* (7thed.). Chennai: Namratha publications.
5. Awasthi, V.B. (2012). *Introduction to General and Applied Entomology* (3rd ed.). India: Scientific publishers,
6. AbishekShukla, D. (2009).*A Handbook of Economic Entomology*. New Delhi:
7. edams eBooks.
8. Ministry of Agriculture, Government of India (1995). *Manual on Integrated Pest Management in Rice & Cotton*.
9. Chapman RF. (1998). *The Insects: Structure and Function*. Cambridge: Cambridge Univ. Press.
10. Romoser, W.S &Stoffolano, J.G. (1998). *The Science of Entomology*. New York:McGraw-Hill Company.

Semester III

Practical III - Physiology & Genetics and EvolutionCourse code: PZ20P3

(Conducted during III Semester)

Hours/ Week	Credits	Total Hours	Marks
4	4	60	100

Objectives

1. To equip the students to analyse the physiological processes and inheritance.
2. To develop the skill to trace the phylogenetic relationship of living organisms.

Course Outcomes

O	pon completion of this course the students will be ble to:	SO ddressed	L
O - 1	call the functioning of organ and organ systems and endelian inheritance, population genetics, adaptive diation and evidence of evolution.	SO - 1	
O - 2	terpret the importance of factors in physiological ctivities and genes in inheritance, changes in gene and ene frequencies in a population.	SO - 3	
O - 3	entify the sex and mutant forms in *Drosophila*, inical features of disorders, gene frequencies in natural opulation.	SO - 2	p
O - 4	esign experiments based on Hardy-Weinberg Law, nzyme activity and effect of physical factors on hysiological activities.	SO - 4	n

Physiology

1. Effect of temperature on heartbeat of Freshwater Mussel and calculation of Q10.
2. Effect of temperature on salivary amylase activity and calculation of Q10.
3. Effect of pH on salivary amylase activity.
4. Salt loss and salt gain in a freshwater fish.
5. Examination of excretory products of fish, bird and mammals.
6. Survey of digestive enzymes in Cockroach.
7. Counting of blood cells using a hemocytometer.
8. Haemolysis of blood – Demonstration.
9. Observation of haemin crystals in blood.
10. Estimation of haemoglobin.

Charts/ Slides/ Models/ Bookplates/ Instruments

EEG, ECG, Conditional reflex, Skeletal muscle, Kymograph,Sphygmomanometer, Intestine, Nervous tissue, Liver, Lungs, Heart, Kidney.

Genetics and Evolution

1. Demonstration of monohybrid and dihybrid cross using beads.
2. Identification of sex and mutant forms of *Drosophila*.
3. Observation of Simple Mendelian Traits in man.
4. Calculation of gene frequencies using Hardy-Weinberg equilibrium - ABO bloodgroup.
5. Demonstration of natural selection using beads.
6. Demonstration of genetic drift using beads.
7. Analysis of dermatoglyphic data (fingerprint patterns) of the class population.
8. Study of homologous organs (fore limbs and hind limbs of vertebrates).
9. Study of analogous organs (wings of animals).
10. Adaptive radiation - beaks in Birds.

Specimens / Charts / Models / Photographs

Karyotype of syndromes (Down's syndrome, Klinefelter's syndrome and Turner's syndrome), Chromosomal banding Pedigree chart, Fossils (Ammonite, Trilobite, Nautiloid fossil), Geographical isolation (Indian and African Elephants), Seasonal Isolation (Sea Urchin), Phylogram, Universal Tree ofLife, Coevolution.

Semester IV

Practical IV – Microbiology & Biotechnology and Nanobiology

Course Code: PZ20P4

Hours/ Week	Credits	Total Hours	Marks
4	4	60	100

Objectives

1. To demonstrate competency in routine microbiological and biotechnologicaltechniques.
2. To develop skills in cell culture and analytical techniques for procuring employabilityin research laboratories.

Course Outcomes

O	**pon completion of this course the students will be ble to:**	**SO ddressed**	**L**
O - 1	call microbiological and biotechnological experiment rotocols.	SO - 1	
O - 2	entify tools and techniques relevant to microbiology nd bio-nanotechnology.	SO - 2	
O - 3	erform microbiological and biotechnological xperiments pertinent for the welfare of the nvironment and society.	SO - 4	p
O - 4	nalyse the impact of microbiological, biotechnological roducts and genetically modified organisms in ioremediation.	SO - 3	n

Microbiology

1. Preparation of culture media.
2. Isolation of bacteria from soil and water (Streak plate method).
3. Serial dilution technique.
4. Measurement of growth of bacteria (turbidimetric method).
5. Bacterial count by plate count method.
6. Observation of bacterial motility by Hanging Drop method.
7. Gram staining of bacteria.
8. Negative staining of bacteria.
9. Methylene blue reduction test to assess the quality of milk.

10. Antibiotic susceptibility test by disc-diffusion method.

Specimen/ Models/ Charts

Salmonella, *Clostridium*, Rabies virus, hepatitis – B, *Entamoeba*, *Azolla*, ocular and stage micrometer, inoculation loop, autoclave, laminar airflow chamber.

Biotechnology and Nanobiology

1. Extraction and estimation of genomic DNA from goat liver.
2. Separation of DNA using Agarose gel electrophoresis.
3. Polymerase chain reaction (Demonstration).
4. Culture of animal cells (Demonstration).
5. Immobilization of yeast cells using sodium alginate method.
6. Alcohol fermentation from fruit juice (wine).
7. Estimation of ethanol content in wine.
8. Production of amylase by bacteria.
9. Preparation of nanosolution (silver).
10. Biofabrication of nanomaterials by using plant materials.

Flow charts/ Instruments/ Figures

Plasmid DNA isolation, Insulin production by rDNA Technology, Hybridoma production, Synthesis of DNA nanoarray, Southern blotting, Biosensor (glucometer), Air-lift bioreactor, Superbug, Buckyballs, Dendrimers.

Semester IV

PG Self-Learning Course Environmental Impact Assessment and Audit

Course Code: PZ20S2

No of credits	Marks
2	100

Learning Objectives

1. To demonstrate the students the importance of EIA and environmental audits.
2. To develop the skill to assess and audit the impact of environmental pollution.

Course Outcomes

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	define activities involved in Environmental Auditing, Environmental protection and project proposals.	PSO - 1	R
CO - 2	describethe impact of proposed developments on natural and man-made environment.	PSO - 4	U
CO - 3	develop cognitive, technical and creative skills which enable students for life-long learning and participate in environmental protection and conservation activities for sustainable environment and gain employability.	PSO - 2	Ap
CO - 4	formulate hypotheses and test them by designing appropriate experiments, analyze, interpret the data and communicate the results through effective written and oral communication.	PSO - 3	An

UNIT I

Introduction to Environmental Impact Assessment(EIA) and Audit: Environment and Industries, Input information, Plant operation, Environmental Management planning, Waste Streams impact on water bodies.

UNIT II

Environmental Impact Assessment planning:Activities, Methodologyfor Environmental Impact Assessment, Role of Environmental Engineering firm, Role of Regulatory agencies andcontrol boards, Role of the Public.

UNIT III

Environmental Audit: Introduction, Environmental information Purpose and advantage of studies, General approach of environmental Auditing Environmental Audit, Audit programs in India, Auditing program in major polluting Industries, Reports of the Environmental auditstudies.

UNIT IV

Pollution prevention and control laws and acts: Constitution of India andenvironment, Environment laws, Administrative and legislative arrangement for Environmental protection, Indian Standards, Pollution control acts in India, criticalappraisal,fiscal incentives for environmental protection.

UNIT V

Environmental Projects: Guidelines of preparation of project report and its evaluation, methods of clearance fromthe concern authorities at various labels.

Reference Books

1. Prabu, PC.,Udayasoorian and G. Balasuramanian (2009). *An Introduction to Ecology andEnvironmental Science*. Delhi: Avinash Paperbacks.
2. Biswarup Mukherjee (2011). *Environmental Biology and Toxicology*. Faridabad: Silver LinePublications.
3. Santosh Kumar Garg, RajeshwariGarg and RanjniGarg (2007). Delhi: Khanna Publishers.
4. Hunt D. Johnson C (1995).*Environmental Management Systems*.London: McGraw Hill.
5. International Chamber of Commerce (1991).ICC Guide to Effective Environmental Auditing.Paris: ICC Publication No 483.

M.Sc. Syllabus (2023 Board)

SEMESTER I

CORE COURSE I: STRUCTURE AND FUNCTION OF INVERTEBRATES

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
ZP231CC1	5	1	-	1	4	7	105	25	75	100

Pre-requisite:

Students should know the taxonomical classification of invertebrates in relation to their functional morphology.

Learning Objectives:

1. To realize the range of diversification of invertebrate animals.
2. To understand the concept of classification and their characteristic features of major group of invertebrates.
3. To know the functional morphology of system biology of invertebrates
4. To enable to find out the ancestors or derivatives of any taxon.

Course Outcomes

On the successful completion of the course, student will be able to:		
CO1	remember the general concepts and major groups in animal classification, origin, struct5re, functions and distribution of life in all its forms.	**K1**
CO2	understand the evolutionary process. All are linked in a sequence of life pattern	**K2**
CO3	apply this for pre-professional work in agriculture and conservation of life forms.	**K3**
CO4	analyze what lies beyond our present knowledge of life process.	**K4**
CO5	evaluate and to create the perfect phylogenetic relationship in classification.	**K5**

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6**– Create

Units	Contents	No. of Hours
I	Structure and function in invertebrates: Principles of Animal taxonomy; Species concept; International code of zoological nomenclature; Taxonomic procedures; New trends in taxonomy	**21**
II	organization of coelom: Acoelomates; Pseudocoelomates; Coelomates: Protostomia and Deuterostomes; Locomotion: Flagella and ciliary movement in Protozoa; Hydrostatic movement in Coelenterata, Annelida and Echinodermata	**21**
III	Nutrition and Digestion: Patterns of feeding and digestion in lower metazoan; Filter feeding in Polychaeta, Mollusca and Echinodermata. Respiration: Organs of respiration: Gills, lungs and trachea; Respiratory	**21**

	pigments; Mechanism of respiration	
IV	Excretion: Organs of excretion: coelom, coelomoducts, Nephridia and Malpighian tubules; Mechanisms of excretion; Excretion and osmoregulation. Nervous system: Primitive nervous system: Coelenterata and Echinodermata; Advanced nervous system: Annelida, Arthropoda (Crustacea and lnsecta) and Mollusca (Cephalopoda); Trends in neural evolution	**21**
V	Invertebrate larvae: Larval forms of free-living invertebrates - Larval forms of parasites; Strategies and Evolutionary significance of larval forms. Minor Phyla: Concept and significance; Organization and general characters	**21**

Text Books:

1. Ekambaranatha Iyer, 2000. A Manual of Zoology, 10th edition, Viswanathan, S., Printers & Publishers Pvt Ltd.
2. Barrington, E. J.W. 1979. Invertebrate Structure and Function. The English Language Book Society and Nelson, pp-765.
3. Ruppert and Barnes, R.D. (2006). Invertebrate Zoology, VIII Edition. Holt Saunders International Edition.

Reference Books:

1. Barnes, R. D. 1974. Invertebrate Zoology, (Second Edition), Holt-Saunders International Edition, pp-1024.
2. Barnes, R. S. K., P. Calow, P. J. W. Olive, D. W. Golding, J. J. Spicer. 2013. The Invertebrates: A Synthesis. Third Edition. John Wiles & Sons Inc., Hoboken. New Jersey, New Delhi.
3. Dechenik, J. A. 2015. Biology of Invertebrates (Seventh Edition). Published by McGraw Hill Education (India) Private Limited, pp-624.

Web Resources

1. https://www.uou.ac.in/sites/default/files/slm/MSCZO-501.pdf
2. https://manoa.hawaii.edu/exploringourfluidearth/biological/invertebrates/structure-and-function
3. https://www.zoologytalks.com/category/structure-and-functions-of- invertebrates/
4. https://www.bilasagirlscollege.ac.in/newsData/D54.pdf

MAPPING WITH PROGRAMME OUTCOMES

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	2	3	3	3	2
CO2	3	3	2	2	3	3	2
CO3	3	2	3	2	3	3	2
CO4	3	2	3	2	3	3	2
CO5	3	2	3	2	3	3	2
TOTAL	15	12	13	11	13	11	10
AVERAGE	3	2.4	2.6	2.2	2.6	2.2	2

3 – Strong, 2- Medium, 1- Low

MAPPING WITH PROGRAMME SPECIFIC OUTCOMES

COs	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	3	2
CO2	3	3	2	3	3
CO3	2	2	3	3	2
CO4	3	3	3	3	3
CO 5	2	2	2	2	2
Total	13	13	12	14	12
Average	2.6	2.6	2.4	2.8	2.4

SEMESTER – I

CORE COURSE II: COMPARATIVE ANATOMY OF VERTEBRATES

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
ZP231CC2	5	1	-	1	5	7	105	25	75	100

Pre-requisite:

Students withknowledge and comprehension on zoology

Learning Objectives:

1. To impart conceptual knowledge about the animal life in the air and their behaviours.
2. To understanding the origin and efficiency of mammals and evolutionary changes that occurred in the life of vertebrates.

Course Outcomes:

On successful completion of the course, the student will be able to:		
CO1	remember the general concepts and major groups in animal classification, origin, structure, functions, and distribution of life in all its forms.	**K1**
CO2	understand the evolutionary process. All are linked in a sequence of life patterns.	**K2**
CO3	apply this for pre-professional work in agriculture and conservation of life forms.	**K3**
CO4	analyze what lies beyond our present knowledge of life process.	**K4**
CO5	evaluate and to create the perfect phylogenetic relationship in classification.	**K5**

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create

Unit	Contents	Hours
I	**Origin of vertebrates:** Concept ofProtochordata; The nature of vertebratemorphology; Definition,scopeandrelationtootherdisciplines; Importance of the study of vertebratemorphology.	21
II	**Origin and classification ofvertebrates:** Vertebrate integument and itsderivatives.	21

	Development,generalstructureandfunctionsofskinanditsderivatives; Glands, scales, horns, claws, nails, hoofs, feathers andhairs.	
III	**General plan of circulation in variousgroups:** Blood; Evolution ofheart; Evolution of aortic arches and portalsystems. Respiratorysystem: Characters of respiratorytissue; Internal and external respiration; Comparative account of respiratoryorgans	21
IV	**Skeletalsystem:** Form, function, body size and skeletal elements of thebody; Comparative account of jawsuspensorium, Vertebral column; Limbs andgirdles; Evolution of Urinogenital system in vertebrateseries.	21
V	**Senseorgans:** Simplereceptors; Organs of Olfaction andtaste; Lateral linesystem; Electroreception. Nervous system: Comparative anatomy of the brain in relation to itsfunctions; Comparative anatomy of spinalcord; Nerves-Cranial, Peripheral and Autonomous nervoussystems.	21
Self-Study	Scopeandrelation of vertebrate morphology tootherdisciplines, Vertebrate integument and itsderivatives, Evolution of aortic arches and portalsystems, Comparative account of jawsuspensorium, Comparative anatomy of spinalcord	

Text Books:

1. Yong, J. Z. 1981. The life of Vertebrates, English language Book society, London, pp-645.
2. Romer, A.S. 1971. The Vertebrate body, W.B.S. Saunders, Philadelphia, pp-600.
3. Ayyar, E.K. and T.N. Ananthakrishnan, 1992. Manual of Zoology Vol. II (Chordata), S. Viswanathan (Printers and Publishers) Pvt Ltd., Madras, 891p.
4. Jordan, E.K. and P.S. Verma, 1995. Chordate Zoology and Elements of Animal Physiology, 10th edition, S. Chand & Co Ltd., Ram Nagar, New Delhi, 1151 pp.
5. Ganguly, Sinha, Bharati Goswami and Adhikari, 2004. Biology of animals Vol.II - New central book Agency (p) Ltd.

Reference Books:

1. Waterman, A.J. 1972. Chordate Structure and Function, MacMillan Co., New York, pp.587.
2. Parker T. J. and W. A. Haswell. 1962. A text book of Zoology, Vol. 2, Vertebrates, 7th Edition, Mac Millan Press, London, pp-750.
3. EkambaranathaAyyar and T. N. Ananthakrishnan. 2009. Manual of Zoology, Vol – II, S. Viswanathan Pvt. Ltd. Chennai.
4. Kotpal, 2019. R.L. Modern Text Book of Zoology Vertebrates, 4th Edition, Rastogi Publications, Meerut, pp-968.

Web sources:

1. Swayam Prabha: https://www.swayamprabha.gov.in/index.php/program/archive/9
2. https://bit.ly/3Av1Ejg/
3. https://bit.ly/3kqTfYz/
4. https://biologyeducare.com/aves/
5. https://www.vedantu.com/biology/mammalia/

MAPPING WITH PROGRAMME OUTCOMES

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	1	3	2	3	2

CO2	3	1	1	3	2	3	2
CO3	3	2	1	2	2	2	2
CO4	3	1	1	3	1	3	2
CO5	3	2	1	2	3	3	2
Total	15	8	5	13	10	14	10
Average	3	1.6	1	2.6	2	2.8	2

*3 - Strong; 2 - Medium; 1 - Low

MAPPING WITH PROGRAMME SPECIFIC OUTCOMES

COs	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	3	2	3	2
CO2	3	3	2	2	3
CO3	2	2	3	2	2
CO4	3	3	3	3	3
CO 5	2	3	2	2	2
Total	13	14	12	12	12
Average	2.6	2.8	2.4	2.4	2.4

SEMESTER I

CORE LAB COURSE I: LAB COURSE IN INVERTEBRATES & VERTEBRATES

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
ZP231CP1	-	-	4		3	4	60	25	75	100

Pre-requisite

Basic knowledge on the animals living in different habitats

Learning Objectives:

1. Understanding the salient features and functional anatomy of different systems and the skeletal system in invertebrates & vertebrates.
2. Developing the skill in mounting techniques of the biological samples.

Course Outcomes

On the successful completion of the course, student will be able to**:**		
CO1	understand the structure and functions of various systems in animals	**K1**

CO2	learn the adaptive features of different groups of animals	**K2**
CO3	learn the mounting techniques	**K3**
CO4	acquire strong knowledge on the animal skeletal system	**K4**

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create

INVERTEBRATES

Dissection

Earthworm : Nervous system
Pila : Digestive and nervous systems
Sepia : Nervous system
Cockroach : Nervous system
Grasshopper : Digestive system and mouth parts
Prawn : Appendages, nervous and digestive systems
Crab : Nervous system

Study of the following slides with special reference to their salient features and their modes of life

1. *Amoeba*
2. *Entamoeba histolytica*
3. *Paramecium*
4. *Hydra* with bud
5. Sporocyst – Liver fluke
6. *Cercaria* larva
7. *Tape worm (Scolex)*
8. *Ascaris* T. S.
9. Mysis of prawn

Spotters

1. Scorpion
2. *Penaeus indicus*
3. *Emerita* (*Hippa*)
4. *Pernaviridis*

Mounting

Earthworm : Body setae
Pila : Radula
Cockroach : Mouth parts
Grasshopper : Mouth parts

VERTEBRATES

Study the nervous system of Indian dog shark - Dissection

1. Nervous system of *Scoliodonlaticaudatus* – 5th or Trigeminal nerve
2. Nervous system of *Scoliodonlaticaudatus* – 7th or Facial nerve
3. Nervous system of *Scoliodonlaticaudatus* – 9th and 10th or Glossopharyngeal &Vagus nerve

Study of the following specimens with special reference to their salient features and their modes of life
1. *Amphioxus* sp. (Lancelet) 2. *Ascidia* sp. (sea squirt) 3. *Scoliodonlaticaudatus*(Indian dog shark) 4. *Trygons*p. (Sting ray) 5. *Torpedo* sp. (Electric ray) 6. *Arius maculatus* (Cat fish) 7. *Belonecancila*(Flute fish) 8. *Exocoetuspoecilopterus*(Flying fish) 9. *Mugilcephalus*(Mullet) 10. *Tilapia mossambicus*(Tilapia) 11. *Rachycentron canadum* (Cobia) 12. *Tetrodonpunctatus*(Puffer fish) 13. *Dendrophis*sp. (Tree snake)
Study of the different types of scales in fishes
1. Cycloid scale 2. Ctenoid scale 3. Placoid scale
Study of the frog skeleton system (Representative samples)
1. Entire skeleton 2. Skull 3. Hyoid apparatus 4. Pectoral girdle and sternum 5. Pelvic girdle 6. Fore limb 7. Hind limb
Mounting
1. Weberian ossicles of fish

Text Books:

1. Lal, S.S. 2009. Practical Zoology, Rastogi Publications, pp-484.
2. Iuliis G. D. and D. Pulerà, 2007. The Dissection of Vertebrates: A Laboratory Manual. Academic Press, Imprint of Elsevier Publication, pp-416.
3. Verma, P.S. 2000. Manual of Practical Zoology: Chordates, S. Chand Publishing Company, pp-528

Reference Books:

1. Preeti, G., and C. Mridula, 2000. Modern Experimental Zoology, Indus International Publication.
2. Sinha, J., A. K. Chatterjeee, P. Chattopadhya. 2011. Advanced Practical Zoology, Arunabha Sen Publishers, pp-1070.

Web Resources:

1. http://www.csrtimys.res.in/
2. http://csb.gov.in/
3. https://iinrg.icar.gov.in/
4. https://www.nationalgeographic.com/animals/invertebrates/
5. https://www.youtube.com/watch?v=b04hc_kOY10

6. https://bit.ly/3CzTEy8
7. http://tolweb.org/Chordata/2499
8. https://www.nhm.ac.uk/

MAPPING WITH PROGRAMME OUTCOMES

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	3	3	2	3	2	2
CO2	3	2	3	3	3	2	2	2
CO3	3	2	3	3	3	2	2	2
CO4	3	2	3	3	2	2	2	2
TOTAL	12	6	12	12	10	9	8	8
AVERAGE	3	1.5	3	3	2.5	2.25	2	2

3 – Strong, 2- Medium, 1- Low

MAPPING WITH PROGRAMME SPECIFIC OUTCOMES

COs	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	3	3
CO2	3	3	2	2	3
CO3	2	2	3	2	2
CO4	3	3	3	3	3
Total	11	11	10	10	11
Average	2.75	2.75	2.5	2.5	2.75

SEMESTER I

ELECTIVE COURSE - I

(a) MOLECULES AND THEIR INTERACTION RELEVANT TO BIOLOGY

Course Code	L	T	P	S	Credits	Inst. Hours	Total hrs	Marks		
								CIA	External	Total
ZP231EC1	3	1	-	1	3	5	75	25	75	100

Pre-requisite:

Understanding fundamental properties of elements, atoms, molecules, chemical bonds, linkages and structure, composition, metabolism, and functions of biomolecules.

Learning Objectives

1. Students should know the fundamentals of biochemistry.
2. To developanalyticaland communicative skillstoconduct experiments andinterpret theresults

Course Outcome

On the successful completion of the course, student will be able to:		
CO1	learn the structure, properties, metabolism, and bioenergetics of	**K1**

	biomolecules	
CO2	acquire knowledge on various classes and major types of enzymes, classification, their mechanism of action and regulation	**K2**
CO3	understand the fundamentals of biophysical chemistry and biochemistry, importance, and applications of methods in conforming the structure of biopolymers	**K3**
CO4	comprehend the structural organization of and proteins, carbohydrates, nucleic acids and lipids	**K4**
CO5	familiarize the use of methods for the identification, characterization, and conformation of biopolymer structures	**K5**

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate

Units	Contents	No. of Hours
I	Basics of biophysical chemistry and biochemistry: Structure of atoms, molecules, and chemical bonds - Principles of biophysical chemistry (pH, buffer, reaction kinetics, thermodynamics, colligative properties).	15
II	Biomolecular interactions and their properties: Stabilizing interactions (Vander Waals, electrostatic, hydrogen bonding, hydrophobic interaction etc. - Composition, structure, metabolism, and function of biomolecules (carbohydrates, lipids, proteins, nucleic acids, and vitamins).	15
III	Bioenergetics and enzymology: Bioenergetics, glycolysis, oxidative phosphorylation, coupled reaction, group transfer, biological energy transducers - Principles of catalysis, enzymes and enzyme kinetics, enzyme regulation, mechanism of enzyme catalysis, isoenzymes	15
IV	Structural conformation of proteins and nucleic acids: Conformation of proteins (Ramachandran plot, secondary, tertiary and quaternary structure; domains; motifs and folds) - Conformation of nucleic acids (A-, B-, Z-DNA), t-RNA, micro-RNA).	15
V	Stabilizing interactions in biomolecules: Stability of protein and nucleic acid structures - hydrogen bonding, covalent bonding, hydrophobic interactions and disulfide linkage.	15

Self-study	Structure of atoms, Hydrophobic interactions, Glycolysis t-RNA, Nucleic acid structures

Text Books

1. Berg, J. M., J. L. Tymoczko and L. Stryer 2002. Biochemistry. 5th Ed., W.H. Freeman & Co., New York, pp-1050.
2. Kuchel P.W. and G. B. Ralston. 2008. Biochemistry. McGraw Hill (India) Private Limited, UP, pp-580.
3. McKee T. and J. R. McKee. 2012. Biochemistry: The Molecular Basis of Life. (7^{th} Edition). Oxford University Press, US, pp-793.
4. Nelson D.L. and M.M. Cox. 2012. Lehninger's Principles of Biochemistry. (6th Edition). W. H. Freeman Publishers, New York, pp-1158.

5. Satyanarayana U. and U. Chakrapani, 2006. Biochemistry. (3rd Edition). Books and Allied (P) Ltd. Calcutta, pp-695

References

1. Buchanan, B.B., W. Gruissem and R.L. Jones. 2015. Biochemistry and Molecular Biology of Plants. John Wiley and Sons Ltd., UK, pp-1280.
2. Murray, R.K., D.K. Granner, P.A. Mayes and V.W. Rodwell. 2003. Harper's Illustrated Biochemistry (26th Edition), The McGraw-Hill Companies, Inc., USA, pp-704.
3. Palmer, T. 2004. Enzymes. Affiliated East-West Press Pvt. Ltd., New Delhi, pp-416.
4. Voet D. and J.G. Voet. 2011. Biochemistry. (4th Edition). John Wiley & Sons (Asia) Pvt. Ltd., pp-1428.

Web Resources:

1. http://biochemical-pathways.com/#/map/1
2. https://www.ebi.ac.uk/chembl/
3. http://www.iubmb-nicholson.org/chart.html
4. https://www.sigmaaldrich.com/IN/en/search/enzymes?focus=products&page=1&perpage=30&sort=relevance&term=enzymes&type=product

MAPPING WITH PROGRAMME OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3	3	1	2	3	1	3
CO 2	3	2	2	2	2	1	3
CO 3	3	3	2	2	3	2	3
CO 4	3	2	1	1	3	2	2
CO5	2	2	3	3	2	3	3
Total	14	12	9	10	13	9	14
Average	2.8	2.4	1.8	2	2.6	1.8	2.8

3 – Strong, 2 – Medium, 1 - Low

MAPPING WITH PROGRAMME SPECIFIC OUTCOMES

COs	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	3	3
CO2	3	3	2	2	3
CO3	2	2	3	2	2
CO4	3	3	3	3	3
CO5	3	2	2	3	3
Total	14	13	13	13	14
Average	2.8	2.6	2.6	2.6	2.8

SEMESTER I

ELECTIVE COURSE - I(b) FORENSIC BIOLOGY

Course Code	L	T	P	S	Credits	Inst. Hours	Total hrs	Marks		
								CIA	External	Total
ZP231EC2	3	1	-	1	3	5	75	25	75	100

Pre-requisite:

Students should know the fundamentals of natural science and have a curiosity of criminology.

Learning Objectives:

1. Students should emphasize the importance of scientific methods in crime detection and disseminate information on the advancements in the field of forensic science.
2. Derive to skills to identify crime through various forensic techniques

Course Outcomes

On the successful completion of the course, student will be able to		
CO1	recall the fundamentals of forensic biology, psychology, and criminal profiling.	**K1**
CO2	outline the use of scientific evidence in a legal context using basic facts, fundamental principles, and functions of forensic science.	**K2**
CO3	apply the knowledge gained on forensic, dermatoglyphic, serological and odonatological techniques to render forensic service during real-time crime scenes.	**K3**
CO4	analyze fingerprints, personal identification evidence, bite marks and pug marks.	**K4**
CO5	evaluate information to find strategies to resolve problems in forensic biology.	**K5**

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate

Units	Contents	No. of Hours
I	Concepts and scope, functions, and historical aspects of forensic science. Importance, nature, location, collection and preservation of biological exhibits and crime scene investigation of biological evidence. Forensic dermatoglyphics - biological basis of fingerprints, formation of ridges, fundamental principles of fingerprinting, types of fingerprints, fingerprint patterns, automated fingerprint identification system.	15
II	Forensic examination of hair - importance, nature, location, structure, growth phases of hair, collection, evaluation, and tests for their identification. Forensic Serology - identification of body fluids, collection and preservation of blood evidence, distinction between human and non-human blood, semen - forensic significance of semen, composition and morphology of spermatozoa, collection, evaluation and tests for identification of semen. Composition and forensic significance of saliva, sweat, milk and urine.	15
III	Structural variation, types of teeth - human and non-human teeth, determination of age from teeth, eruption sequence, dental anomalies, their significance in personal identification. Bite marks - forensic significance, collection and preservation of bite marks, photography and evaluation of bite marks, lip prints in forensic investigations.	15
IV	Forensic Entomology - insects of forensic importance, collection of entomological evidence during death investigations. The role of aquatic insects in forensic investigations, insect succession on carrion and its relationship to determine time since death, factors influencing insect succession on carrion, its application to forensic entomology. Forensic Microbiology - types and identification of microbial organisms of forensic significance.	15
V	Importance of Wildlife Protection Act-1972- Schedules in the protection of endangered species of flora and fauna. Identification of wildlife materials such as skin, fur, bones, nails, horn, teeth, plants, plant parts and products by conventional and modern methods. Identification of pug marks of various animals, DNA techniques in wildlife investigations.	15

Self-study	Historical aspects of fingerprints, Collection, and preservation of blood Types of teeth, Forensic microbiology, DNA techniques

Text Books:

1. S. Chowdhuri (1971). *Forensic Biology*. New Delhi: BPRD.
2. R. Saferstein (1993). *Forensic Science Handbook* (Vol. 3). New Jersey: Prentice Hall.

References

1. R.S. Ramotowski (2013). Lee and Gaensleen's, Advances in Fingerprint Technology (3rd ed.). Boca Raton: CRC Press.
2. L. Stryer, (1988). Biochemistry (3rded.). New York: W.H. Freeman and Company.
3. R.K. Murray, D.K. Granner, P.A. Mayes and V.W. Rodwell, (1993). Harper's Biochemistry. Norwalk: APPLETON and Lange.
4. M. Bernstein (1997). Forensic odontology in, Introduction to Forensic Sciences (2nd ed.), W.G. Eckert (Editor). Boca Raton: CRC Press.
5. J. Dix (1999). Handbook for Death Scene Investigations. Boca Raton: CRC Press.
6. V.J. Geberth, (2006). Practical Homicide Investigation. Boca Raton CRC Press.
7. W.G. Eckert and S.H. James (1989). Interpretation of Bloodstain Evidence at Crime Scenes. Boca Raton: CRC Press.
8. G.T. Duncan and M.I. Tracey (1997). Serology and DNA typing in, Introduction to Forensic Sciences (2nd ed.), W.G. Eckert (Editor.). Boca Raton: CRC Press.

Web Resources:

1. http://www.dnaftb.org/
2. https://forensicdental.wordpress.com/
3. https://www.forensicsciencesimplified.org/
4. http://www.istl.org/03-spring/internet.html

MAPPING WITH PROGRAMME OUTCOMES

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3	3	1	2	3	1	3
CO 2	3	2	2	2	2	1	3
CO 3	3	3	2	2	3	2	3
CO 4	3	2	1	1	3	2	2
CO5	2	2	3	3	2	3	3
Total	14	12	9	10	13	9	14
Average	2.8	2.4	1.8	2	2.6	1.8	2.8

3 – Strong, 2 – Medium, 1 - Low

MAPPING WITH PROGRAMME SPECIFIC OUTCOMES

COs	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	2	3	2	2	3
CO3	2	2	3	2	2
CO4	3	3	3	3	3
CO5	3	2	2	3	3
Total	13	13	13	13	14
Average	2.8	2.6	2.6	2.6	2.8

SEMESTER: I

ELECTIVE COURSE - I

(c) WILDLIFE CONSERVATION AND MANAGEMENT

Course Code	L	T	P	S	Credits	Inst. Hours	Total hrs	Marks		
								CIA	External	Total
ZP231EC3	3	1	-	1	3	5	75	25	75	100

Pre-requisite:

Students should know the importance of wild-life and be responsible to conserve the environment and the ecosystem.

Learning Objectives

1. To equip students with adequate knowledge ofvarious biodiversity monitoring methodologies, conservation, and management
2. To identify the issues ofvertebratepests,wildlifeconflictandover abundantspecies,wildlifehealthand diseases.

Course Outcomes

On the successful completion of the course, student will be able to:		
CO1	develop the ability to use the fundamental principles of wildlife ecology to solve local, regional and national conservation and management issues	**K1**
CO2	develop the ability to work collaborativelyon team-basedprojects	**K2**
CO3	demonstrateproficiencyinthewriting,speaking,andcriticalthinkingskillsn eededtobecome a wild life technician	**K3**
CO4	gain an appreciation for the modern scope of scientific inquiry in the field of wild life conservation management	**K4**
CO5	developan ability to analyze, present and interpret wildlife conservation management information.	**K5**

Units	Contents	No. of Hours
I	Definition and importance of wildlife; Types of ecosystems. Causes of depletion ofwildlife; Classification of wetlandandanimalinhabitants; Population vulnerability analysis and its components; Factors responsible for the extinction of animals;Types of protected areas and the concept of zoning within the protected areas.	15
II	WildlifeSanctuaries and National Parks in India: Theories of populationdispersal; Animal movement, concept of home range and territory; Tracking movement byremotesensingand GIS. Wildlife conservation, ethics and importance of conservation;Impact ofhabitat destruction and fragmentation on wildlife; Biological parameters such as food, cover, forage and their impact on wild life;	15
III	Populationattributes; concepts of exponential and logistic growth rates of wildlife; Density dependentand independent population regulation; Impact of introduced species on preexisting flora andfauna of wildlife; Identification and estimation of wild animals by fecal sample analysis, hairidentification,pugmarks and census methods.Predator-preymodels and impact ofpredation.	15
IV	Wildlifeconservationobjectives-Captivebreedingtechniquesandtranslocationandreintroduction;Inviolateareaandcriticalhabitatsandtheirimpactonwildlife;Differentterrestrialhabitatsofwildlifeinindia;Restorationofdegradedhabitat.Damagecausedbywildlifein Indiaanditsmitigation;Sickanimalrefuges inprotectedareas. Type of wildlife management-manipulative, custodial; Management of over abundant wild animal populations causing damages to nearby inhabitants and their crops and animals;	15
V	Tools and techniques to control the menace of wild animals; man, wildlife conflict resolution and mitigation; Management of exotic and invasive wetland species in India. Habitat manipulation– control and regulation of grazing. Weed eradication; Major diseases of domestic and wild animals and their control and impact of wild life tourism.	15

Self-study	Types of ecosystems, Wild life sanctuaries and national parks in India, Wild life conservation, Weed eradication

Text Books

1. Caughley, G., and Sinclair, A.R.E. (1994) Wildlife Ecology and Management. BlackwellScience.
2. Goutam Kumar Saha &Subhendu Mazumdar (2017). *Wildlife Biology: An Indian Perspective*.New Delhi: PHI Learning Pvt. Ltd.

3. Singh, S.K (2015). *Textbook of wildlife management* (2nd ed.). Delhi: CBS Publishers and Distributors Pvt. Ltd.

ReferenceBooks

1. Woodroffe, R., Thirgood, S. and Rabinowitz, A. (2005) People and Wildlife, Conflict orCo-existence?CambridgeUniversity.

2. Bookhout, T.A. (1996) Research and Management Techniques for Wildlife and Habitats(5th edition)TheWildlifeSociety,Allen Press.

3. Sutherland, W.J. (2000) The Conservation Handbook: Research, Management and Policy. BlackwellSciences

4. Hunter M.L.,Gibbs,J.B.andSterling,E.J.(2008) Problemsolving in ConservationBiology and Wildlife Management: Exercises for Class, Field, and Laboratory. BlackwellPublishing.

5. Taj Rawat (2012). *Biodiversity Conservation and Wildlife Tourism*. Delhi: Discovery Publishing House Pvt. Ltd.

6. Kumar, U. &Asija, M.J. (2007). *Biodiversity - Principle and Conservation* (2nd ed.). JodhpurStudent Editors.

7. SeshadiriBalakrishnan, (1969). *The Twilight of India's Wildlife*. Chennai: Oxford University Press.

8. Gee, E.P. (1969). *Wildlife in India* (1sted.). London: Collins Foundation Books.

9. Anthony R.E. Sinclair, John M. Fryxell& Graeme Caughley (2006). *Wildlife Ecology*, Conservation, and Management(2nd ed.). USA: Blackwell Publishing.

Web Sources

1. https://education.nationalgeographic.org/resource/wildlife-conservation/
2. https://www.clearias.com/wildlife-conservation-projects/
3. https://www.wii.gov.in/
4. https://www.mdpi.com/2673-7159/1/2/9

MAPPING WITH PROGRAMME OUTCOMES

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	3	3	3	2	2
CO2	3	2	3	3	3	2	2
CO3	3	2	3	3	3	2	2
CO4	3	2	3	3	3	2	2
CO5	3	2	3	3	3	2	2
TOTAL	15	10	15	15	15	10	10
AVERAGE	3	2	3	3	3	2	2

3 – Strong, 2- Medium, 1- Low

MAPPING WITH PROGRAMME SPECIFIC OUTCOMES

COs	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	2	3	2	2	3
CO3	2	2	3	2	2
CO4	3	3	3	3	3
CO5	3	2	2	3	3
Total	13	13	13	13	14
Average	2.8	2.6	2.6	2.6	2.8

SEMESTER I

ELECTIVECOURSE –IIa)BIOSTATISTICS

Course Code	L	T	P	S	Credits	Inst. Hours	Total hrs	Marks		
								CIA	External	Total
ZP231EC4	3	1	-	1	3	5	75	25	75	100

Pre-requisite:

Students should be aware of the importance of analysis of quantitative and qualitative information from biological studies

Learning Objectives:

The main objectives of this course are:

1. To enable the students to understand the basic concepts in Biostatistics and analyse the data to derive inferences in various biological experiments.
2. To develop analytical skills of statistics and draw valid conclusions in research.

Course outcomes

COs	Upon completion of this course the students will be able to:	CL
CO1	recall different biological data, methods of collection and analysis of data.	K1
CO2	comprehend the design and application of biostatistics relevant to experimental and population studies.	K2
CO3	acquire skills to perform various statistical analyses using modern statistical techniques and software.	K3
CO4	analyze the data and interpret the results manually or by using software	K4
CO5	evaluate on the merits and limitation of practical problems in biological/ health management study as well as to propose and implement appropriate statistical design/ methods of analysis.	K5

K1- Remember; **K2**- Understand; **K3**- Apply; **K4**-Analyze; **K5**-Evaluate

Units	Content	No. of hours
I	Definition, scope and application of statistics; Primary and secondary data: Source and implications; Classification and tabulation of biological data: Types and applications. Variables: Definition and types. Frequency distribution: Construction of frequency, distribution table for grouped data; Graphic methods: Frequency polygon and ogive curve; Diagrammatic representation: Histogram, bar diagram, pictogram, and	15

	pie chart.	
II	Measures of central tendency: Mean, median and mode for continuous and discontinuous variables. Measures of dispersion: Range, variation, standard deviation, standard error, and coefficient of variation.	15
III	Probability: Theories and rules; Probability - Addition and multiplication theorem; Probability distribution: Properties and application of Normal, Binomial and Poisson distributions.	15
IV	Hypothesis testing: Student '*t*' test - paired sample and mean difference '*t*' tests. Correlation: Types - Karl Pearsons Co-efficient, Rank correlation, Significance test for correlation coefficients. Regression analysis: Computation of biological data, calculation of regression co-efficient, graphical representation and prediction.	15
V	Analysis of variance: one way and two-way classification. Data analysis with comprehensive statistical software using Statistical Package for the Social Sciences (SPSS).	15

Self-Study	Graphic methods: Frequency polygon and ogive curve; Diagrammatic representation: Histogram, bar diagram, pictogram and pie chart.

Textbooks

1. Arora, P. N. and P. K. Malhan. (1996). *Biostatistics*, Himalaya Publishing House, Mumbai, pp-447.
2. Gurumani, N. (2005). *Introduction to Biostatistics*, M.J.P. Publishers, Delhi, pp-407.
3. Das, D. and A. Das. (2004). *Academic Statistics in Biology and Psychology*, Academic Publisher, Kolkata, pp-363.
4. Palanichamy, S. and Manoharan, M. (1990). *Statistical Methods for Biologists*, Palani Paramount Publications, Tamil Nadu, pp-264.

Reference books

1. Pillai, R.S.N. and V. Bagavathi (2016). *Statistics Theory and Practice* (8th ed.).New Delhi: S. Chand Publishing Company Ltd.
2. Khan, I. and Khanum, A. (2014). *Fundamentals of Biostatistics* (3rd ed.): Hyderabad. Ukaaz Publications.
3. Zar, J.H. (1984). *Biostatistical Analysis* (2nd ed.). London: Prentice-Hall International Inc.
4. Bailey, N.T.J. (1997). *Statistical methods in Biology* **(**3rd ed.). New York: Cam. University Press.
5. Sokal, R. and James, F. (1973). *Introduction to Biostatistics.* Tokyo, Japan: W.H. Freeman and Company Ltd.
6. Daniel, W.W. (1987). *Biostatistics: A foundations for Analysis in the Health Sciences*. New York: John Wiley &Sons.
7. Gupta, S.P. (1998). *Statistical Methods.* New Delhi: S. Chand and Company Ltd.
8. Banerjee, P.K. (2005). *Introduction to Biostatistics.* New Delhi: S. Chand and Company Ltd.
9. Pranab Kumar Banerjee (2009). *Introduction to Biostatistics,* New Delhi:

S. Chand and Company Ltd.

Web Resources

1. https://faculty.ksu.edu.sa/sites/default/files/introduction_to_biostatistics-106.pdf
2. https://www.youtube.com/watch?v=1Q6_LRZwZrc
3. https://www.youtube.com/watch?v=7CqolAC_owc
4. https://www.ibm.com/docs/en/spss-statistics/25.0.0?topic=tutorial
5. https://www.statisticshowto.com/probability-and-statistics/spss-tutorial-beginners/

MAPPING WITH PROGRAMME OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3	1	1	x	1	1	3
CO 2	3	3	2	1	2	2	3
CO 3	3	2	2	x	x	3	3
CO 4	3	2	1	1	2	3	3
CO 5	3	3	2	2	2	3	3
TOTAL	15	11	8	4	7	12	15
AVERAGE	3	2.2	1.6	0.8	1.4	2.4	3

S-Strong (3) M-Medium (2) L-Low (1)

MAPPING WITH PROGRAMME SPECIFIC OUTCOMES

COs	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	2	3	3	2	3
CO3	2	3	3	3	2
CO4	3	3	3	3	3
CO5	3	2	3	3	3
Total	13	14	15	14	14
Average	2.6	2.8	3	2.8	2.8

SEMESTER I

ELECTIVE COURSE - II (b) APPLIED ZOOLOGY

Course Code	L	T	P	S	Credits	Inst. Hours	Total hrs	Marks		
								CIA	External	Total
ZP231EC5	3	1	-	1	3	5	75	25	75	100

Prerequisite:

A genuine passion towards the culture of economically important cultivable organisms.

Learning Objectives

1. To deepen the knowledge of students in general and applied areas of Zoology.
2. To provide employment and job opportunities in the public, private and government sector.

Course Outcomes

Upon completion of this course the students will be able to:		
CO - 1	apply the knowledge of animal husbandry in economic	**K1**

	development.	
CO - 2	identify the kinds of bees and the methods of bee keeping.	**K2**
CO - 3	rear silkworms, harvest and market the cocoons.	**K3**
CO - 4	apply skills and experience about the management of poultry and Dairy farming.	**K4**
CO - 5	culture of economically important finfish and shell fishes.	**K5**

Units	Content	hours
I	**Apiculture:** Scope–classification and kinds of bees–bees and their society–life cycle of *Apis indica* –food of honey bees - relationship between plants and bees. Methods of bee keeping(primitive and modern) – Honey bee products: honey, bee wax, bee venom. **Lac culture** – scope – lac insect *Lacciferlacca* and its life cycle – processing of lac - lac products and importance.	15
II	**Sericulture:** Scope–Silk Road - CSB - Moriculture: varieties of mulberry, methods ofpropagation, harvesting of leaves – Common species of Silkworm– Life cycle of mulberry silkworm – Diseases of silkworm: pebrine, grasserie, sotto diseases, muscardine – pest of silkworm: uzifly. Rearing of silkworm – mounting – spinning - harvesting of cocoons – silk reeling and marketing.	15
III	**Poultry Keeping:** Scope–commercial layers and broilers - poultry housing - types of poultryhouses – management of chick, growers, layers and broilers – debeaking - sexing in chicks - Nutritive value of egg. Diseases of poultry – Ranikhet, Fowl pox, Coryza, Coccidiosis, Polyneuritis – vaccination.	15
IV	**Dairy Farming:** Scope–Breeds of Dairy animals–Establishment of a typical Dairy farm–Management of cow (Newborn, calf, Heifer, milking cow) – Diseases (Mastitis, Rinder Pest, FMD). Nutritive value of milk - dairy products (Standard milk, skimmed milk, toned milk and fermented milk-curd, ghee, cheese) Pasteurization. Leather industry – scope – processing of skin**.**	15
V	**Integrated Farming**: Definition and Scope.Agri-based fish farming–paddy cum fish culture–Horticulture-cum-fish farming. Integrated bee keeping - Live-stock fish farming - Duck-cum fish culture, fish-cum poultry farming, fish cum dairy farming, goat-cum fish integration, fish cum pig farming - multi-trophic aquaculture – Livestock – Poultry – Fish – Horticulture	15

Text Books

Arumugam, N., Murugan, T., Johnson Rajeshwar, J. and Ram Prabhu, R. **(**2011). *AppliedZoology*. Nagercoil: Saras Publications.

Reference Books

1. Vasantharaj David, B. (2004). *General and Applied Entomology* (2nd ed.). New Delhi: Tata McGraw-Hill Publishing Company Ltd.
2. Johnson, J. and Jeya Chandra, I. (2005). *Apiculture.*Marthandam: Olympic Grafix.

3. Tharadevi, C.S., Jayashree, K.V. and Arumugam, N. (2014). *Bee Keeeping.*Nagercoil : Saras
Publications.
4. Johnson, M. and Kesary, M. (2015). *Sericulture* (5th ed.). Marthandam: CSI Press.
5. Ganga, G. and Sulochana Chetty (1997). *An Introduction to Sericulture.* Delhi: Oxford and IBH Publishing Co. Pvt. Ltd.
6. Gnanamani, M.R. (2005). *Profitable Poultry Farming*. Madurai: J. Hitone Publications.
7. Shukla, G.S. and Upadhyay, V.B. (1998). *Economic Zoology.* Jaipur: Rastogi Publications.
8. John Moran (2005). *Tropical Dairy Farming.* Australia: Landlinks Press.
9. Uma Shankar Singh (2008). *Dairy Farming.* New Delhi: Anmol Publishers.

Web Resources

1. https://guides.library.charlotte.edu/c.php?g=173165&p=1142033
2. https://www.slideshare.net/ManoKhan88/1-basic-concepts-in-economic-zoologypptx
3. https://egov.uok.edu.in/elearning/tutorials/1011020512BR15103CR15Apiculture%20Lac%20culture%20and%20%20sericultureapiculture%20lac%20culture%20and%20%20sericulture%20upload.pdf
4. https://www.echocommunity.org/en/resources/e7940e6c-ebbb-4b78-9115-fa5de38fa0d7
5. https://www.fao.org/documents/card/en?details=cb5353en

MAPPING WITH PROGRAMME OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3	1	1	-	1	1	3
CO 2	3	3	2	1	2	2	3
CO 3	3	2	2	-	-	3	3
CO 4	3	2	1	1	2	3	3
CO 5	3	3	2	2	2	3	3
TOTAL	15	11	8	4	7	12	15
AVERAGE	3	2.2	1.6	0.8	1.4	2.4	3

S-Strong (3) M-Medium (2) L-Low (1)

MAPPING WITH PROGRAMME SPECIFIC OUTCOMES

COs	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	2	3	3	2	3
CO3	2	3	3	3	2
CO4	3	3	3	3	3
CO5	3	2	3	3	3
Total	13	14	15	14	14
Average	2.6	2.8	3	2.8	2.8

SEMESTER I

ELECTIVE COURSE – II(c) PEST MANAGEMENT

Course Code	L	T	P	S	Credits	Inst. Hours	Total hrs	Marks		
								CIA	External	Total
ZP231EC6	3	1	-	1	3	5	75	25	75	100

Prerequisite:

Need to have a fundamental understanding of entomology, plant pathology, and integrated pest management strategies.

Learning Objectives

1. To provide awareness on various pests and their control measures.
2. To apply Integrated Pest Management strategies to resonate home based food products with

the general public.

Course Outcomes

CO	Upon completion of this course the students will be able to:	
CO - 1	outline the pest groups affecting different agricultural crops and control measures.	**K1**
CO - 2	select correct IPM in cropping systems with traditional and alternative control measures.	**K2**
CO - 3	analyze the impact of pesticides on environment and adopt better agricultural practices.	**K3**
CO - 4	evaluate the control measures adopted for pests of household and stored products.	**K4**

Units	Content	No. of hours
I	**Introduction:** definition of pest–outline of pest groups affecting agricultural crops–populationdynamics of pests – causes for pest out breaks. Pest control methods: cultural, chemical and biological - pesticides, precautions, safety devices - pesticide poisoning symptoms and first aid.	15
II	**Pesticides:** organochlorine, organophosphorus and organocarbamates–inorganic and natural pesticides. Preparation of pesticides: formulations – packages, manufacture. Toxicity levels – LD_{50} values. Mode of action of pesticides.	15
III	**Pests of Agricultural importance:** bionomics and life cycles of any two pests of the following: **c**ereals (rice); oilseeds (coconut, groundnut); vegetables (brinjal); pulses; plantation crops (coffee); fruits (citrus) and pesticide formulations.	15
IV	**Household pests and Pests of stored products:** household pests (cockroaches, termites,silverfish, flies and mosquitoes) and their control measures. Rodents as pests – local rodents, life history, feeding habits, reproduction, and behaviour – methods of rodent control. Stored grain pest (rice weevil, flour beetle, cigarette beetle).	15

V	**Mode of Pest Control:** Pesticide spraying appliances. Residual toxicity of pesticides–Environment degradation and its prevention. Biological control of pest – parasites, predators, and pathogens – chemosterilants – pheromones - Bacculovirus-mediated pest control. Integrated pest management and its relevance to 21st century.	15

1. Text Book

Dhawan, A.K., Balwinder Singh, Manmeet B Bhullar (2012). *Integrated Pest Management*. Chennai: Scientific Publishers.

Reference Books

1. Nayar, Ananthakrishnan and David (1976). *General and Applied Entomology*. New Delhi: Tata McGraw Hill Publishers.
2. Metcalf and Flint (1973). *Destructive and useful Insects* (4th ed.). New Delhi: Tata McGraw Hill Publishers.
3. Roya, D.N. and Abrown, A.W. (1981). *Entomology: Medical and Veterinary* (3rd ed.). Bangalore: The Bangalore Printing and publishing company.
4. Cremlyn, R. (1979). *Pesticides: Preparation and mode of Action.* New Jersey: John Wiley & Sons Ltd.
5. Ignacimuthu, S. and B V David (2009). *Ecofriendly Insect Pest Management.* Delhi: Elite Publishing House Pvt Ltd (Ind).

Web Sources

1. https://guides.library.cornell.edu/c.php?g=672215&p=4733120
2. https://growingsmallfarms.ces.ncsu.edu/growingsmallfarms-insectlinks/
3. https://content.ces.ncsu.edu/insect-and-related-pests-of-vegetables
4. https://content.ces.ncsu.edu/insect-management-on-organic-farms
5. https://www.epa.gov/ipm/integrated-pest-management-tools-resources-support-ipm-implementation

MAPPING WITH PROGRAMME OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3	1	1	x	1	1	3
CO 2	3	3	2	1	2	2	3
CO 3	2	2	3	2	3	3	3
CO 4	3	2	3	1	2	3	3
TOTAL	11	8	9	4	8	9	12
AVERAGE	2.75	2	2.25	0.8	2	2.25	5

S-Strong (3) M-Medium (2) L-Low (1)

MAPPING WITH PROGRAMME SPECIFIC OUTCOMES

COs	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	2	3	3	2	3
CO3	2	3	3	3	2
CO4	3	3	3	3	3
Total	10	12	12	11	11
Average	2.5	3	3	2.5	2.5

SEMESTER I

ELECTIVE LAB COURSE I: MOLECULES AND THEIR INTERACTION RELEVANT TO BIOLOGY & BIOSTATISTICS

Course Code	L	T	P	S	Credits	Inst. Hours	Total hrs	Marks		
								CIA	External	Total
ZP231EP1	-	-	2		2	2	30	25	75	100

Pre-requisite

Basic practical knowledge on the molecules and their interaction to animal body and analysis of quantitative and qualitative information from biological samples.

Learning Objectives:

1. Understanding the salient features and functional anatomy of different systems and the skeletal system in invertebrates & vertebrates.
2. To design experimental problems, analyze and evaluate critically with inferential biostatistics.

Course Outcomes

COs	Upon completion of this course the students will be able to:	KL
CO1	learn and study of chemical and physical structure of biological macromolecules.	K1
CO2	analyze the biomolecules and physicochemical parameters in samples	K2
CO3	analyze and interpret the collected data using statistical methods	K3
CO4	design biological experiments and evaluate the samples applying appropriate statical methods.	K4

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create

Molecules and their Interaction Relevant to Biology

1. Colorimetry-Verification of Beer-Lambert'slaw.
2. Preparation of solutions in normality, percentage, ppt, ppm
3. Quantitativeestimationofglucose(Blood/ tissue) Standard graph method
4. Determination of velocity of salivary amylase activity by applying Michaelis - Menten equation.
5. Determination of pH of unknown solution using Known pKa – Application of Henderson–Hasselbalch equation.

Instruments/Charts/Models: Colorimeter, pH Meter, Centrifuge, Chromatogram, PAGE

Biostatistics

6. Measures of central tendency: mean, median and mode.
7. Measures of dispersion- Standard deviation and standard error.
8. Correlation co-efficient: Length and width of molluscan shells.

Text Books:

Reference Books

1. Geetha K. Damodaraan, 2010. Practical Biochemistry. Jaypee Brothers Medical Publishers Pvt. Ltd.
2. Divya Shanthi, 2018. An easy guide for practical Biochemistry. Jaypee Brothers Medical Publishers Pvt. limited, 01-Nov-2008 -
3. Gupta, S.P.(1998). Statical methods. New Delhi: S. Chand and Company Ltd.

4, Gurumani, N. An introduction to Biostatistics. 2004. MJP publishers, Triplicane, Chennai.

MAPPING WITH PROGRAMME OUTCOMES

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
CO 1	3	3	1	2	3	1	3
CO 2	3	2	2	2	2	1	3
CO 3	3	3	2	2	3	2	3
CO 4	3	2	1	1	3	2	2
Total	12	10	6	7	11	6	11
Average	3	2.5	1.5	1.75	2.75	1.5	2.75

3 – Strong, 2- Medium, 1- Low

MAPPING WITH PROGRAMME SPECIFIC OUTCOMES

COs	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	3	3	3	3
CO2	2	3	2	2	3
CO3	2	2	3	3	2
CO4	3	3	3	3	3
CO5	2	2	3	3	3
Total	12	12	14	14	14
Average	2.4	2.4	2.8	2.8	2.8

SEMESTER I

SPECIFICVALUE ADDED COURSE

BASICS OF EXCEL

Course Code	Credits	Total Hours	Total Marks
ZP231V01	**1**	**30**	**100**

Prerequisite:

Basic computer literacy and familiarity with navigating computer applications.

Objectives:

To equip the students to present data using Excel's various features and printing options.

COs	On completion of this course, students will be able to	KL
CO 1	recall the components of Excel's interface and basic cell formatting.	K1
CO 2	summarize the significance of relative, absolute, and mixed cell references in formulae.	K2
CO 3	apply data entry techniques and utilize basic calculations and formulas.	K3
CO 4	analyze different chart types to determine their suitability for presenting specific types of data.	K3
CO 5	evaluate the effectiveness of using functions and charts to ensure clarity and effective visualization.	K5
CO 6	design and create various types of charts (bar, column, pie) based on specific data sets.	K6

Unit 1: Excel Essentials and Interface: Introduction to Excel's - Excel interface, workbooks, and sheets – selection of cells, rows, and columns - basic cell formatting: font, alignment, and fill.

Unit 2: Data Entry, Formulas, and Functions: Data entry techniques and AutoFill - Introduction to formulas and basic calculations - Using SUM, AVERAGE, COUNT, and other functions - cell references: relative, absolute, and mixed.

Unit 3: Data Management and Analysis: Sorting and filtering data using find and replace to manipulate data – Data analysis using excel (t test, Regression, Correlation, ANOVA), data validation for data integrity.

Unit 4: Charts and visualization: Creating different chart types: bar, column, and pie charts - formatting and enhancing charts for clarity - Adding labels, titles, and legends to charts.

Unit 5: Printing, Sharing, and Review: Setting up print options and page layout - printing worksheets and workbooks - sharing workbooks via email and cloud storage - review of key concepts and practical exercises.

Reference books:

1. Kabir Das. 2021.Microsoft Excel: Short keys and formulas. Notion Press, India.
2. Maneet Singh Mehta. 2021. Microsoft Excel Professionals. 2021 guide. BPB Publications, India.
3. Lokesh Lalwani. 2019. Excel 2019 – All in one. 1st Edn. BPB Publications, India.
4. John Walkaenbach. 2015. Microsoft Excel 2016 Bible – Comprehensive tutorial resource. John Wiley and Sons, Indiana.
5. Greg Harvey. 2016. Microsoft Excel 2016. DummisPublisger

SEMESTER II

CORE COURSE III: CELLULAR AND MOLECULAR BIOLOGY

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
ZP232CC1	4	1	-	1	5	6	90	25	75	100

Pre-requisite

Students should have knowledge of the basic cellular structures and their salient functions.

Learning Objectives

1. To acquire knowledge on molecular organization of the cell and cell organelles, growth, and communications.
2. To develop skills needed to innovate and contribute to the advancement in cell and molecular biology.

Course Outcomes

On the successful completion of the course, students will be able to:		
1.	recall general concepts of cell biology and fundamental cellular structures and organelles.	**K1**
2.	explain the various cellular components and their activities.	**K2**
3.	identify the changes or losses in cell function caused by dysregulation.	**K3**
4.	compare different cellular processes, their regulation, and their significance.	**K4**
5.	assess the societal and environmental impacts through cellular and molecular research.	**K5**

K1- Remember; **K2**- Understand; **K3**- Apply; **K4**-Analyze; **K5**-Evaluate

Units	Contents	No. of Hours
I	General features of the cell: Cell theory; Diversity of cell size and shapes. Protoplasm and deutroplasm – cell organelles; Membrane structure and functions - membrane models, membrane/channel proteins, diffusion, osmosis, active transport, ion pumps (Sodium and potassium pump).	18
II	Cell organelles: Ultra-structure and functions of intracellular organelles – nucleus, nuclear pore complex, nucleolus, chromosomes, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, centrosomes, peroxisomes, ribosomes.	18
III	Cell cycle and cell division: Phases of Cell Cycle – Mitosis, Significance of Mitosis - meiosis, significance of meiosis. Control	18

	of the cell cycle - regulator molecules - positive regulation - negative regulation. Structure of DNA and RNA; Process of DNA replication, transcription, and translation in pro- and eukaryotic cells.	
IV	Cell communication and cell signaling: Membrane - associated receptors for peptide and steroid hormones - signaling through G-protein coupled receptors, signal transduction pathways (RTK pathway and MAP kinase pathway). Gap junction and tight junction, extracellular space and matrix, interaction of cells with other cells and non-cellular structures.	18
V	Cancer cells: Characteristic features of normal and cancer cells. Carcinogens: types and cancer induction. Metastasis. Oncogenes and tumor suppressor genes, therapeutic interventions of uncontrolled cell growth. Apoptosis – mechanism and regulation. Ageing and senescence.	18

Self-study	Diversity of cell size and shapes, Ultra-structure and functions of lysosomes, Stages in cell cycle, Gap junction and tight junction, Characteristic features of normal and cancer cells.

Textbooks

1. Plopper, G., D. Sharp, and E. Sikorski. 2015. *Lewin's Cells* (Third Edition), Jones & Bartlett, New Delhi.
2. Ajoy Paul, 2011. *Textbook of Cell and Molecular Biology*, Books and Allied Pvt. Ltd.

Reference Books

1. Alberts, B., A. Johnson, J. Lewis, *et al*., 2015. *Molecular Biology of the Cell* (Sixth Edition), Garland Science, New York.
2. Lodish, H., C. A. Kaiser, A. Bretscher, *et al*., 2013. *Molecular Cell Biology* (Seventh Edition), Macmillan, England.
3. Karp, G. 2010. *Cell Biology* (Sixth Edition), John Wiley & Sons, Singapore.
4. Tropp, B, 2008. *Molecular Biology Genes to Proteins* (Third Edition), Jones & Bartlett, US.
5. Abbas, A. K., A. H. Lichtman and S. Pillai, 2007. *Cell and Molecular Immunology* (Sixth Edition), Saunders, Philadelphia.

Web Resources

1. https://www.inspiritvr.com/general-bio/cell-biology/passive-and-active-transport-study-guide
2. https://www.khanacademy.org/test-prep/mcat/cells/eukaryotic-cells/a/organelles-article
3. https://www.khanacademy.org/science/ap-biology/cell-communication-and-cell-cycle/changes-in-signal-transduction-pathways/a/intracellular-signal-transduction
4. https://bio.libretexts.org/Bookshelves/Cell_and_Molecular_Biology/Book%3A_CellsMolecules_and_Mechanisms_(Wong)/11%3A_Protein_Modification_and_Trafficking/11.02%3A_Protein_Trafficking
5. https://openoregon.pressbooks.pub/mhccmajorsbio/chapter/control-of-the-cell-cycle/

MAPPING WITH PROGRAMME OUTCOMES

PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3	3	3	3	2	3	3	3
CO2	3	3	1	2	2	2	2	3	1	2	2	1
CO3	3	3	3	3	3	3	2	2	3	2	3	2
CO4	3	3	1	2	2	2	2	2	3	2	3	2
CO5	2	3	3	3	3	3	3	2	3	3	2	3
TOTAL	14	15	11	13	13	13	12	12	12	12	13	11
AVERAGE	2.8	3.0	2.2	2.6	2.6	2.6	2.4	2.4	2.4	2.4	2.6	2.2

3-Strong, 2- Medium, 1- Low

SEMESTER II

CORE COURSE IV: DEVELOPMENTAL BIOLOGY

Course Code	L	T	P	S	Credits	Inst. Hours	Total hrs	Marks		
								CIA	External	Total
ZP232CC2	4	1	-	1	5	6	90	25	75	100

Pre-requisite

A basic understanding of biology and genetics is recommended to effectively grasp the concepts in developmental biology.

Learning Objectives

1. Understand the principles of developmental biology to analyze and compare the embryonic development of different animal species.
2. Study the concepts, procedures, and uses of genes and hormones to propose strategies to improve and control the development of certain animal species.

Course Outcome

On the successful completion of the course, student will be able to:		
CO - 1	recall and summarize the chief events in animal development, recognizing their significance and historical context	**K1**
CO - 2	understand the different mechanisms and how extrinsic and intrinsic factors influence embryonic development in various animal embryos.	**K2**
CO - 3	apply their knowledge to explain the role of hormones in animal development.	**K3**
CO - 4	analyze the different stages of embryonic development and the genetic	**K4**

	control mechanisms involved.	
CO - 5	critically evaluate ethical issues associated with cryopreservation in mammalian reproduction.	**K5**
CO - 6	design and propose experiments related to biochemical changes during regeneration or cryopreservation techniques.	**K6**

. **K1**- Remember; **K2**- Understand; **K3**- Apply; **K4**-Analyze; **K5**-Evaluate; **K6**- Create

Units	Contents	No. of Hours
I	Pattern of animal development: Chief events in animal development. Gametogenesis: Origin of germ cells, spermatogenesis - sperm morphology in relation to the type of fertilization, oogenesis - oogenesis in insects and amphibians; composition and synthesis of yolk in invertebrates (insects and crustaceans) and vertebrates; Genetic control of vitellogenin synthesis in amphibians.	18
II	Fertilization:Sperm aggregation, sperm activation, chemotaxis, sperm maturation and capacitation in mammals, acrosome reaction. sperm – egg interaction. Sperm entry into the egg - egg activation - intracellular calcium release - cortical reaction - physiological polyspermy - fusion of male and female pronuclei - post fertilization metabolic activation – parthenogenesis.	18
III	Cleavage and gastrulation:Pattern of embryonic cleavage, mechanisms of cleavage – Gastrulation - morphogenic movements - gastrulation in respective animal embryos (Sea urchin, Amphibians, Mammals); Fate maps - (Amphibian and Chick), Epigenesis and preformation – Formation of primary germ layers	18
IV	Embryonic Development; Embryonic development of fish and birds, formation of extra embryonic membranes in mammal –Formation and migration of neural crest cells - types of neural crest cells - primary and secondary neurulation. Organogenesis (mammal): Development of ectodermal derivatives (nervous system). endodermal (digestive system), mesodermal (circulator system). Gene and development: Anterior- posterior axis in determination in drosophila, Maternal effect genes - *Bicoid* and *Nanos* proteins; Generation of dorsal - ventral polarity- Genetic control of segmentation – Gap genes; pair rule genes; Homeotic genes	18
V	Post embryonic development metamorphosis: Endocrine control of metamorphosis in insect and amphibian - Endocrine control of moulting and growth in crustaceans and insects - Neoteny and pedogenesis. Regeneration: Types of regeneration, Regeneration in planaria and frog - Regenerative ability in different animal groups. Factors stimulating regeneration. – Aging and senescence: Biology of senescence- cause of aging- mechanism involved inapoptosis. Experimental Embryology: Mammalian reproduction: Mammalian reproductive cycle, Hormonal regulation, Endocrine changes associated with normal pregnancy, Induced ovulation in humans – Cryopreservation of gametes/embryos - Ethical issues in cryopreservation	18

Self-study	Spermatogenesis**,** Oogenesis in amphibians, parthenogenesis, Fate maps, Regenerative ability in different animal groups..

Textbooks

1. Gilbert. S. F. 2006. *Developmental Biology,* 8th Edition, INC Publishers, USA
2. Balinsky, B. I. 1981. *Introduction to Embryology*. (5th Edition), CBS College Publishers, New York.

Reference books

1. Tyler, M.S, 2000. Developmental Biology - A Guide for Experimental Study, Sunderland, MA.
2. Subramoniam, T, 2011. Molecular Developmental Biology (2nd Edition), Narosa Publishers, India.
3. Slack J.M.W, 2012. Essential Developmental Biology (3rd Edition), Wily-Blackwell Publications, USA.
4. Mari-Beffa, M. and J. Knight, 2005. Key Experiments in Practical Developmental Biology, Cambridge University Press, UK.
5. Lewis Wolpert, Cheryll Tickle, Alfonso Martinez Arias, 2019. *Principles of Development*. Sixth Edition. Oxford University Press, USA.

Web resources

1. https://www.easybiologyclass.com/tag/developmental-biology/
2. www.studocu.com › document › lecture-notes › view
3. ocw.mit.edu › courses › 7-22-developmental-biology-f.
4. https://learninglink.oup.com/access/barresi-12e
5. https://www.khanacademy.org/science/biology/developmental-biology

MAPPING WITH PROGRAMME OUTCOMES

PROGRAMME SPECIFIC OUTCOMES

COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PO 7**
CO1	3	2	1	3	2	3	3	3	2	3	2	2
CO2	3	1	1	3	2	3	3	3	2	2	3	2
CO3	3	2	1	2	2	2	2	2	3	2	2	2
CO4	3	1	1	3	1	3	3	3	3	3	3	2
CO5	3	2	1	2	3	3	2	3	2	2	2	2
Total	15	8	5	13	10	14	13	14	12	12	12	10
Average	3	1.6	1	2.6	2	2.8	2.6	2.8	2.4	2.4	2.4	2

3 - Strong; 2 - Medium; 1 - Low

SEMESTER II

CORE LAB COURSE II: LAB COURSE IN CELL BIOLOGY AND DEVELOPMENTAL BIOLOGY

Course Code	L	T	P	S	Credits	Inst.	Total	Marks

						Hours	hrs	CIA	External	Total
ZP232CP1	-	-	4	-	2	4	60	25	75	100

Pre-requisite

Students should have acquired basic knowledge relevant to this lab course.

Learning Objectives

1. To demonstrate significant cellular, molecular biological principles into practical understanding.
2. To gain theoretical knowledge and hands-on skills in developmental biology.

Course Outcomes

1.	recall the principles of using a micrometer for cell size determination and the stages of mitosis & meiosis and their characteristics.	**K1**
2.	comprehend the steps involved in preparing blood smears and mounting the muscle fibres using microscopy.	**K2**
3.	develop handling - skills through the wet-lab course.	**K3**
4.	interpret observations & make connections between reproductive processes and the ecological context of the organisms studied	**K4**
5.	evaluate and compare different developmental stages in chick embryos.	**K5**

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate;

Cell and Molecular Biology

1. Determination of cell size using micrometer.
2. Identification of Mitotic stages in onion root tips.
3. Identification of various stages of meiosis in the testes of grasshopper.
4. Observation of polytene chromosome in salivary gland cells of Chironomus larva.
5. Detection of sex chromatin in squamous epithelium.
6. Identification of blood cells in the haemolymph of the cockroach.
7. Identification of blood cells in human blood.
8. Mounting of the coxal striated muscle fibers of cockroach.
9. Observation of adipocytes - fat body of cockroach.
10. Isolation of total RNA from bacterial cells/ tissues. (Demonstration)

Spotters: Fluid mosaic model, Golgi complex, Cancer cell, Cadherins, Karyotype, Haemocytometer.

Spotters: Fluid mosaic model, Golgi complex, Cancer cell, Cadherins, Karyotype, Haemocytometer.

Developmental Biology

Gametogenesis - Observation of gametes from gonadal tissue sections

1. **Oogenesis:** Section through ovary of shrimp, fish, frog and mammals
2. **Spermatogenesi**s: Section through testis of shrimp, fish, calottes and mammals.
3. **Fertilization**: Induced spawning in fish.
4. **Embryogenesis**: Observation and whole mount preparation of the

i. Chick blastoderm - 18 hours of development
ii. Chick embryonic stage - 24 hours of development
iii. Chick embryonic stage - 48 hours of development
iv. Chick embryonic stage - 72 hours of development
v. Chick embryonic stage - 96 hours of development

5. **Histological observation:** Section through various developmental stages in chick embryo
6. **Experimental Embryology:** Regeneration in Frog Tadpoles - Blastema formation.
7. **Metamorphosis:** Demonstration of metamorphosis in Frog Tadpole using exogenous Iodine
8. **Cryopreservation:** Demonstration of cryopreservation of gametes of fin fish/shell fish

Reference books:

1. Renu Gupta, SeemaMakhija, Dr. Ravi Toteja, 2018. *Cell Biology : Practical Manual*. Prestige Publishers, Idia.
2. MamtaVerma, 2023. Practical Book Cell Biology &Cytogenetics Lab. Krishna Prakashan Media (P) Ltd., Idia.
3. Wilt, F.H. and N.K. Wessel, 1967. Methods in Developmental Biology, Thomas Y Crowell, New York.
4. Slack J.M.W, 2012. Essential Developmental Biology (3rd Edition), Wily-Blackwell Publications, USA, pp-496.
5. Mari-Beffa, M. and J. Knight, 2005. Key Experiments in Practical Developmental Biology, Cambridge University Press, UK, pp-404.

MAPPING WITH PROGRAMME OUTCOMES
MAPPING WITH PROGRAMME SPECIFIC OUTCOMES

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	1	3	2	3	2	3	3	2	3	2
CO2	3	1	1	3	2	3	2	3	3	2	2	3
CO3	3	2	1	2	2	2	2	2	2	3	2	2
CO4	3	1	1	3	1	3	2	3	3	3	3	3
CO5	3	2	1	2	3	3	2	2	3	2	2	2
Total	15	8	5	13	10	14	10	13	14	12	12	12
Average	3	1.6	1	2.6	2	2.8	2	2.6	2.8	2.4	2.4	2.4

3 - Strong; 2 - Medium; 1 - Low

SEMESTER II

ELECTIVE COURSE III: a) ECONOMIC ENTOMOLOGY

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
ZP232EC1	2	1		1	3	4	60	25	75	100

Pre-requisite

Basic background in biological sciences with a special emphasis on the study of insects.

Learning Objectives

1. Develop the ability to identify and classify insects into major orders and understand their economic importance.
2. Acquire practical skills in observing and documenting the life cycles and behaviors of beneficial and destructive insects.

Course Outcomes

On the successful completion of the course, students will be able to:		
1.	recall the features of various insect orders and describe the life history, social organization, and management practices of insects.	**K1**
2.	understand the biology of insects associated with medical, household, and veterinary/public health importance.	**K2**
3.	apply their knowledge of pest biology to assess damage and beneficial insect life cycles to practical rearing.	**K3**
4.	analyze the causes of pest outbreaks and the economic threshold levels.	**K4**
5.	synthesize knowledge to propose effective control measures for vectors associated with medical, household, and veterinary/public health importance.	**K5**

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate;

Unit	Contents	No. of hours
I	Overview of insects and insect taxonomy:Insects and their biological success - Man and insects;**S**alient features of Class Insecta and orders - Orthoptera, Isoptera, Hemiptera, Diptera, Coleoptera, Lepidoptera, Dermaptera, Odonata, Neuroptera and Hymenoptera. Basic concepts in Insect Taxonomy and classification.	12
II	Beneficial insects:Silkworms - types, life cycle of *Bombyxmori*, diseases and its management and rearing methods - Types of honey bees, life history, social organization (colonies and caste system), honey bee care and management of bee hive - Lac insects - life history, lac cultivation; Pollinators, predators, parasitoids, scavengers, weed killers, soil-builders.	12
III	Destructive insects:Insect pests - definition - Categories of pests - Types of damage to plants by insects - Causes of pest outbreak - Economic threshold level - Biology of the insect pests - Pests of paddy, cotton, sugarcane, vegetables, coconut and stored grains cereals.	12
IV	Pest management/Control strategies:Methods and principles of pest control - Natural control, Artificial control, Merits and demerits or limitations of these methods in pest control - Development and uses of pest resistant plant varieties - Integrated pest management - Concepts and practice.	12
V	Vector biology:Stable fly and cattle fly; Fowl - shaft louse and chicken flea; sheep and goat - head maggot and sheep ked. Insects associated with medical importance and management - head louse *Pediculushumanuscapitis*, mosquitoes - *Anopheles*, *Culex*, *Aedes*, flea –	12

	Xenopsyllacheopis, eye fly, sand fly, ticks, mites and bed bug. Insects associated with household insects - cockroaches, termites and silverfish. Vectors of veterinary and public health importance - Mosquitoes as potential vectors of human diseases-control measures.	

Self-study	Types of honey bees, Pest of Paddy, Natural control of pest.

Textbooks

1. Ayyar, L.V. R, 1936. Hand book of Economic Entomology for South India. Narendra Publishing House. New Delhi.
2. Vasantharaj David, B. and V.V. Ramamurthy, 2016. Elements of Economic Entomology, Eighth Edition, Brillion Publishing, New York.
3. Ross. H.H. 195. A Text Book of Entomology, John Wiley & Sons Inc., New York.

Reference Books

1. Chapman, R.F., S.J. Simpson and A.E. Douglas, 2012. The Insects: Structure and Function, Fifth Edition, Cambridge University Press, Lodo.
2. Daly, H.V., J.T. Doyen and P.R. Ehrlich, 1978. Introduction to Insect Biology and Diversity. McGraw-Hill Kogakusha Ltd., Tokyo.
3. Hill, D.S, 1974. Agricultural Insect Pests of the Tropics and Their Control. Cambridge University Press, New York.
4. Krishnaswami. S, 1973. Sericulture Manual, Vol. I & II, Silkworm rearing, FAO Agricultural Science Bulletin, Rome.
5. Mani, M.S, 1982. General Entomology. Oxford & IBH Publishing Co., India.

Web Resources

1. https://egyankosh.ac.in/bitstream/123456789/85342/1/Unit-4.pdf
2. https://www.rlbcau.ac.in/pdf/PGCourse/Entomology/Insect%20Taxonomy%20(APE%20503).pdf
3. https://egov.uok.edu.in/elearning/tutorials/1011020512BR15103CR15Apiculture%20Lac%20culture%20and%20%20sericultureapiculture%20lac%20culture%20and%20%20sericulture%20upload.pdf
4. https://agritech.tnau.ac.in/farm_enterprises/fe_api_pestanddiseases.html
5. https://cpacollege.ac.in/assets/uploads/1645091697APPLIED_ZOOLOGY_SEM_NOTE_pdf.pdf

MAPPING WITH PROGRAMME OUTCOMES

MAPPING WITH PROGRAMME SPECIFIC OUTCOMES

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	3	2	3	2	3	2	3	3	3
CO2	3	2	3	3	2	3	2	3	3	2	2	3
CO3	2	2	3	3	2	2	2	2	2	3	2	2
CO4	2	2	3	3	2	2	2	2	3	3	3	3
CO5	2	2	3	3	2	2	2	2	2	2	3	3
Total	12	10	15	13	14	12	10	12	12	13	13	14
Average	2.4	2	3	2.6	2.8	2.4	2	2.4	2.4	2.6	2.6	2.8

3 - Strong; 2 - Medium; 1-Low

SEMESTER II

ELECTIVE COURSE III: b) PARASITOLOGY

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hrs.	Marks		
								CIA	External	Total
ZP232EC2	2	1	-	1	3	4	60	25	75	100

Pre-requisite:

The students with a basic background in biological sciences with a special emphasis on the study of parasites.

Course Objectives:

1. To enable the students to be aware of the cosmopolitan distribution of parasites.
2. Develop skills for employment in clinical laboratories and health departments.

Course Outcomes

On the successful completion of the course, student will be able to:		
1.	define the basic biology and life cycle of parasites including epidemiology, diagnosis, and treatment.	**K1**
2.	explain morphological characters of parasites, developmental stages and their infestation.	**K2**
3.	identify appropriate techniques and develop basic skills for detection of parasites.	**K3**
4.	analyse the medical and public health aspects of human parasitic infections.	**K4**
5.	compare the diagnostic methods of parasitic infestation in veterinary hospitals, clinics and research laboratories.	**K5**

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate

Unit	Contents	No. of hours
I	Taxonomy and classification of parasites - origin and evolution of parasitism - host parasite relationship, classification of parasites and hosts - transmission of parasites - Parasitic zoonoses- pathogenesis - clinical manifestations of parasitic diseases.	12
II	Protozoan parasites: Introduction and classification. Intestinal Amoeba - Pathogenic free-living amoeba - Intestinal flagellates - Trypanosomiasis, Leishmaniasis, Balantoidiasis, Malaria,	12

	Isosporiasis, *Toxoplasmosis*,*Cryptosporidiosis*, *Pneumocystis* Protozoans of minor medical importance.	
III	Helminth parasites: *Trichuriasis*, *Trichinellosis*, Strongyloidiasis, Ascariasis, Enterobiasis, Filariasis, hookworm diseases, Dracunculiasis, Onchocerciasis, Loiasis, Larva migrants. Nematodes of lesser medical importance - Diphyllobothriasis, Taeniasis, Echinococcosis, Sparganosis, Schistosomiasis, Fascioliasis, Fasciolopsiasis, Paragonimiasis, Clonorchiasis, Trematodes of minor medical importance.	12
IV	**Parasitic Insects**: Prevalence, transmission, and control of parasitic infections. Parasitic infection in a compromised host. Applied Parasitology - Eosinophilia in parasitic infections, Nosocomial parasitic infections. Evasion and parasitic mode of life - morphological, biochemical, and ethological adaptations. Quality assurance and laboratory safety.	12
V	**Diagnostic methods in parasitology**: General rules for microscopical examination. Microscopical examination of blood, stool, urine, sputum and biopsy material for parasites. Cultural examination - preparation of media - techniques for cultivation of *E. histolytica*, Leishmania, Plasmodium. *Immunodiagnostic methods - IFA, AGD, IHA, IFAT, CFT, DAT, BF, DFAT*. Molecular characterization of stage specific antigen nucleotide probes for diagnosis of protozoan diseases.	12

Self-study	host parasite relationship, Intestinal Amoeba, Quality assurance and laboratory safety, General rules for microscopical examination

Textbooks

1. JayaramPanikerC. K. &SougataGhosh, 2013. Paniker's Textbook of Medical Parasitology. Jaypee Brothers Medical Publishers, Maharastra, India.
2. Rajesh Karyakarte&AjitDamle, 2008. *Medical Parasitology* (2nd ed.). Books and Allied (P) Ltd., Kolkata.

Reference Books

1. Ichhpujani R.L. & Rajesh Bhatia, 2002. *Medical Parasitology.* Jaypee printers. New Delhi
2. Patvaik, B.D, 2001. *Parasitic Insects.* Delhi: Dominant Publishers and Distributors.
3. Jones, A.W, 1976. *Introduction to Parasitology.*: Addison -Wesley Publishing Company. Boston, USA
4. Subah, C.P, 2001. *Textbook of Medical Parasitology*: All Publishers and Distributors.Chennai.
5. Elizabeth Zeibig, 2012. *Clinical Parasitology: A Practical Approach*. 2nd Edition. Saunders, United States.

Web Resources

1. https://www.cartercenter.org/resources/pdfs/health/ephti/library/lecture_notes/health_science_students/medicalparasitology.pdf
2. https://www.amboss.com/us/knowledge/general-parasitology/
3. https://www.jaypeedigital.com/eReader/chapter/9789352704804/ch1
4. https://www.physio-pedia.com/Parasitic_Infections
5. https://www.mdpi.com/2414-6366/7/10/253

MAPPING WITH PROGRAMME OUTCOMES

MAPPING WITH PROGRAMME SPECIFIC OUTCOMES

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	3	2	3	2	3	2	3	3	3
CO2	3	2	3	3	2	3	2	3	3	2	2	3
CO3	2	2	3	3	2	2	2	2	2	3	2	2
CO4	2	2	3	3	2	2	2	2	3	3	3	3
CO5	2	2	3	3	2	2	2	2	2	2	3	3
Total	12	10	15	13	14	12	10	12	12	13	13	14
Average	2.4	2	3	2.6	2.8	2.4	2	2.4	2.4	2.6	2.6	2.8

3 - Strong; 2 - Medium; 1-Low

SEMESTER II

ELECTIVE COURSE III: c) AGROCHEMICALS AND PEST MANAGEMENT

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hrs.	Marks		
								CIA	External	Total
ZP232EC3	2	1		1	3	4	60	25	75	100

Pre-requisite

The students with a basic background in biological sciences with a special emphasis on the study of fertilizers and insects' pests.

Learning Objectives

1. To enable the students to be aware of the various types of biological pesticides and their uses.
2. Able to control pest and about their selective mode of action. It also gives an account of eco-friendly biological pesticides.

Course Outomes

On the successful completion of the course, student will be able to:		
1.	outline agrochemicals, their modes of action and their fate in the agro-ecosystem.	**K1**
2.	recognize pesticide families based on their specific modes of activity.	**K2**
3.	apply appropriate pesticide management strategies by evaluating specific pest type.	**K3**
4.	analyze the impact of agrochemicals and pesticides for effective pest management.	**K4**
5.	evaluate the efficacy of organic manures, chemical fertilizers, conventional pesticides and bio-pesticides for agronomical practices.	**K5**

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate

Unit	Contents	No. of hours
I	Definition, classification, morphology, and internal systems; Plant pests – weeds, bacteria, fungi, Viruses, nematodes, molluscs, Arthropods, birds, mammals etc.; Causes of outbreak of pest, growth and development; Classification based on nature of damage: Public health pests, Agricultural pests, Domestic pests, Animal husbandry pests, Structural pests.	12
II	Manures: types, composition and value, sources of manures, Compost-Different composting technologies-Mechanical compost. plants-Vermicomposting- Green Manures - Oil cakes, Sewage Sludge-Biogas plant slurry.	12
III	Chemical fertilizers: Classification and value. N- fertilizers: Manufacturing of Ammonium Sulphate, Ammonium Chloride, Ammonium Nitrate and urea; P- fertilizers: sources, processing rock phosphate, bones for bone meal preparation; K- fertilizers: sources, Potassium Chloride, Potassium Sulphate and Potassium Nitrate;Biofertilizers: Classification and value; *viz*., *Rhizobium*, *Azotobacters*, *Azolla*, Blue Green Algae, VAM	12
IV	Conventional chemicals/ pesticides based on target species: Acaricides, Fungicides, Rodenticides, Nematicides, Molluscicides, Fumigants and Repellents; Based on chemical nature: Organophosphates; Organochlorines, Carbamates etc.; Structure, chemical name, physical and chemical properties; Mode of action, uses, toxicity; Application of Pesticides, devices used; dose estimation for field application.	12
V	Potential pesticidal plants; Plant extracts and Bio-organisms: Azadirachtin and its role in pest control; Other biopesticides: Pyrethrins, Pyrethroids, Rotenone, Nicotine and Nicotinoids. Growth inhibitors or physiological antagonists, chemo-sterilant; pheromones and attractants; Insect growth regulators, juvenile hormones, moulting hormones; BT methodology, genetically	12

	modified and transgenic plants	

Textbooks

1. Sathe, T. V. 2008. *Agrochemicals and Pest Management*.Daya Publishing House, New Delhi.
2. Patil, T. V. Sathe. 2003. *Insect Predators and Pest Management*. Daya Publishing House, New Delhi.

Self-study	Types of manure, Biofertilizer: *Rhizobium*, *Azotobacters*, *Azolla*, Blue Green Algae,

Reference books

1. Dent, D, 2000. *Insect pest management.* 2nd edition. CAB International. E-pdf.
2. Roberts, D.A, 1978. Fundamentals of Plant Pest Control. First Edition. W. H. Freeman.
3. Koul, O. and Dhaliwal, G.S, 2003. Phytochemical Biopesticides, Harwood Academic Publishers, Amsterdam.
4. Pedigo, L.P, 1996. Entomology and pest management, Prentice Hall, N. Delhi.

Web Resources

1. https://ugcmoocs.inflibnet.ac.in/assets/uploads/1/165/5582/et/35%20script20030610100303 3939.pdf
2. https://byjus.com/biology/effects-of-agrochemicals/
3. https://www.vedantu.com/biology/agrochemicals
4. https://www.gov.nl.ca/ecc/files/env-protection-pesticides-business-manuals-applic-chapter7.pdf
5. https://courseware.cutm.ac.in/wp-content/uploads/2020/06/Lecture-Notes-IPDM.pdf

MAPPING WITH MAPPING WITH PROGRAMME OUTCOMES
MAPPING WITH PROGRAMME SPECIFIC OUTCOMES

COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CO1	3	2	3	3	2	2	3	3	2	3	3	3
CO2	3	2	3	3	2	2	2	3	3	2	2	3
CO3	3	2	3	3	2	2	2	2	2	3	2	2
CO4	3	2	3	3	2	2	2	2	3	3	3	3
CO5	3	2	3	3	2	2	2	2	2	2	3	3
Total	15	10	15	15	10	10	10	12	12	13	13	14
Average	3	2	3	3	2	2	2	2.4	2.4	2.6	2.6	2.8

3 - Strong; 2 - Medium; 1-Low

SEMESTER II

ELECTIVE COURSE IV: a) RESEARCH METHODOLOGY

Course Code	L	T	P	S	Credits	Inst. Hours	Total hours	Marks		
								CIA	External	Total
ZP232EC4	2	1		1	3	4	60	25	75	100

Pre-requisite

Students should have a good understanding of the fundamental methods used in experimental biology.

Learning Objectives

1. To impart knowledge on the basic principle, methodologies and applications of instruments in biological sciences.
2. Develop essential research skills to operate and apply various biological science instruments.

Course Outcomes

On the successful completion of the course, students will be able to:		
1.	recall the principles of laboratory equipments, research techniques and the process of scientific report writing.	**K1**
2.	Explain the procedures involved in operating laboratory equipment, applying research techniques, and engaging in scientific writing.	**K2**
3.	apply biological techniques in laboratory settings to gain practical experience in research processes and scientific report writing.	**K3**
4.	analyze the principles and techniques to make wise choices in experimental design, data interpretation, and research reports in biological sciences.	**K4**
5	evaluate the quality, reliability, and limitations of data generated by research techniques and obtained from literature for specific research goals.	**K5**

K1 - Remember; **K2 -** Understand; **K3** – Apply; **K4** – Analyse; **K5 -** Evaluate

Units	Contents	No. of hours
I	Analytical Techniques: Good laboratory practice (GLP), pH meter, Colorimeter, Spectrophotometer - UV-Visible, Atomic Absorption, Flame photometer, FTIR spectrometry.	12
II	Microscopy & Micro technique: Principle, Working mechanism and applications of Bright field, Phase contrast, Electron, Confocal Microscope and Atomic force microscope. Histology – Fixation, Sectioning and Staining. Histochemistry for carbohydrates, proteins, lipids.	12

III	Separation Techniques: Centrifugation – Differential and Density gradient, types and applications of Centrifuges. Chromatography - Principle, HPLC and Affinity chromatography, GAS Chromatography Mass Spectrometry. Electrophoresis - Principle, Agarose gel electrophoresis and PAGE.	12
IV	Tracer techniques: Radioactive **i**sotopes, Radiolabeling**,** Radiocarbon dating**,** Radioactivity counters - Scintillation Counter, Geiger Muller Counter.	12
V	Scientific Writing: Essential steps in research, Review of literature, Literature citation, Research report – Abstract, Tables - Figures - Formatting and typing, Open access journals, Predatory journals, Impact factor, Citation index, H-index, Plagiarism, CopyRight.	12

Self-study	Principle, Working mechanism and applications of Electron and Phase contrast Microscope, Centrifugation - Principle, types and applications of Centrifuges, Bioinstrumentation of pH meter, Colorimeter, and UV-Visible Spectrophotometer, Quantification of carbohydrate, protein, lipid, Essential steps in research.

Textbooks

1. Veerakumari. L, 2006.*Bioinstrumentation*.MJP Publishers.Triplicane, Chennai.
2. Gurumani. N, 2006.*Research Methodology for Biological Sciences*.MJP Publishers.Triplicane, Chennai

Reference Books

1. Marimuthu. R, 2008.*Microscopy and Microtechnique*.MJP Publishers.Chennai.
2. Keith Wilson and John Walker, 2018. *Principles and Techniques of Practical Biochemistry* (8th ed.). Cambridge University Press. India.
3. Pranav Kumar, 2018. *Fundamentals and Techniques of Biophysics and Molecular Biology*.Pathfinder publication. India.
4. Paneerselvam R, 2016. *Research Methodology*.PHI Learning Pvt. Ltd. India.
5. Gurumani N, 2010.*Scientific thesis writing and paper presentation*. MJP Publishers. Chennai

Web Resources

1. https://en.wikipedia.org/wiki/Microtechnique
2. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5206469/
3. https://www.vedantu.com/physics/spectroscopy
4. https://en.wikipedia.org/wiki/Blot_(biology)
5. https://en.wikipedia.org/wiki/List_of_research_methods_in_biology

MAPPING WITH PROGRAMME OUTCOMES
MAPPING WITH PROGRAMME SPECIFIC OUTCOMES

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	1	3	2	3	2	3	3	2	3	2
CO2	3	1	1	3	2	3	2	3	3	2	2	3
CO3	3	2	1	2	2	2	2	2	2	3	2	2
CO4	3	1	1	3	1	3	2	3	3	3	3	3
CO5	3	2	1	2	3	3	2	2	3	2	2	2
Total	15	8	5	13	10	14	10	13	14	12	12	12
Average	3	1.6	1	2.6	2	2.8	2	2.6	2.8	2.4	2.4	2.4

3 -Strong; 2 -Medium; 1 -Low

SEMESTER II

ELECTIVE COURSE IV: b) APICULTURE

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
ZP232EC5	**3**	1	-	-	**3**	**4**	**60**	**25**	**75**	**100**

Pre-requisite

Students should be aware of importance of honey bees and their impacts on the ecosystem.

Learning Objectives

1. Impart knowledge on the morphology, life cycle, characteristics of honey bees and bee keeping.
2. Acquired skills to perform bee keeping from managing colonies of bees to harvest honey and other bee related by-products in different setups and as an Entrepreneurial venture.

Course Outcomes

On the successful completion of the course, students will be able to:		
1.	understand the morphology, life cycle, characteristics of honey bees and bee keeping.	**K1**
2.	acquire skills to perform bee keeping from managing colonies of bees in order to harvest honey and other Bee related by-products in different setups and as an Entrepreneurial venture.	**K2**
3.	knowledge on the harvesting, preserving and processing of bee products and identification of the appropriate markets to sell the produce.	**K3**
4.	identify of different bee enemies and diseases and control measures and its management	**K4**
5.	evaluate the honey chemical composition of different environment.	**K5**

K1 - Remember; **K2** - Understand; **K3** – Apply; **K4**-Analyze **K5**-Evaluate

Units	Contents	No. of Hours

I	Introduction to Apiculture. Scope and importance. History, classification, types of honey bees - morphology, mouth parts and sting of Honey bees – life cycle of different species and their behavioural patterns. Social organization of bee colony. morphology, mouth parts and sting of Honey bees –	12
II	Bee-keeping system, tools and equipment's needed for bee keeping. Types of bee hives, structure, and functional features. Criteria for site selection for apiculture and factors affecting them. Flora for apiculture – selection of Bees for apiculture, Method of bee keeping.	12
III	Identification and Preventive measures to be taken against pests (The Greater wax moth & Wasps and Hornets) and parasites (tracheal mite). Diseases (Nosema disease, Sac-brood disease, European foulbrood disease), and their control measures. Colony collapse disorder and its management.	12
IV	Bee products, uses and importance- Honey, Royal jelly, Propolis, Pollen and Bee venom. Harvesting, Processing, Packaging and Marketing of bee products.	12
V	Apiculture industry around the world and Role of Central Bee Research & Training institute in India. Apiculture as an Entrepreneurial venture.	12

Self-study	Introduction to Apiculture. History, classification, types, life Cycle, Tools and equipment's needed for bee keeping, Diseases affecting honey bees and their control measures. Bee products, uses and importance- Honey, Royal jelly, Propolis, Pollen and Bee venom.

Text book

1. Singh, D., Singh, D. Pratap. 2006. *A Handbook of Beekeeping*. Agrobios, India.
2. Mishra R.C. 2002. *Perspectives in Indian Apiculture*, Agrobios, India.

Reference Books

1. Dharam P. Abrol, 2019. Beekeeping: A compressive guide to bees and beekeeping. Scientific Publishers. Jodhpur, India.
2. Caron, D.W, 2013 (revised from 1999). Honey Bee Biology and Beekeeping. Wicwas Press. United States.
3. Dewey M. Caron, Lawrence John Connor, 2013. Honey Bee Biology and Beekeeping, Revised Hardcover. Wicwas Press. United States.
4. Ross Conrad, Gary Paul Nabhan, 2007. *Natural Beekeeping: Organic Approaches to Modern Apiculture.*Chelsea Green Publishing. United States.
5. Alphonse Avitabile, Jan Propst, 1998. The Beekeeper's Handbook.Comstock Pub. Associates. Cornell University Press.

Web Resources

1. https://www.britannica.com/topic/beekeeping
2. https://nbb.gov.in/pdf/Pests&DiseasesHoneybees&Management.pdf
3. https://www.aakash.ac.in/important-concepts/biology/apiculture-in-indian

4. https://vikaspedia.in/agriculture/farm-based-enterprises/bee-keeping-1/about-bee-keeping
5. https://beebuilt.com/pages/beekeeping-for-beginners

MAPPING WITH PROGRAMME OUTCOMES
PROGRAMME SPECIFIC OUTCOMES

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CO1	2	1	2	2	2	3	3	2	2	3	2	2
CO2	3	1	2	2	1	3	2	2	2	3	2	2
CO3	3	2	2	2	2	2	1	2	2	3	2	2
CO4	2	3	3	2	2	3	3	2	3	3	2	2
CO5	3	2	3	2	3	2	3	2	3	3	2	2
TOTAL	13	9	12	10	10	13	12	10	12	15	10	10
AVERAGE	2.6	1.8	2.4	2	2	2.6	2.4	2	2.4	3	2	2

3 – Strong, 2- Medium, 1- Low

SEMESTER II

ELECTIVE COURSE – IV: c)SERICULTURE

Course Code	L	T	P	S	Credits	Inst. Hours	Total hours	Marks		
								CIA	External	Total
ZP232EC6	2	1		1	3	4	60	25	75	100

Pre-requisite:

Students should have a fundamental knowledge of biology, an entrepreneurial mindset, and an appreciation for the economic and cultural significance of sericulture.

Learning Objectives:

1. To gain in-depth knowledge of silk fiber types, sources, properties, and the significance of sericulture in India.
2. To develop practical skills in moriculture, silkworm rearing, and cocoon processing.

Course Outcomes

On the successful completion of the course, students will be able to:		
1.	recall and describe the fundamental concepts, terminology, and processes related to sericulture, and sericulture industry practices.	**K1**
2.	demonstrate the key concepts, processes, properties of silk fiber, mulberry cultivation techniques, cocoon characteristics, and the significance of sericulture practices in the silk production industry.	**K2**
3.	apply their knowledge of sericulture principles and practices to solve practical problems and optimizing cocoon processing techniques.	**K3**
4.	criticallyanalyze the challenges and opportunities in the sericulture industry and assess the economic and environmental implications of sericulture practices.	**K4**
5.	evaluate the effectiveness of different sericulture practices, technologies, and policies, and make informed decisions to optimize silk production.	**K5**

K1 -Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate

Unit	Contents	No. of hours
I	Introduction to textile fibers; types - natural and synthetic fibers; sources of silk fiber - Tasar, Muga, Anaphe, Gonometa, Fagara, spider and mussel; properties and importance of silk fiber.History, development, status, characteristics, and advantages of sericulture in India.	12
II	Host plants; Moriculture - distribution, morphology, propagation- seedling, cutting, grafting, layering and micropropagation methods, maintenance- irrigation, manuring and pruning, pests and diseases of mulberry.	12
III	*Bombyxmori*- morphology, anatomy, life cycle, geographical locations, larval moults, voltinism, indigenous and commercial races. Diapause. Egg-storage and transportation.	12
IV	Rearing houses and equipment. Rearing operations- disinfection, brushing, feeding and spacing. Moulting and spinning. Harvest. Rearing methods- chawki, lasso, showa, shelf-rearing, floor-rearing and shoot rearing. Diseases of *Bombyxmori*- protozoan, bacterial, viral and fungal. Pests of silkworm- Uzi fly, dermestids, mites, ants, nematodes, aves and mammals.	12
V	Physical and commercial characteristics of cocoons. Cocoon harvesting and marketing. Cocoon sorting, stifling, deflossing, riddling, cooking, brushing, reeling and re-reeling. Weaving. By-products of sericulture industry.	12

Self-study	Sources of silk fiber - Tasar, Muga, Anaphe, Gonometa, Fagara, spider and mussel.

Textbooks

1. Ganga, G and J. SulochanaChetty, 2019. An Introduction to sericulture (2nd edn). Oxford and IBH Pub. Co. Pvt. Ltd., Delhi.

2. Johnson, M. and Kesary, M, 2019. Sericulture. Saras publications, Nagercoil.

Reference Books

1. Food and Agriculture organization 1976. Manual on sericulture I, II & III. Delhi: Oxford and IBH Pub. Co. Pvt. Ltd., Delhi.
2. M.S. Jolly, 1987. Appropriate Sericulture Techniques. CSR & TI, Mysore
3. S.R. Ullal and M.N. Narasimhanna, 1987. Hand book of practical sericulture. CSB, Bangalore.
4. M.N. Narasimhanna, 1988. Manual on silkworm egg production. CSB, Bangalore.
5. Dandin, S.B., Jayaswal, J. and Giridhar. K, 2010. Handbook of sericulture technologies, Central Silk Board, Bangalore, India.

Web Resources

1. https://agritech.tnau.ac.in/sericulture/
2. https://csb.gov.in/
3. https://silks.csb.gov.in/
4. https://www.britannica.com/topic/sericulture
5. https://agritech.tnau.ac.in/sericulture/seri_index.html
6. https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/sericulture
7. https://vikaspedia.in/agriculture/farm-based-enterprises/sericulture/sericulture-in-india

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO 1	2	1	1	1	1	1	2	1	1	3	1	1
CO 2	2	2	1	1	1	1	2	1	1	3	1	1
CO 3	3	2	1	1	1	1	2	1	1	3	1	1
CO 4	3	3	1	1	1	1	2	1	1	3	1	1
CO 5	3	3	1	1	1	1	2	1	1	3	1	1
TOTAL	13	11	5	5	5	5	10	5	5	15	5	5
AVERAGE	2.6	2.2	1	1	1	1	2	1	1	3	1	1

3 – Strong, 2 – Medium, 1 - Low

SEMESTER II

ELECTIVE LAB COURSE -II: ECONOMIC ENTOMOLOGY & RESEARCH METHODOLOGY

Course Code	L	T	P	S	Credits	Inst. Hours	Total hours	Marks		
								CIA	External	Total
ZP232EP1	2	1		1	3	2	30	25	75	100

Pre-requisite:

Students should have knowledge relevant to economic entomology & research methodology.

Learning Objectives:

1. To equip students with skills in both the practical aspects of economic entomology and the essential research methodology.
2. To acquire skills necessary for conducting meaningful studies in these field.

Course Outcomes

On the successful completion of the course, students will be able to:		
1.	comprehend the principles and concepts of economic entomology & research methodology.	**K1**
2.	summarize the economic impact of insect pests. explain the principles behind different ttechniques& research designs	**K2**
3.	utilize appropriate methodologies to collect and analyze data of insects and apply statistical techniques to interpret and draw conclusions.	**K3**
4.	interpret practical solutions to address challenges in economic entomology, incorporating research methodology principles.	**K4**
5.	evaluate research methodologies and experimental designs used in economic entomology studies.	**K5**

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate;

Economic Entomology

1. Collect and identify common insect pests in your local environment
2. Dissection: Silk glands of silkworm.
3. Mounting: Mouth parts of honey bee. Mosquito.
4. Phototacticbehavior of insect pests.
5. Collection and Identification of insect pests in the mulberry plants.

Specimen/Spotters/Models: Silkworm larva, pupa and adult, honey bee colony, Rhinoceros beetle, Red Palm Weevil, Banana Stem Weevil.

Research Methodology

1. Whole mount preparation of two specimens.
2. Separation of amino acids using thin layer chromatography.
3. Sectioning and staining of a tissue.
4. Separation of pigments by column chromatography using plant extract (Demonstration).
5. Agarose Gel electrophoresis (Demonstration).

Instruments/ Charts/ Models: Phase contrast microscope, Fluorescent microscope, Spectrophotometer, HPLC, Flame photometer, Microtome, Electrophoretic apparatus.

Textbooks

1. Bajia, R., R.N. Kencharaddi, B. Bairwa, K. Kumar, V. Kumar. *Practical handbook on fundamentals of entomology.* Second edition. Kalyani Publishers.Chennai.
2. Gurumani N, 2019. *Research Methodology: For Biological Sciences.* Kindle Edition. Chennai.

Reference Books

1. Trigunayat, M.M, 2016. *A Manual of Practical Entomology*. 3rd Ed. Scientific Publishers. Jodhpur, Rajasthan.
2. Agrawal, N, 2022. *Fundamental Entomology: A Practical Manual*. Narendra Publishing House, New Delhi.
3. Ch Raja Goud, 2022. *Practical Manual on Fundamentals of Entomology*. Om Publishers. New Delhi
4. VinayakBairagi&MousamiVaibhavMunot, 2019. *Research Methodology: A Practical and Scientific Approach*. CRC press. Florida, United States.
5. Catherine Dawson, 2002. *Practical Research Methods*: *A User-Friendly Guide to Mastering Research Techniques and Projects*. Ubs Publishers' Distributors Pvt.Ltd.Ernakulam, Kerala.

Web Resources

1. https://www.researchgate.net/publication/327282644_A_Textbook_of_Economic_Entomology_M_Dayib
2. https://academic-accelerator.com/encyclopedia/economic-entomology
3. https://books.google.co.in/books?id=z2s6nQAACAAJ&printsec=frontcover&source=gbs_ge_summary_r&cad=0#v=onepage&q&f=false
4. https://jru.edu.in/studentcorner/labmanual/agriculture/Insect%20morphology%20and%20%20systematics.pdf
5. https://www.scribbr.com/dissertation/methodology/

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO 1	1	1	1	1	1	1	2	1	1	2	1	1
CO 2	1	1	1	1	1	1	2	1	1	2	2	1
CO 3	2	1	1	1	2	1	2	1	1	3	2	2
CO 4	3	2	2	2	1	3	2	1	1	3	1	3
CO 5	3	2	2	3	3	1	2	1	2	3	3	3
TOTAL	10	7	7	8	5	7	10	5	6	13	9	10
AVERAGE	2.6	2.2	2.2	2.4	1.4	2.2	2	1.4	1.6	2.4	1.8	2.6

3 – Strong, 2 – Medium, 1 - Low

SEMESTER II

SKILL ENHANCEMENT COURSE I: POULTRY FARMING

Course Code	L	T	P	S	Credits	Inst. Hours	Total hours	Marks		
								CIA	External	Total
ZP232SE1	2	1		1	2	4	60	25	75	100

Pre-requisite

Students should be aware of economic and cultural importance of Poultry farming**.**

Learning Objectives:

1. To know the needs for Poultry farming and the status of India in global market.
2. Acquire the skills to apply the techniques and practices needed or Poultry farming.

Course Outcomes:

On the successful completion of the course, students will be able to:		
1.	recall the key components of a poultry house to ensure optimal living conditions for poultry.	**K1**
2.	explain the different methods of rearing and the significance of proper vaccination programs in poultry farming.	**K2**
3.	develop a practical feeding plan for a specific stage of poultry considering their nutritional requirements.	**K3**
4.	analyze the impact of different housing systems on poultry welfare and productivity,	**K4**
5.	critically assess the effectiveness of poultry feeds and the disease control measures in poultry farming,	**K5**
6.	design a comprehensive waste management and recycling system for poultry farms.	**K6**

K1- Remember; **K2**- Understand; **K3**- Apply; **K4**-Analyze; **K5**-Evaluate; **K6**- Create

Unit	Contents	No. of hours
I	General introduction to poultry farming - Definition of Poultry - Past and present scenario of poultry industry in India -Principles of poultry housing - Poultry houses - Systems of poultry farming	12
II	Management of chicks - growers and layers - Management of Broilers. - Preparation of project report for banking and insurance.	12
III	Poultry feed management-Principles of feeding, Nutrient requirements for different stages of layers and broilers - Feed formulation and Methods of feeding.	12
IV	Poultry diseases-viral, bacterial, fungal and parasitic (two each); symptoms, control and management; Vaccination programme.	12
V	Selection, care and handling of hatching eggs - Egg testing. Methods of hatching. - Brooding and rearing -. Sexing of chicks. - Farm and Water Hygiene - Recycling of poultry waste.	12

Text Books

1. Sreenivasaiah., P. V, 2015. *Textbook of Poultry Science*. 1st Edition. Write & Print Publications, New Delhi.
2. Jull A. Morley, 2007. *Successful Poultry Management*. 2nd Edition. Biotech Books, New Delhi.

Reference Books

1. Jadhav, J, Siddique, M.F., KavithaMeena, 2019. *Handbook of Poultry Production and Management*. 3rd Edition.Jaypee Brothers Medical Publishers, Chennai.
2. Jagdish Prasad, 2015. *Poultry Production and Management Paperback – 1*. 5h EditionKalyani Publishers, Chennai.
3. Das, D, 2021. *Textbook on Poultry Management.*Narendra Publishing House, New Delhi.
4. Eiri Board, 2008. *Hand Book of Poultry Farming and Feed Formulations*. Engineers India Research Institute. India.
5. Sharma R P et al. *Poultry Production in India*. Poultry Science, India.

Web Resources

1. https://dahd.nic.in/sites/default/filess/Excerpts%20of%20Poultry%20Farmn%20Manual.pdf
2. https://www.fao.org/3/i3531e/i3531e.pdf
3. https://egyankosh.ac.in/bitstream/123456789/59735/1/Poultry%20farming%20in%20india.pdf
4. https://seyianwo.files.wordpress.com/2015/04/poultry-lecture-note.pdf
5. https://surendranathcollege.ac.in/new/upload/SUMAN_TAMANGPoultry%20Farming2021-02-14Poultry%20Farming-converted.pdf

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MAPPING WITH PROGRAMME OUTCOMES

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO 1	PSO2	PSO3	PSO4	PSO5
CO1	1	2	1	2	2	2	2	1	1	3	3	3
CO2	1	1	2	3	1	2	2	1	2	2	1	2
CO3	2	1	2	2	1	3	2	1	2	2	2	2
CO4	3	2	1	2	1	2	1	2	2	1	1	1
CO5	1	2	2	2	2	2	3	2	3	2	2	3
CO6	2	3	3	2	3	3	3	3	2	3	2	2
Total	13	11	11	14	10	14	13	10	12	13	11	13
Average	2.1	1.8	1.8	2.3	1.6	2.3	2.1	1.6	2	2.1	1.8	2.1

3 - Strong; 2 - Medium; 1-Low

SEMESTER – I & II

LIFE SKILL TRAINING – I ETHICS

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
PG23LST1	**1**				**1**	**1**	**1**	**-**	**50**	**100**

Prerequisites: Value education-its purpose and significance in the present world

Learning Objectives

1. To familiarize students with values of the individual, society, culture, one's own health and life philosophy,
2. To impart knowledge of professional ethical standards, codes of ethics, obligations, safety, rights, and other worldwide challenges.

Course Outcomes	On completion of this course the student will be able t	
CO1	understand deeper insight of the meaning of their existence.	K1
CO2	recognize the philosophy of life and individual qualities	K2
CO3	acquire the skills required for a successful personal and professional life.	K3
CO4	develop as socially responsible citizens.	K4
CO5	create a peaceful, communal community and embrace unity.	**K3**

Unit	Contents	No. of Hours
I	**Goal Setting:** Definition - Brainstorming Session – Setting Goals – Few components of setting goals.	**3**
II	**Group Dynamics:** Definition - Nature of Groups – Types of Groups – Determinants of group behavior	**3**
III	**Conflict Resolution:** Definition – What is a conflict resolution – Why should conflicts be resolved? - Lessons for life	**3**
IV	**Decision Making:** Definition – 3C's of decision making – Seven Steps to effective decision making – Barriers in effective decision making	**3**
V	**Anger Management:** Effects of anger – Tips to reduce anger – Anger warning signs – Identify your triggers – Ways to cool down your anger.	**3**
TOTAL		**15**
Self-Study Portion: Salient values for life, Human Rights, Social Evils and how to tackle them, Holistic living, Duties and responsibilities.		

Textbooks

Life Skill Training – I Ethics, Holy Cross College (Autonomous), Nagercoil

Reference Books

1. Holy Cross College (Autonomous), Nagercoil (2007). Foundation Course Life's Challenges. Sipca Computers.

2. Mathew, Sam (2010). Self Help Life Book. Opus Press Publisher.

3. Swati Mehrotra. (2016). Inspiring Souls Moral Values and Life Skills (1st ed.) [English]. Acevision Publisher Pvt. Ltd.
4. IraiAnbu, v. (2010, August). Random Thoughts (1st ed.) [English]. THG Publishing Private Limited, 2019.
5. Holy Cross College (Autonomous), Nagercoil (2007). Foundation Course Life's Challenges. Sipca Computers.

Web Resources

1. https://positivepsychology.com/goal-setting-exercises/
2. https://www.gov.nl.ca/iet/files/CCB_GroupDynamicsGuide.pdf
3. https://en.wikipedia.org/wiki/Conflict_resolution
4. https://asana.com/resources/decision-making-process
5. https://www.mayoclinic.org/healthy-lifestyle/adult-health/in-depth/anger-management/art-20045434

	Content addressed with Local Needs
	Content addressed with NationalNeeds
	Content addressed with Regional Needs
	Content addressed with Global Needs

M.Phil Zoology
Semester I
C3: Paper II- Recent Trends in Zoology
Course Code: MPZ183

No. of hours per week		Credit	Total no. of hours	Marks
Contact	**Library**	4	75	100
5	3			

Objectives

1. To provide an understanding on the latest developments and technologies introduced in the field of Biology.
2. To update the knowledge and information especially in Zoology.

Course Outcomes

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	gain knowledge on tissue engineering, transgenic biology and immunotechnology.	PSO - 3	U
CO - 2	identify the molecular markers, analyse the methods of sequencing and therapeutic measures.	PSO - 3	An; E
CO - 3	classifynanomaterials and discuss biomedical and environmental applications.	PSO - 7	U; Ap
CO - 4	apply the knowledge gained from environmental education in ecological research	PSO - 2	Ap
CO - 5	describe the significance of stem cell technology and its application in medicine.	PSO - 5	Ap
CO - 6	follow ethical principles in handling biological materials.	PSO - 9	Ap

UNIT I

Cell and tissue engineering: Biomaterials for tissue engineering – approaches in tissue engineering - Artificial skin, bone grafts, artificial nerve grafts. Transgenic biology: Gene transfer methods, Transgenic plants and animals. Immunotechnology: Hybridoma – production and applications of monoclonal antibodies - Flow cytometry - Blotting techniques: Southern, Northern and Western - Polymerase chain reaction.

UNIT II

Molecular markers and their applications. Gene therapy – types, approaches and antisense gene therapy.Human genome project, mapping and sequencing.Genomic research - methods of genome sequencing.Proteomic research - Methods of proteome analysis.

UNIT III

Nanotechnology basics- Introduction to nano world- classification of nano materials - application of nano crystals, nano factories, nano biosensors, optical biosensors - DNA sensors, quantum dots. Biomedical applications: drugs- drug delivery - photodynamic therapy. Application of nano particles in pollution control, waste water treatment, nano particles as biosensors, risk and threats of nano particles to environment and mankind.

UNIT IV

Environmental education, planning and management. Bioremediation. Renewable and non-renewable sources of energy, conventional and non conventional – solar energy - Biogas production - Nuclear energy - Indian nuclear power plant. Biodiversity - Types, Measures of diversity - Biodiversity conservation laws. Remote sensing and radiotelemetry in ecological research.

UNIT V

Stem cell Biology- embryonic and adult stem cells- reprogramming in stem cell biology- molecular mechanisms of self-renewal - pluripotency, multipotency and lineage differentiation. Skin stem cells - neural stem cells- cancer stem cells - stem cell gene therapy. Stem cells and diabetes - repair of damaged heart using stem cells. Bioethics: need for ethical review - biosafety - ethical implications on transgenic animals- monitoring the welfare of transgenic animals - laboratory animal ethics - ethical guidelines for use of animals in scientific research. Intellectual Property Rights (IPR) and patenting of biological materials.

Reference Books

1. Mark Ratner & Daniel Ratner (2007). A general introduction to the next big idea. New Delhi, India: Dorling Kindersley (India) Pvt. Ltd.
2. Emmanuel, C. Rev.Fr. Ignacimuthu. S.J. & Vincent, S. (2006). Applied Genetics: Recent trends and techniques. Chennai, India: MJP Publishers.
3. Parthasarathy, B.K. (2007). Nanotechnology in Life Science. New Delhi, India: ISHA Books.
4. Gupta, P.K. (2009). Elements of Biotechnology. Meerut: Rastogi Publications.
5. Singh, B.D. (2006). Biotechnology Expanding Horizons. Chennai: Kalyani Publishers.
6. Satyanarayana, V. (2004). Biotechnology.Kolkota: Books and Allied (P) Ltd.
7. Dubey, R.C. (2006). A Text Book of Biotechnology (4^{th}ed.). New Delhi: S. Chand and Co. Ltd.
8. Robert Lanza, John Gearhart, Brigid Hogan, Douglas Melton, Roger Pederson, Donnall Thomas, James Thomson and Ian Sir Wilmut (2009). Essentials of Stem Cell Biology(2^{nd}ed.). San Diego, USA: Academic Press.

Semester I

C4: Optional: In-depth study paper (a) Aquaculture

Course code: MPZ184

No. of hours per week		Credit	Total no. of hours	Marks
Contact	**Library**	5	45	100
3	4			

Objectives

1. To provide knowledge on the rearing of aquatic organisms in controlled or selected aquatic environments for commercial or recreational, or public purpose.
2. To promote the development ofenvironmentally sound aquaculture: reducing the impact of waste and preventing pollution.

Course Outcomes

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	gain knowledge on the rearing on aquatic organisms in the selected aquatic environment.	PSO - 3	U
CO - 2	assess the nutritional requirements and strategies for feeding management.	PSO - 6	E
CO - 3	culture, harvest and market of finfish, shellfish and seaweed.	PSO - 7	Ap
CO - 4	gain knowledge on development of transgenic fishes and aquaculture management.	PSO - 9	U
CO - 5	review research articles in aquaculture, design experiments and write scientific reports.	PSO - 5	Ap

UNIT I

Scope and status of aquaculture: Scope of Aquaculture. Present state of Aquaculture (Aquaculture in the world and Aquaculture in India). Basic principles of Aquaculture - desirable characteristics of cultivable organisms. Kinds of aquaculture- extensive culture, semi-intensive culture and intensive culture; race way culture; monoculture; monosex culture; poly culture; Integrated fish culture; waste water fish culture; pen culture; cage culture.

UNIT II

Fish nutrition and Feed technology: Principles of fish nutrition: Nutritional requirements of cultivable finfish and shellfish. Feed ingredients and their composition, feed formulation, preparation and evaluation; digestibility of feeds, feed additives (attractants, growth stimulants, colour enhancers and probiotics) and binders. Live feed organism: Diatom, Rotifer, Cladoceran, Artemia and Tubifex. Nutritional pathology: Antinutritional factors and antimetabolites, microbial toxins, methods of elimination, nutrient deficiency and symptoms. Feeding management: methods of feeding, ration size and frequency, feed performance and economics.

UNIT III

Fin fish culture, Shell fish culture and Seaweed culture: Culture of carps: indigenous and exotic carps, mullet, milk fish, trout and air breathing fishes. Induced breeding: seed procurement - hypophysation - Management of nursery, rearing and stocking ponds - Fish seed transportation.Ornamental fish culture. Fresh water prawns: breeding, larval rearing and culture. Culture of penaeid prawns: species selection-seed production-eyestalk ablation-larval

rearing- culture- Harvesting and marketing. Oyster culture (pearl oyster and edible oyster) and mussel culture.Seaweed culture.

UNIT IV

Fish Biotechnology and Genetics: Chromosomal manipulation - cytogenetics - hybridization - transgenic species - cryopreservation of gametes - bioencapsulation. Heritability - growth rate-stocks and strains-spawning time-food conversion efficiency; sex determination - sex ratio-sex linkage-sex reversal and sex determination – Androgenesis, Gynogenesis and sex determination - H-Y antigen.

UNIT V

Aquaculture management and Review of Research papers: Water quality management-dissolved gases- environment and biological factors. Fish diseases and their management - parasitic, viral, bacterial, fungal, protozoan, Pollution hazards.Aquatic weeds and their control.

Review of relevant research articles in the field of Aquaculture.

Reference Books

1. Bardach, J. (1972).Aquaculture. New York.: Wiley-Interscience Publication.
2. Jhingran, V.G. (1991). Fish and Fisheries of India. New Delhi: Hindustan Publishing Co.
3. Jeyaram, V.C. (1981). The Fresh water Fishes in India Hand book. Kolkatta: ZSI.
4. Pillay, T.V.R. (1990). Aquaculture: Principles and Practices. England: Fishing News Books Ltd.
5. Purdon E.Colin(1993). Genetics and Fish Breeding. London: Chapman and Hall Publication.
6. Chris Andrews, AdrienExell& Neville Carrington(1988). Manual of Fish Health. London: Salamander books Ltd.
7. JaquesArrignon (1999). Management of Fresh water Fisheries.Delhi: **O**xford and IBH Publishers.
8. Christopher Meseke (1985). Fish Aquaculture, United Kingdom, UK: Pergamon Press.
9. Zdenek Lucky (1977). Amerind Publishing Co. Pvt. Ltd., New Delhi: Methods for the diagnosis of fish diseases.

Semester I

C4: Optional - In-depth study paper (b) Applied Entomology

Course code: MPZ185

No. of hours per week		Credit	Total no. of hours	Marks
Contact	**Library**	5	45	100
3	4			

Objectives

1. To know about the insect diversity and biology.
2. To identify the economically important insects and explore the ways ofexploiting the beneficial ones.
3. To understand and adopt practices for integrated pest management so as to minimize the environmental damage, human health risks and cost associated with pest suppression.

Course Outcomes

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	classify insects according to their morphology, lifecycle and habitat.	PSO - 2	R
CO - 2	explain the anatomy and physiology of insects. dentify pest insects of the major horticultural crops.	PSO - 6	R;Ap
CO - 3	acquire knowledge on insect pest management techniques such as cultural, physical, biological, chemical, IPM etc.	PSO - 3	U
CO - 4	gain knowledge of beneficial and productive insects and conservation of the environment.	PSO - 8	U
CO - 5	apply effective control measures for harmful insect pests.	PSO - 7	Ap
CO - 6	eview of relevant research article in the field of pest management and plan sustainable agriculture.	PSO - 9	An

UNIT I

Introduction to the study of Entomology: Outline classification of insects up to super families - key to the identification of various orders (Thysanura, Orthoptera, Dyctoptera, Odonata, Thysanoptera, Isoptera, Anapleura, Coleoptera, Lepidoptera, Hemiptera, Diptera and Hymenoptera) with common South Indian examples.

UNIT II

Insect structure and function: Insect body plan and the following systems: integumentary, digestive, excretory, circulatory, respiratory, muscular, locomotory, nervous, sensory, exocrine and endocrine, reproduction and development.

UNIT III

Beneficial and Productive insects: Beneficial insects: Insects in biological research, insects as entomophagous, pollinators, food consumers, soil builders, weed killers, scavengers, predators and parasites effecting biological control and bio-indicators. Productive insects: Insects that produce honey and bee wax, silk, lac, dyes, and medicines. Forensic Entomology

UNIT IV

Harmful insects: Insect pests and pest control: pests of major crops (cotton, sugarcane, paddy) - pests of vegetables, stored grains, and pulses- pests of house hold goods and structural materials. Principles and Application of pesticides – dusting and spraying.Insect vectors and diseases: Bioecology, medical importance and management – Mosquitoes (malaria and filariasis), Common and Greater Housefly (dysentery and other gastro intestinal disorders), Fleas and Lice (plague, typhus fever and Trench fever), Bed bugs (Q-fever) and Tsetse flies (sleeping sickness).

UNIT V

Pest management and Review of research papers: Integrated Pest Management (IPM). Food preference and bioenergetics – feeding stimulants- feeding deterrents.
Review of relevant research articles in the field of Pest management.

Reference Books

1. Tembhare, D.B.(1997). Modern Entomology. India: Himalaya Publishing House.
2. Vasantharaj David, B.(2003).General and Applied Entomology (2nded.). New York: McGraw-Hill Publishers.
3. RamakrishnanIyer, T. V. (1940). Handbook of Economic Entomology for South India. South India: Superintendent, Government Press.
4. Dennis S. Hill (1975). Agricultural insect pests of the tropics and their control. United Kingdom, UK: Cambridge University Press.
5. Clell Lee Metcalf and Wesley Pillsbury Flint (1962). Destructive and Useful insects **(**4thed.). New York: McGraw-Hill Publication.
6. Pradhan, S. (2002). Agricultural Entomology and Pest control. New Delhi: ICAR.
7. Little, V.A. (1967). General and Applied Entomology**.** New Delhi: Oxford and IBH Co.
8. Ralph H. Davidson, William F. Lyon (1987). Insect pests of farm, garden and orchard (8thed.). New York: John Wiley & Sons.
9. Ross, H.H., Ross, C.A. and Ross, J.R.P.(1982). A text book of Entomology. New York: John Wiley & Sons Publication.
10. Moni, M.S. (1982). Text book of Entomology. New Delhi: Oxford and IBH Co.
11. Dunston P. Ambrose (2007). The insects: Beneficial and Harmful aspects. New Delhi, India: Kalyani Publishers.
12. Dorothy Gennard (2007). Forensic Entomology. New York: John Wiley Sons Publication.
13. Jason H. Byrd, James L. Carstener(2009).Book of Forensic Entomology. United Kingdom, UK: CRC Press.
14. Nayar, K.K., Ananthakrishnan, T.N. and Vasantharaj David B. (1976). General and Applied Entomology. New York: Tata McGraw- Hill Publishers.
15. Vasantha Raj David and Ananthakrishnan (2003). General and Applied Entomology. New York: Tata McGraw- Hill Publishers.

Semester I

C4: Optional: In-depth study paper (c) Environmental Biology

Course code: MPZ186

No. of hours per week		Credit	Total no. of hours	Marks
Contact	**Library**	5	45	100
3	4			

Objectives

1. To provide a comprehensive coverage on components of environment, biodiversity.
2. To assess the impact of toxicants on organisms.

Course Outcomes

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	Gain knowledge on diversity of life on earth and assess biodiversity.	PSO - 1	U; R
CO - 2	Explain the interrelatedness of humans and the environment.	PSO - 6	U
CO - 3	Identify different environmental problems and suggest possible solutions.	PSO - 2	An; Ap
CO - 4	Identify Government policies to conserve biodiversity and pollution control.	PSO - 9	An; Ap
CO - 5	Apply Scientific Method to analyze and interpret data and communicate in both oral and written form.	PSO - 7	U; E
CO - 6	Accept employment in a variety of environmental and health related professions.	PSO - 4	Ap

UNIT I

Biodiversity: Measures of biodiversity - Diversity indices: Dominance index- Shannon Weiner index-Similarity index- Dissimilarity index- Association index. **Ecosystem**: Types – Abiotic and Biotic components -Primary productivity and measurements - Energy flow- Nutrient cycling, Homeostasis. Field sampling techniques - Animal trapping techniques - Basic methods in behavioral and food habit studies.Specimen collection and preservation.

UNIT II

Population Ecology and Ethology: Population: Population growth - growth patterns, growth models- (time lag models). Life history strategies: r and k selection, Life tables and Survivorship curves. Demography.Behaviour in insects and birds – Social life in ants and termites - Foraging and defensive behavior - Nesting behavior - Clutch size and Sex ratio.

UNIT III

Environmental degradation: Environmental pollution - Air, Water, Soil, Radioactive and Noise Pollution and their impact. Degradation of environment due to Mining, Industries, Agriculture and Urbanization– Global warming.Xenobiotics. Bioremediation: Microbial and phytoremediation.

UNIT IV

Toxicology: Toxicity of pollutants – safety evaluation – acute and chronic toxicity – Bioassays (LC_{50}/LD_{50} determination) – selection of test animals – probit analysis – Dose response – behavioural aspects. Impact of toxicants on organisms: Feeding energetics - hematology – respiration – Excretion - Histological, Biochemical and Molecular changes.

UNIT V

Environmental management and Review of research papers: Concept of Bioconservation- Sustainable ecodevelopment – Environmental Impact Assessment (EPA) - Remote sensing and its applications in Ecology. Nonconventional sources of energy. Status and management of endangered animals of India.

Review of relevant research articles in the field of Environmental studies.

Reference books

1. Bhatia, A.L. (2010). Text book of Environmental Biology. New Delhi: I.K. International Publishing House Pvt. Ltd.
2. Benny Joseph (2005). Environmental studies. New Delhi: The McGraw-Hill Companies.
3. Kato, M. (Ed.)(2000). The biology of biodiversity. Tokyo: Springer – Verlag Publication.
4. Kapoor, V.C. (2001). Practice of Animal taxonomy (5th ed.). New Delhi: Oxford and IBH Publishing Co. Pvt. Ltd.
5. Simpson, G.G. (1969).Principles of animal taxonomy. New Delhi: Oxford and IBH Publishing Co. Ltd.
6. SupriyoChakraborty (2004). Biodiversity. Jaipur: Pointer Publishers.
7. Pande, K., Shukla, J.P. and Trivedi, S.P.(2006). Fundamentals of Toxicology. Kolkata, India: New Central Book Agency (P) Ltd.
8. Trivedi, P.C. and Sharma, K.C. (2003). Biodiversity Conservation
   Jaipur: Avishekar Publishers.
9. Trivedi, R.N.(1993). Text Book of Environmental Sciences. New Delhi: Anmol Publications Pvt. Ltd.
10. Shukla, S.K. and Srivastava, P.R.(1992). Water Pollution and Toxicology. New Delhi: Common-Wealth Publishers.
11. Subramanian, M.A. (2004). Toxicology. Principles and Methods. Chennai: MJP Publishers.
12. Sharma, P.D. (1999). Ecology and Environment. Meerut: Rastogi Publications.
13. Dash, M.L. (1996). Fundamentals of Ecology. New Delhi: Tata McGraw-Hill Publishing Company Ltd.
14. Odum, E. P. (1983). Basic Ecology. USA: W.B. Saunders Company.

	Content addressed with Local Needs
	Content addressed with National Needs
	Content addressed with Regional Needs
	Content addressed with Global Needs