Semester II

UG - NMEC - Common Ailments and Simple Remedies

Course Code: ZNM172

(Interdisciplinary)

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

Learning Objectives

1. To create awareness of the changing life style and its impact in human health.
2. To acquire sufficient foundation for achieving a reasonable level of employability.

Course outcomes

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	identify common health problems like anaemia, blood pressure, stroke and diabetes.	PSO - 1	U
CO - 2	gain knowledge on the changing life style and its impact on human health.	PSO - 1	U
CO - 3	discuss symptoms and treatment of common diseases.	PSO - 4	U; R
CO - 4	analyse and put forth remedies for old age-related ailments.	PSO - 8	U; R

Unit I

Anaemia and types of anaemia. Blood pressure-types, symptoms, treatments and prevention. Stroke and Heart attack. Diabetes- causes, symptoms, diagnosis and treatment.

Unit II

Dental caries and Pyorrhoea - causes, symptoms, treatment and prevention. Jaundice- causes, types, symptoms, treatment and prevention. Typhoid- causes, types, symptoms and treatment, Digestive disorders: Diarrhoea - causes and treatment, Chronic constipation- causes, prevention.

Unit III

Common cold, cough-treatment, primary complex- causes and treatment, Asthma- causes, symptoms and treatment. Headache- causes and types.

Unit IV

Dengue fever- causes, types, symptoms and treatment, Malaria - causes, types, symptoms and treatment, Filariasis (Elephantiasis) - causes, types, symptoms and treatment.

Unit V

Aging- old age related ailments - Depression of loneliness and some remedies to keep them engaged, loss of memory, osteoporosis, Parkinson's disease, Alzheimer's disease, Fomentation and cleansing enema. Arthritis- causes, types, symptoms and treatments.

Textbook

John M. Fowler (1970). Radiant Living**.** Pune: Oriental Watchman Publishing House.

Reference Books

1. Chugh, S.N. (2006). Emergency Medicine (2nd ed.). India: PeePee Publishers and Distributors Pvt.
2. Clifford R. Anderson (1999). Your Guide to Health. Pune: Oriental Watchman Publishing House.
3. Chawla, N.P.S. (1994). Penguin India Family Medical Encyclopedia. New Delhi: Penguin Book Publication.
4. Valantine Fuster, R. & Wayne Alexander (2001). The Heart (10th ed.). USA: McGraw-Hill Publications.
5. Anne McIntyre (1994). Simple Home Remedies for Common Ailments. USA: Gaia Books Publisher.

Semester III / V
UG - Self Learning Course - Ornamental Fish Culture
Course Code: ZC17S1

No. of credits	Marks
2	100

Learning Objectives

1. To enable the students to realize the importance and culture of economically important aquatic organisms.
2. To develop skills in ornamental fish culture so as to enable the students to become entrepreneur.

Unit I

Introduction: Scope - Construction of fish tanks - Seating the tank – ornamental fish tank as a biological filter. **Setting up of tanks:** bottom gravel – planting with plants – filling with water - maintenance of water quality – stocking of fishes.

Unit II

Accessories for fish tanks: hood and light source – nets – suction tube – scrapper tool – aerator – lights – filters – Underwater bottom filter - Under gravel filter – Poly foam filter – Overhead trickle purification system (OTP) - Filter with activated charcoal (Carbon filter) - filtration. **Popular ornamental fishes:** Egg laying fishes (Zebra fish, Gold fish, Barbs, Gourami, Fighter), Live bearing fishes (Guppies, Mollies, Platys and Swordtails).

Unit III

Transport of fishes: Oxygen packing – Anesthetics used in fish transport – Mechanism of action – Transport of export consignment – Preparing of fishes – Methods of sedation – Carbonic acid – Tertiary butyl alcohol. **Food and feeding:** Culture of live food organisms – Copepods, Tubifex, Brine shrimp (Artemia), Cladoceran (Daphnia), Blood worm (Chironomus larva) - Artificial feeds: feed ingredients and feed formulations – Feeding – Balanced diet for aquarium fishes, Holiday or vacation feed.

Unit IV

Aquarium plants: Floating, rooted and submerged. **Breeding:** Oviparous fishes – Breeding methods in egg layers – Breeding of live bearing ornamental fishes – Culture techniques – Stocking tank.

Unit V

Diseases and treatment methods: Protozoan – Fungal - Bacterial – Viral – Ectoparasites and endoparasites. **Economics of commercial farming**.

Textbook

Jameson, J.D. and Santhanam, R. (1996). Manual of Ornamental fishes and Farming Technologies. Thoothukudi: Fisheries College and Research Institute.

Reference Books

1. Butcher, L. (1992). Manual of Ornamental Fish. Gloucestershire: British Small Animal Veterinary Association Publications.
2. Jameson, J.D., Srinivasan, A. and Venkataramanujam (1995). Ornamental Fish Culture Technology. Chennai: TANUVAS Publications.
3. Hawkins, A.D. (1981). Aquarium Systems. New York: Academic Press.
4. Kishori Lal Tekriwal and Andrew Arunava Rao (1999). Ornamental Aquarium Fish of India. England: Kingdom Books.
5. Dawes, J.A. (1984). The Freshwater Aquarium. London: Roberts Royee Ltd.

Semester III
Major Elective I - (b) Clinical Laboratory Technology
Course Code: ZC1733

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

Learning Objectives

1. To gain knowledge on the laboratory techniques adopted in medical diagnostic laboratories.
2. To procure jobs in hospitals, research laboratories and pharmaceutical industries.

Course outcomes

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	acquire knowledge about laboratory techniques, maintenance of records and ethics of clinical labs.	PSO - 1	U
CO - 2	perform basic clinical laboratory procedures using appropriate laboratory techniques.	PSO - 3	R; Ap
CO - 3	use instruments in accordance with laboratory protocol.	PSO - 3	R; Ap
CO - 4	calculate and interpret laboratory results using standard protocol.	PSO - 8	An

Unit I

Essential pre-requisites of a Clinical Laboratory: Scope; Safety and first aid in laboratory accidents. Cleaning of glassware; Sterilization – physical and chemical methods. Preparation of Normal, Molar and Percentage solution. Biomedical waste management.

Unit II

Common Laboratory Instruments and their applications: Microscope, Balance, pH meter, Colorimeter, Autoanalyzer, Centrifuge, Incubator, Water bath, Hemocytometer, Sahli's haemoglobinometer.

Unit III

Clinical Haematology: Collection of blood (Venous and capillary), Blood grouping, Separation of plasma and serum, Blood cell count – Total count and differential count, Haemoglobin estimation by Sahli's method, Erythrocyte sedimentation rate (ESR). Analysis of blood glucose, HbA1c test, serum urea, serum creatinine, alkaline phosphatase, cholesterol, High density lipid (HDL) and low density lipid (LDL), Triglycerides.

Unit IV

Examination of body fluids: Sputum analysis – Physical properties and microscopic examination. Cerebrospinal fluid - Collection, Physical, chemical and microscopic examination. Serous fluid (Pleural, pericardial and peritoneal), Synovial fluid.

Unit V

Urine and Stool Analysis: Urine – collection, composition, volume, colour and transparency. Analysis of urine for glucose, albumin, bilirubin, urobilinogen and ketone. Microscopic examination for bacteria, organized and unorganized deposits and blood. Pregnancy test. Stool - collection, types. Microscopic examination of stool. Identification of intestinal parasites (Saline wet mount). Testing faecal occult blood.

Textbook

Rajan, S. (2012). Manual for Medical Laboratory and Technology (1st ed.). Chennai: Anjanaa Book House.

Reference Books

1. Kanai, L. Mukherjee (2005). Medical Laboratory Technology, A procedure manual for routine diagnostic tests, Vol I, II & III (19th ed.). New Delhi: Tata McGraw – Hill Publishing Company Ltd.
2. John Bernard Henry (2001). Clinical diagnosis and management by laboratory methods (20th ed.). Philadelphia: Saunders & Co.
3. Ramnik Sood, M.D. (2003). Medical Laboratory Technology, Methods and Interpretation (4th ed.). New Delhi: Jaypee Brothers Medical Publishers (P) Ltd.
4. Mary Vijaya, T., Mini, M.L., Sunitha Kumari, K., Asha, K.R.T. (2003). Practical Clinical Biochemistry Manual. Kaliakkavilai: Rishi Publications.

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Semester III
Allied Zoology - General Zoology
Course Code: ZA1731

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

Learning Objectives

1. To acquire a basic knowledge about animal diversity and general principles of Cell Biology, Genetics, Developmental Biology, Evolution and Physiology.
2. To seek employment in educational institutions and museums.

Course outcomes

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	describe general principles of taxonomy on animal classification.	PSO - 1	U
CO - 2	explain the specific characteristics of invertebrates and vertebrates.	PSO - 1	R
CO - 3	explain the structure of cells, chromosomes and apply the knowledge of genetics in identifying genetic disorders.	PSO - 5	R ; Ap
CO - 4	explain the development and evolution of animal life.	PSO - 1	R
CO - 5	recognize the major functions of organ systems in human body and the role played by animals in their environment.	PSO - 7	R
CO - 6	apply diverse taxonomic resources for animal identification and simple experimental procedures pertaining to the course.	PSO - 2	Ap

Unit I

Invertebrate Zoology: General characters of Invertebrates - Classification up to phylum with two examples for each. Paramecium - external features, conjugation. Obelia – external features, polymorphism. Ascaris - external features, parasitic adaptations. Penaeus – external features. Star fish – external features, water vascular system.

Unit II

Chordate Zoology: General characters of chordates - Outline classification up to classes with one example and characteristics of Chordates. Rabbit – external characters. Migration of fishes. Identification of poisonous and non-poisonous snakes, poison apparatus, first-aid for snake bite. Flight adaptations in birds. Dentition in mammals.

Unit III

Cell Biology and Genetics: Structure of prokaryotic and eukaryotic cell. Human chromosomes – structure – types and function. Simple Mendelian traits in man, Genetics of blood groups in man, sex linked inheritance in man – colour blindness and haemophilia. Non-disjunction and syndromes in man: Klinefelter's, Turner's and Down's syndrome.

Unit IV

Developmental Zoology and Evolution: Early development in frog - structure of sperm and ovum. Fertilization, cleavage, blastulaion and gastrulation. Placenta – Types and functions. Urey Miller Experiment and Modern synthetic theory of evolution.

Unit V

Physiology: Digestion – digestion of carbohydrates, proteins and fats. Respiration – structure and functions of lungs in man. Excretion - structure and functions of kidney in man. Circulation: structure and function of human heart. Nervous system - central, peripheral, sympathetic, parasympathetic and structure of a neuron.

Textbook

Arumugam, N. (2011). Allied Zoology, Vol. I to III. Nagercoil: Saras Publications.

Reference Books

1. Ekambaranatha Ayyer, M.A. (1986). Manual of Zoology Vol. I & II. Chennai: S. Viswanathan Printers and Publishers Pvt. Ltd.
2. Jordan, E.L. and Verma, P.S. (1988). Chordate Zoology New Delhi: S. Chand and Co. Ltd.
3. Kotpal, R.L. (2004). Modern Text Book of Zoology – Invertebrates (9^{th} ed.). Meerut: Rastogi Publications.
4. Kotpal, R.L. (2004). Vertebrates. Meerut: Rastogi Publications.
5. Nagabhushanum, R., Kodarkar, M.S. and Sarogini, R. (1982). Textbook of Animal Physiology (2^{nd} ed.). New Delhi: Oxford and IBH Publishing Co. Pvt. Ltd.
6. Verma, P.S. and Agarwal, V.K. (2003). Chordate embryology (10^{th} ed.). New Delhi: S. Chand and Co. Ltd.
7. Rastogi, V.B. and Jayaraj, M.S. (2000). Textbook of Genetics. Meerut: Kedarnath Ramnath Publishers.
8. Verma, P.S. and Agarwal, V.K. (2010). Cell Biology, Genetics, Molecular Biology, Physiology, Evolution and Ecology. New Delhi: S. Chand & Co.

Semester IV
Major Core IV – Genetics
Course Code: ZC1741

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

Learning Objectives

1. To enable the students to understand the basic principles of hereditary mechanisms and its applications.
2. To create job opportunities in genetic counseling centers, forensic and clinical laboratories.

Course outcomes

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	describe the fundamental principles of genetics based on Mendelian concepts.	PSO - 2	U
CO - 2	gain knowledge on chromosome mapping and genetic concepts affecting society.	PSO - 8	U
CO - 3	select and apply experimental procedures to solve genetic problems.	PSO - 9	R; Ap
CO - 4	interpret the phenotype, genotype and karyotype and derive conclusions based on genetic data.	PSO - 3	Ap
CO - 5	evaluate biological factors that influence human heredity.	PSO - 8	An
CO - 6	recognize the experimental rationale of genetic studies and develop skills necessary for advanced study or research.	PSO - 6	R; An

Unit I

Mendelian laws of inheritance - Monohybrid and dihybrid - back cross and test cross. Complete, incomplete and codominance. Interactions of genes: Complementary genes, Supplementary genes, Epistasis, Lethal genes. Polygenic inheritance (Skin colour in man), Multiple alleles: ABO blood group in man, Rh factor in man; coat colour in rabbit.

Unit II

Linkage - kinds, theories of linkage, linkage groups. Crossing over - mechanism, theories of crossing over, cytological evidence (Stern's experiment and Tetrad analysis), significance of crossing over. Chromosome map: two point and three point cross, construction of chromosome map. Sex determination in man and Drosophila. Non disjunction - Primary and secondary non disjunction in Drosophila. Syndromes in man: Turner's, Klinefelter's and Down syndrome.

Unit III

Cytoplasmic inheritance - Kappa particles in Paramecium, milk factor in mice, shell coiling in Limnaea. DNA as genetic material - Bacterial transformation, conjugation and transduction. Mutation: Chromosomal mutation - changes in structure and number, aneuploidy and euploidy, Gene mutation - mutagens. DNA repair mechanisms.

Unit IV

Human chromosomes: autosomes and allosomes – Karyotype and idiogram. Simple Mendelian traits in man. Twins - types, development and application. Inborn errors of metabolism. (Phenylketonuria, Alkaptonuria, Albinism). Sex - Linked genes and their inheritance: X - linked genes (Colour blindness and Haemophilia), holandric genes.

Unit V

Population genetics – Hardy Weinberg equilibrium – calculation of gene frequency – factors affecting gene frequency – selection, mutation, genetic drift and migration. Inbreeding, out breeding and heterosis. Eugenics, Euthenics and Euphenics. Pedigree analysis. Genetic prognosis - Genetic counselling.

Textbook

Meyyan, R. P. (2011). Genetics. Nagercoil: Saras Publications.

Reference Books

1. Verma, P.S. and Agarwal, V.K. (2009). Genetics, Revised ed. New Delhi: S. Chand & Co.
2. Peter Snustad, D. and Michael J. Simmons (2010). Principles of Genetics (2nd ed.). USA: John Wiley and Sons.
3. Chatterjee, S. (2009). Genetics. New Delhi: APH Publishing Corporation.
4. Singh, B.D. (2008). Fundamentals of Genetics (4th ed.). Ludhiana: Kalyani Publishers.
5. Gardner, Simmons, Snustad (2006). Principles of Genetics (8th ed.). USA: John Wiley & Sons.
6. Ahluwalia, K.B. (2009). Genetics (2nd ed.). New Delhi: New Age International

Semester IV
Allied Zoology - Applied Zoology
Course Code: ZA1741

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

Learning Objectives

1. To understand the concepts of Apiculture, Sericulture, Poultry, Dairy farming and Aquaculture.
2. To acquire basic knowledge in applied Zoology and motivate the students for self-employment and to discern distinct entrepreneurial traits.

Course outcomes

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	describe the various aspects of animal husbandry in economic development.	PSO - 6	U
CO - 2	explain the appliances used in bee keeping and discuss the significance of apiculture.	PSO - 6	R; Ap
CO - 3	rear silkworms, identify the disease and cocoon marketing.	PSO - 7	Ap
CO - 4	gain knowledge for the establishment of poultry and dairy farm.	PSO - 7	An; Ap
CO - 5	adopt aquaculture practices as a profitable hobby.	PSO - 6	C

Unit I

Apiculture: classification and kinds of bees, bees and their society - caste distinction and their functions. Methods of bee keeping (primitive and modern). Honey bee products: honey, bee wax, bee venom.

Unit II

Sericulture: Moriculture – methods of propagation – Common species of Silkworm – Life cycle of mulberry silkworm (egg, larva, pupa and adult). Rearing of silkworm – mounting – spinning- harvesting of cocoons – silk reeling and marketing.

Unit III

Poultry Farming: Poultry housing - types of poultry houses – management of chick, growers, layers and broilers. Sexing in chicks, Nutritive value of egg. Diseases of poultry – Ranikhet, Fowl pox, Coryza, Coccidiosis, Polyneuritis.

Unit IV

Dairy Farming: Breeds of Dairy animals – Establishment of a typical Dairy farm – Management of cow (Newborn, calf, Heifer, milking cow) – Diseases (Mastitis, Rinder Pest, Foot and Mouth Disease). Dairy products (Standard milk, skimmed milk, toned milk and fermented milk - curd, ghee, cheese) Pasteurization.

Unit V

Aquaculture: Aquaculture in India – Important cultivable organisms and their qualities – culture of Indian major carps, Marine prawn culture, Pearl culture. Integrated fish culture (Paddy cum fish culture).

Textbook

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

Reference Books

1. Johnson, J. and Jeya Chandra, I. (2005). Apiculture. Marthandam: Olympic Grafix.
2. Ganga, G. and Sulochana Chetty (1997). An Introduction to Sericulture. New Delhi: Oxford and IBH Publishing Co.Pvt. Ltd.
3. Gnanamani, M.R. (2005). Profitable Poultry Farming. Madurai: J. Hitone Publications.
4. Santhanakumar, G. and Selvaraj, A.M. (2002). Concepts of Aquaculture. Nagercoil: Meenam Publications.
5. John Moran (2005). Tropical Dairy Farming. Australia: Landlinks Press.
6. Uma Shankar Singh (2008). Dairy Farming. New Delhi: Anmol Publishers.

Semester IV
Allied Zoology Practical (General Zoology & Applied Zoology)
Course Code: ZA17P1
(Conducted during Semester III & IV)

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

Learning Objectives

1. To develop practical skills in basic concepts of biology.
2. To make students to acquire more practical knowledge through industrial visits to agro-based farms.

Course outcomes

CO	Upon completion of this course the students will be able	PSO	CL

	to:	addressed	
CO - 1	dentify and classify invertebrates and chordates.	PSO - 1	R
CO - 2	estimate the salinity and oxygen content of water samples.	PSO - 2	An
CO - 3	dentify aquatic culturable organisms and their diseases.	PSO -6	Ap
CO - 4	develop skill in dissection and microscopy.	PSO - 7	Ap
CO - 5	gain knowledge through field visit.	PSO - 3	Ap

General Zoology

1. Dissection: Cockroach – Nervous system.
2. Mounting: Prawn appendages.
3. Mounting: Shark – Placoid scale.
4. Observation of simple Mendelian traits in man.
5. Observation of frog's egg.
6. Analysis of glucose and albumin in Urine.

Museum specimens

Paramecium, Obelia, Ascaris (male and female), Penaeus, Starfish (oral and aboral), Amphioxus, Eel, Naja naja, Pelican, Rabbit.

Slides/Charts/Models/Bookplates:

DNA (Watson & Crick Model), Colour blindness, Shark and Echeneis, Ancon Sheep, Industrial melanism.

Applied Zoology

1. Testing milk using lactometer.
2. Estimation of oxygen in water samples.
3. Estimation of salinity in water samples.
4. Visit to places having importance related to theory.

Spotters / Models / Charts / Bookplates

Honey bee (worker, queen and drone), Newton's bee-hive, silkworm (egg, larva, pupa and adult), Chandrika, Rearing stand, Poultry feeders, Fowl pox, Coccidiosis, Catla catla, Rohu, Mrigala.

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:** Osmo conformers and osmoregulatory, 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 technology 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	identify 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	identify 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: Toxicants - 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 - Epizootic Ulcerative Syndrome, Viral Hemorrhagic Septicemia. Fungal – Gill rot and Saprolegnia is. 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	identify 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 – Precautions to be taken during mounting – harvesting of cocoons. **Cocoon marketing**: transport of cocoons physical characteristic of cocoons – Defective cocoons – cocoon markets. **Grainage technology**: grain ages – procedures in a grain age – 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:	PSO ddressed	CL
CO - 1	explain the influence of physico-chemical factors on marine organisms.	PSO - 5	U
CO - 2	dentify the impact of waves and tides on animal and plant population.	PSO - 2	U
CO - 3	discuss the energy flow in the marine environment.	PSO - 5	U
CO - 4	evaluate the economic importance of marine resources and the mpact of pollutants.	PSO - 3	Ap; E
CO - 5	use scientific technology to assess quantitative parameters in relation to distribution of marine biota.	PSO - 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 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 to:	PSO addressed	CL
CO - 1	discuss the classification and categories of earthworms.	PSO - 1	U
CO - 2	explain the biology of earthworms.	PSO - 1	U
CO - 3	assess the importance of earthworms in soil fertility, medicine and pharmaceutics.	PSO - 5	E
CO - 4	design the methodology for vermiculture and for the production of vermicompost and vermiwash.	PSO - 8	Ap
CO - 5	prepare and market the vermicompost.	PSO - 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 o:	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 animal technology:** 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	identify 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	PSO - 5	R; Ap

	pathological diseases,		
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. 6.Jeffrey K. Actor (2011). Elsevier's Integrated Review Immunology and Microbiology E- Book: Online Access 2nd Edition, Kindle Edition.

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:	PSO addressed	CL
CO - 1	apply the knowledge of animal husbandry in economic development.	PSO - 5	U
CO - 2	dentify the kinds of bees and the methods of bee keeping.	PSO - 8	U
CO - 3	Rear silkworms, harvest and market the cocoons.	PSO - 9	Ap
CO - 4	apply skills and experience about the management of poultry and Dairy farming.	PSO - 9	Ap
CO - 5	culture of economically important finfish and shell fishes.	PSO - 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 Lucifer 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.
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.

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-employmentopportunity.
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 of poultry animals.	PSO - 5	R; Ap
CO - 3	identify the diseases and implement control measures.	PSO - 5	R
CO - 4	develop entrepreneurship skills and commercialize indigenous 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 mounting.

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 organ carbamates – **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 behavior – 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 – Chesterland's – pheromones - Baculovirus-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.).
4. Bangalore: The Bangalore Printing and publishing company.
5. Cremlyn, R. (1979). Pesticides: Preparation and mode of Action. New Jersey: John Wiley & Sons Ltd.
6. 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.

*Content addressed Gender

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

	*Content addressed Gender
	*Content addressed Environment Sustainability
	*Content addressed Human Values
	*Content addressed Professional Ethics
	*Content addressed Indian Knowledge System

M.Sc. Zoology (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 - 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 ofbio membranes, 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. Tight junction, Gap junction – 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 Ma Levels of diversity rgalef 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 micro technique and identify stains todistinguish histological and his to-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 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 homogeneity.

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 bio instruments 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 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 Chironomous larva.
5. Barr-body identification.
6. Observation of striated muscle fibre from the coxal muscle of cockroach.
7. Observation of adipocytes from the fat body of cockroach.
8. Haemolymph smear (Cockroach).
9. 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.
10. Visit to a coastal / aquaculture research centre (report).

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, his to techniques 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, organ systems 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. Hemopoiesis. 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 immunomodulatory strategies used to enhance orsuppress 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 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) 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	identify 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 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

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 work productively with those within and beyond the academy on interdisciplinary collaborative projects.

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 clock**: 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* (4th 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 relationship between parasites and their hosts.	PSO - 2	Ap
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 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 hemocytometer.
8. Hemolysis 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 Hemagglutination.
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 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.
8. Estimation of éthanol content in wine.
9. 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 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; CO2 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 photo assimilates.
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
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 Behavior:

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 gelelectrophoresis, 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.
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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.

	*Content addressed Gender
	*Content addressed Environment Sustainability
	*Content addressed Human Values
	*Content addressed Professional Ethics
	*Content addressed Indian Knowledge System

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 mmunotechnology.	PSO - 3	U
CO - 2	identify the molecular markers, analyse the methods of sequencing and therapeutic measures.	PSO - 3	An; E
CO - 3	classify nanomaterials 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 (4thed.). 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(2nded.). 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 of environmentally sound aquaculture: reducing the impact ofwaste 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 of exploiting 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. Behavior 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 (5^{th}ed.). New Delhi: Oxford and IBH Publishing Co. Pvt. Ltd.
5. Simpson, G.G. (1969). Principles of animal taxonomy. New Delhi: Oxford and IBH PublishingCo. Ltd.
6. Supriyo Chakraborty (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.