

SYLLABUS

for

POST-GRADUATE PROGRAMME IN

ZOOLOGY

Under the National Education Policy (NEP) 2020

(Semester Programme)

University Of Kalyani

Kalyani Nadia

West Bengal PIN 74123

(w.e.f session 2026-27)

Preamble

“Zoology”, a prime branch of biological science, emphasizes on the study of animals both living and extinct. In this beneficial science subject, a person learns the fundamentals of life forms, particularly animal life, and simultaneously understands the key concepts including biomolecules, genetic regulations and cellular activities. The subject enfolds all the fascinating biological processes starting from formation of the first cell to organization and evolution of complex multi-cellular organism.

In a more descriptive sense, the subject helps in understanding the classification of animals, their anatomy, physiology and metabolic processes, formation of embryo and further development, structure of genetic materials and their role in various life processes, ecology and dynamics of ecosystem functioning, evolution and the driving forces, behaviour and distribution of animals, and finally conservation and economic zoology.

The entire post graduate course in Zoology of this University is designed to impart knowledge about the subject in a phased manner. The students learn the basics first e.g., chordate and non-chordate biology, genetics; parasitology, endocrinology; developmental biology, entomology, fish biology in the first two semesters and then advances to six different specializations in the last two semesters. The course offers Discipline specific Core, Skill based courses, Discipline Specific Elective (Major), and Discipline Specific Elective (Minor) papers including practical for Core and Discipline Specific Elective (Major) papers, Research based courses, along with Indian knowledge system. There is also Generic elective paper for students of other disciplines. With the advancement of knowledge in this branch of science, augmented with phenomenal discoveries directly associated with human welfare, the subject is gaining tremendous attraction from the society and wide range of students.

In a nutshell, this entire curriculum is a holistic approach to establish a better teaching- learning platform in animal science. All courses are structured to prepare students for competitive examinations (e.g., CSIR-UGC-DBT-NET, ICMR JRF Exam, GATE, SET) and to develop capacity in research proposal writing and grant acquisition. During the curriculum development process, the guidelines of the National Education Policy (NEP) 2020 have been duly incorporated, with a particular emphasis on employability, entrepreneurship, skill development, and digital literacy. Additionally, the syllabus addresses cross-cutting issues, including ethics, gender sensitization, human values, environmental awareness, and sustainability, thereby ensuring holistic student development and alignment with national academic priorities.

Programme outlines

- **Type of Program:** This is a regular master's program, following the guidelines of NEP 2020.
- **Credit system:** Each academic paper comprises four credits, including three credits dedicated to theoretical study and one credit allocated to practical work, thereby ensuring coherence in the learning process.
- **Duration and eligibility criteria:** The department provides two types of Master of Science programs in Zoology. Students who have completed a three-year Honors degree in zoology are eligible for admission to the two-year M.Sc. program. In contrast, those who have completed a four-year Honors degree in zoology (with or without a research component) are eligible for admission to the one-year M.Sc. program.
- **Evaluation Process:** Divided into two parts, internal assessment and end-term assessment. Practical papers have a continuous evaluation process throughout the semester and end-term viva voce examination. Two internal assessments will be conducted for each paper/course, and the average of these two will determine the final marks. The end-semester examination will comprise short-answer, medium-answer, and long-answer type questions to evaluate the understanding and analytical skills of students comprehensively.
- **Teaching Methods:** To realize the desired learning outcomes, the subsequent teaching–learning strategies will be utilized: Lecture-based Instruction – Systematic dissemination of fundamental concepts via classroom lectures. Autonomous Learning – Encouraging independent study and self-directed learning to enhance conceptual understanding. Technology-Enhanced Learning – Incorporation of digital tools, software, and online resources to facilitate interactive and innovative learning experiences. Problem-solving Methodology – Approaching learning through experimental, on-field problems, case studies, and practical exercises to cultivate analytical and critical thinking abilities.
- **Special Instructions:** To align with NEP 2020, several general courses like Indian Knowledge System (IKS), IPR, Research Methodology and Ethics, Social Service, Internship/Industry visits, Field Visits, Research projects are compulsory. Core courses strengthen foundational knowledge in a subject, and electives offer flexibility. Semesters III and IV include six special papers, from which students must choose one.

- **Field Visits:** Semester II offers a field visit; the place of visit is determined in the departmental committee meeting.
- **Research Projects:** The mentor will distribute the research project to the students.

Programme specific outcome

On successful completion of the M.Sc. in Zoology program, the students will develop following skills: -

1. **Comprehensive Knowledge:** Demonstrate a deep understanding of animal structure, function, diversity, evolution, genetics, molecular biology, and physiology.
2. **Practical Competence:** Apply laboratory and field techniques to investigate animal biology, analyze data, and interpret scientific observations.
3. **Research and Inquiry:** Design, conduct, and report scientific research in zoology, integrating modern methodologies and ethical practices.
4. **Technological Application:** Utilize bioinformatics, biostatistics, remote sensing, , microscopy, cell culture etc. as tools for animal research and management.
5. **Communication and Teamwork:** Present scientific ideas and research findings effectively; collaborate in academic, research, and professional settings.
6. **Ethics and Responsible Practice:** Demonstrate ethical responsibility towards animals and promote sustainable practices in animal biology and conservation.
7. **Interdisciplinary Skills:** Integrate zoological knowledge with related fields such as biotechnology, botany, physiology, environmental science, and public health.
8. **Career Readiness and Entrepreneurship:** Prepare for teaching, research, conservation, industry roles, and pursue professional development through entrepreneurship.

Distribution of credits and marks:

Semester	Code	Detail	Course title	Credit	Marks
Sem I	ZMJT 101	Theory	Anatomy and physiology of non chordates and Chordates	03	100
	ZMJP 101	Practical	Lab exercise	01	
	ZMJT 102	Theory	Inheritance biology and Principles of animal development	03	100
	ZMJP 102	Practical	Lab exercise	01	
	ZMJT 103	Theory	Endocrinology and Metabolism and Environmental Toxicology	03	100
	ZMJP 103	Practical	Lab exercise	01	
Minor (any two)	ZMNET 101	Theory	Fish biology and applied ichthyology and aquaculture technology	02	50
	ZMNET 102	Theory	Forest and agricultural entomology	02	50
	ZMNET 103	Theory	Medical, veterinary and fish parasitology	02	50
	ZSECT 101	Theory	Specialised laboratory course in Zoology	02	50
	ZSECP101	Practical	Exercise	02	50
Total				20	500
Sem II	ZMJT 204	Theory	Economically important arthropods and advanced parasitology and vector biology	03	100
	ZMJP204	Practical	Lab Exercise	01	
	ZMJT 205	Theory	Animal behaviour and Ecology	03	100
	ZMJP205	Practical	Lab Exercise	01	
	ZMJT206	Theory	Immunology and human genetics	03	100
	ZMJP206	Practical	Lab Exercise	01	
Minor any one and ZIDS 101	ZMNET204	Theory	Developmental dynamics and Medical embryology and therapeutics	02	50
	ZMNET 205	Theory	Cell signalling and Reproductive Biotechnology	02	50
	ZMNET 206	Theory	Molecular genetics and Cancer biology	02	50
	ZSECT 201	Theory	Specialised laboratory course in Zoology	02	50
	ZSECP 201	Practical	Exercise	02	50
	ZIDS 201	Theory	Interdisciolinary Zoology	02	50
	ZRM 201	Theory	Research methodology	02	50
Total				22	550

Marks distribution and assessment:

Paper code	Total Marks	Internal assessment	Term End	Pattern of Question
ZMJT	75	10+5 (attendance 5)	60	(for each section in each paper) $30 \times 2 = 60$ $2^{1/2}$ pt x 2 (out of 3) = 5 5 pt x 3 (out of 5) = 15 10 pt x 1 (out of 2) = 10
ZMJP	25	Continuous assessment 20	Viva voce and lab notebook 05	
ZMNET (Any Two or one) and ZIDS	50 each	10	40	For each section in each paper) 20 Points $\times 2 = 40$ $2^{1/2}$ pt x 2 (out of 3) = 5 3pt x 3(out of 4) = 9 6pt x 1(out of 2) = 6
ZSECT	50	10	40	For each section in each paper) 20 Points $\times 2 = 40$ $2^{1/2}$ pt x 2 (out of 3) = 5 3pt x 3(out of 4) = 9 6pt x 1(out of 2) = 6
ZSECP	50	Continuous assessment 40	Viva voce and lab notebook 10	
ZRM	50	10	40	For each section in each paper) 20 Points $\times 2 = 40$ $2^{1/2}$ pt x 2 (out of 3) = 5 3pt x 3(out of 4) = 9 6pt x 1(out of 2) = 6

Abbreviations used in the syllabus**DSC:** Discipline specific core**DSE(MN):** Discipline specific elective minor**DSE(MJ):** Discipline specific elective major**SEC:** Skill based course**RM/RL:** Research based methodology/lab**DS:** Dissertation**IN:** Internship**INS:** Indian knowledge system**GE:** General elective course

SEMESTER I

Theory

1. Discipline specific core (DSC)

No of papers **03** Total credit **12**

ZMJT-101: Anatomy and physiology of non chordates and Chordates

Course Objectives:

The non-chordate and chordate biology must be taught to every student of life science. This section starts with metazoan evolution and the course is highly updated and tailor-made to make a PG student strong enough in the most fundamental aspect of the biological sciences.

Course Learning Outcomes:

The course is designed to prepare the students with knowledge of non-chordate and chordate anatomy and physiology for exploring and assessing biodiversity and ecosystem health. There are emerging scopes of jobs as biologist and ecologists with good taxonomic knowledge in India and abroad.

UNIT I: Anatomy and Physiology of Non-chordates

1. Digestive organs in non-chordates: Structure and functions.
2. Respiration: Structural organization of respiratory organs in major invertebrate groups; factors affecting respiration.
3. Reproduction: Organs and process of reproduction in major non-chordate groups.
4. Sense organs and their importance - Vision, hearing and tactile responses in non-chordates. Chemoreception, photoreception and mechanoreception in non-chordates; sensory organelles and reaction for stimuli in protozoa.
5. Respiratory system: Comparative account of respiratory pigments; transport and exchange of gases.
6. Nervous system: comparative account on nervous system of non-chordates.
7. General organization, segmentation, division of body of insect: head and mouth parts; thorax and thoracic appendages modifications, abdominal appendages and modifications
8. Insect blood: composition, functions and morphology of circulatory system
9. Insect flight: types; structure concerned; functional mechanism; evolution of flight patterns in different insect groups.

UNIT II: Anatomy and physiology of Chordates:

1. Digestive system: Acquisition of Energy: Types of feeding, Digestion (motility and Secretions), Metabolism, and absorption, Physiology of the gastrointestinal system (mammals), including neural and hormonal regulatory mechanisms.
2. Respiratory system in chordates: Comparative anatomy and mechanism of respiration in different groups, transport and exchange of gases, neural and chemical regulation of respiration.

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3. Cardiovascular System in chordates: Myogenic heart, specialized tissue, ECG – its principle and significance, cardiac cycle, heart as a pump, blood pressure, neural and chemical regulation.
4. Thermoregulation in chordates: physical, chemical, neural regulation, heat exchange interaction between animal and environment; Thermoregulation in ectotherm and endotherms ; acclimation and acclimatization.
5. Nervous system in chordates: Gross neuroanatomy of the brain and the spinal cord, central and peripheral nervous system, neural control of muscle tone and posture.

Suggested readings:

- a) Barnes: Invertebrate Zoology (Holt-Saunders International, 4th edition, 1980)
- b) Barnes: The Invertebrates – A synthesis, 3rd edition, Blackwell, 2001
- c) Hunter: Life of Invertebrates, Collier Macmillan Pub. 1979
- d) Marshall: Parker & Haswell Textbook of Zoology, Vol. I & II, 7th edition, Macmillan, 1972
- e) Moore: An Introduction to the Invertebrates, Cambridge University Press, 200
- f) Schmidt Nielsen, K. (1994). Animal Physiology: Adaptation and Environment. Low Price Cambridge Edition.
- g) Kardong, K.V. (2010). Vertebrates: Comparative Anatomy, Function, Evolution. 4th edition. Tata McGraw Hill.
- h) Chapman, R. F., Simpson, S. J. and Douglas, A. E. (2012). The Insects: Structure and Function. 5th ed. Cambridge University Press.
- i) David, B. V. and Ananthakrishnan, T. N. (2006). General and Applied Entomology. Tata McGraw-Hill Publishing.
- j) Gillott, C. (2005). Entomology. 3rd ed. Springer Online Book - ISBN-13 978-1-4020- 3183-0 (e-book).
- k) Gullan, P. J. and Cranston, P. S. (2014). The Insects – an outline of Entomology. 4th ed. Blackwell Publishing.

ZMJT -102: Inheritance biology and Principles of Animal development

Course Objectives:

The curriculum of inheritance biology intends to effectively inculcate in them the desire for deeper understanding of molecular genetics and molecular cell biology in order to manifest creativity and thought-provoking ideas with regards to the rapidly changing field of advance molecular biology across animal kingdom.

The topic covered under Principles of animal development aims to provide a multi-dimensional platform to the students for understanding the basics patterns and process of embryonic development and thereby emphasizing a deep insight into molecular and genetic aspects of the developmental process in different biological specimen.

Course Learning Outcomes:

Successful completion of the curriculum of inheritance biology, the students should have a comprehensive idea on structural and functional aspects of biological macromolecules and genome which would help them to embark and reach new avenues in the field of molecular biology and cytogenetics in their future research.

Principles of animal development enquires about the fundamental processes that underpin the fertilization of an egg cell and its step-by-step transformation into the fascinating complexity of a whole organism. After

completing the course, the students should gain ample knowledge and understanding in the factual basis of embryonic development and its relevancy with differential gene expression in various model organisms which would strive them with immense opportunity to take up active research in molecular embryology in future.

UNIT I: Inheritance Biology

1. Patterns of Inheritance: Mendelian Inheritance; Extensions of Mendelian Inheritance-Multiple Allelism, Incomplete dominance, Codominance, Penetrance and expressivity, Pleiotropy; Polygenic inheritance; Extranuclear Inheritance-Mitochondrial, Maternal effects.
2. Unit of Inheritance: Gene and fine structure - Split genes, Exons, Introns, UTRs; Pseudogenes; Overlapping genes.
3. Inheritance in Bacteria and Bacteriophage: Virus and Bacterial genome, vertical and horizontal gene transfer; bacteriophage λ ; model temperate phage and its cycle. Plasmids; Gene transfer through bacterial transformation, conjugation, transduction.
4. Regulation of Inheritance: Cell Cycle-Phases of Cell cycle; Regulation of cell cycle; Apoptosis-Regulators of Apoptosis, Pathways of Apoptosis; Cell Senescence and Necrosis
5. Process of Inheritance: DNA Replication in Prokaryotes and Eukaryotes - Variations and Nature; Regulation of Replication; Hayflick limit, Inhibitors of replication, Extrachromosomal Replicons

UNIT II: Principles of Animal development

1. Basic concepts in Developmental Biology: potency, induction, competence, commitment: specification, determination and differentiation, morphogenetic gradient and fate map, oogenesis, spermatogenesis
2. External Fertilization in Sea Urchins, Early Development in Sea Urchins, Early cleavage, Blastula formation, Fate maps and the determination of sea urchin blastomeres, Gene regulatory networks and skeletogenic mesenchyme specification, double negative gate, Specification of the vegetal cells
3. Concepts of organogenesis: Development and patterning of vertebrate limb, homeobox genes in patterning, signalling in patterning of the limb.
4. Regeneration– Epimorphic regeneration of a reptile (salamander) limb; Morphallaxis regeneration in Hydra.
5. Teratogenesis and stem cell biology.

Suggested readings:

- a) Introduction to Genetic Analysis (12 Edition)-Anthony J.F. Griffiths et.al
- b) Lodish, Harvey_ Berk, Arnold_ Kaiser, Chris_ Arnold Berk_ Chris - Molecular Cell Biology, Ninth Edition
- c) Genetics: From Genes to genome-Michael L Goldberg et.al.
- d) Genetics Analysis and Principles: Robert J Brooker
- e) The Cell: A molecular Approach. Geoffrey M. Cooper and Robert E. Hausman
- f) Strachan, T and Read, A (2018) Human Molecular Genetics

- g) William S. Klug, Michael R. Cummings, Charlotte A. Spencer, Michael A. Palladino, Darrell Killian - Concepts of Genetics1. Developmental Biology: Scott F Gilbert.
- h) Principles of Development: Louis Wolpert.
- i) Bruce Alberts, Rebecca Heald, Alexander Johnson, David Morgan, M - Molecular Biology of the Cell

ZMJT -103: Endocrinology and Metabolism and Environmental toxicology

Course objectives

The course is designed not only to provide knowledge about various toxicants in our environment but also to know about its fate and interactions in our body. The course will provide detailed knowledge about various types of hormones and their receptors.

Course Learning Outcomes:

At the end of the course the students will be able to- Understand basic concepts of toxicants, know different toxicological testing procedures. gather knowledge about fate and interaction of toxicants in our body, learn toxicants-induced damage of organs, develop the ability of critical thinking about plant allelochemicals, gather concept of various hormones (neurohormones, local hormones etc.) & their receptors. Be able to understand deep knowledge about biosynthesis, structure & function of hormones and their mechanism of action.

UNIT 1: Endocrinology and Metabolism

1. Types of chemical messengers: hormones, neurohormones, pheromones, cytokines, growth factors.
2. Classification of hormones: peptide/protein, steroid, amine (catecholamines, thyroid hormones), eicosanoids.
3. Hormone-receptor signaling pathways: GPCR, RTK, JAK-STAT and steroid hormone signaling, second messenger signaling.
4. Biosynthesis, secretion and regulation of hormones: biosynthesis of Insulin,
5. Biosynthesis and function of steroid and thyroid hormones (T3 and T4) and their regulations.
6. Hormones in reproduction: estrous cycle and menstrual cycle.
7. Neuroendocrine communication: Body's communication systems, interaction between hormones and brain, neural control of glandular secretions, neuroendocrine-axes and feedback mechanism.
8. Hormonal disorders that modulate metabolism: diabetes mellitus, hypo/hyperthyroidism, Cushing/Addison

UNIT II: Environmental toxicology

1. Toxicology of pesticides: Scope, division, toxicants and toxicity, LD50, LC 50 and ED50, Dose-response relationship; Carcinogenic, Mutagenic and Teratogenic effects, Method of testing chemicals on insect and evaluation of toxicity.
2. Group Characteristics and function of pesticides: Organochlorines, Organophosphates insecticides, Carbamates, Pyrethroids, other plant origin bio-insecticides, neonicotinoids and nitrogenous insecticides; fumigants; IGRs, attractants, repellents and anti-feedants. Properties of few individual

insecticides i.e. DDT, HCH (BHC), Lindane, Endosulfan, Parathion, Malathion, Carbaryl, Cypermethrin, etc.

3. Toxicokinetics and toxicodynamics: ADME (Absorption, distribution, metabolism and elimination) of toxicants, kinetic models for drug elimination and organ toxicity (hepato, nephro, neuro, cardio, immuno, repro and respiratory toxicity).
4. Toxicants in public health hazards: Pesticides; heavy metals; radiation; food additives.
5. Safer pesticides: Next-generation molecules to be used as pesticides for plant protection and their chemistry
6. Plant allelochemicals: types and their role in insect-plant interaction.

Suggested reading:

- a) Endocrinology- Fox T, Brooks A, Baidya B. JP Medical London (latest edition)
- b) Jameson JL. Harrison's Endocrinology. McGraw Hill Education (latest edition)
- c) Goodendocr man HM. Basic Medical Endocrinology. Academic Press (latest edition).
- d) Endocrinology-Mac E Hadley and Jon E Levine. Pearson (latest edition).
- e) Introduction to endocrinology- Chandra S Negi. PHI (latest edition).
- f) General endocrinology-Turner CD and Bagnara JT. East-West press Pvt. Ltd. (latest edition).
- g) Vertebrate endocrinology-Norris DO. Elsevier academic press (latest edition).
- h) Basic endocrinology, an interactive approach-Neal JM. Blackwell Science (latest edition).
- i) Endocrine physiology-Molina PE. McGraw Hill Lange (latest edition)
- j) An introduction to neuroendocrinology : Michael Wilkinson and Richard E. Brown, Cambridge University Press (latest edition)
- k) Ernest Hodgson – A textbook of modern toxicology, Wiley-Blackwell (latest edition).
- l) Lindsay Murray, Mark Little, Ovidiu Pascu and Kerry Hoggett- Toxicology handbook, Churchill Livingstone, Australia, (Latest edition).
- m) David A. Wright and Pamela Welbourn- Environmental toxicology, Cambridge University Press, (Latest edition).

2. Discipline specific elective minor and General elective course (DSE-MN and GE)

No of paper 02 Total credit 04

ZMNET-101: Fish biology and applied Ichthyology and aquaculture technology

Course Objectives:

To acquaint the students with the Origin, Evolution and Distribution of major groups of fishes, Ornamental fish culture, Nutrition of fish and Aquaculture methods.

Course Learning Outcomes:

Students will be exposed to the Origin, Evolution and Distribution of the fishes. They will get idea about the Ornamental fish culture, fish nutrition and aquaculture methods.

UNIT I: Fish Biology

1. Excretion and osmoregulation in fish.
2. Reproduction in fish: reproductive strategies, oviparity, viviparity, ovo-viviparity, parental care, maturity stages, breeding cycle

3. Structure and physiology of endocrine glands in fishes
4. Electroreception in fish, Electric organs
5. Determination of age of fish by scale and hard parts.
6. Poisonous and venomous fish.
7. Fish migration: Types, Theories and Significances.

UNIT II: Applied ichthyology and aquaculture technology

1. Ornamental fish culture: Background, classification, breeding of ornamental fish, common diseases and control.
2. Biology and culture of: Blue green algae, diatoms, rotifers, chironomids, tubifex, brine shrimps.
3. Non conventional aquaculture technology: Raceways and recirculatory system, Cages and pen culture, Wastewater aquaculture Organic aquaculture, Aquaponics and hydroponics, Biofloc culture.
4. Nutrition of fish: Anatomical modification in relation to feeding habits, natural foods, prepared feed, types of feed, feed storage, energy and growth, food conversion ratio and food conversion efficiency, feed additives: Probiotics, prebiotics.
5. Aquaculture methods: concept and significance, Different systems of aquaculture for carps and shrimps: Extensive, Semi-intensive, Intensive.
6. Stock Improvement:
Induced breeding and bundh breeding, sex reversal and sterility, Selective breeding, Androgenesis and Gynogenesis, Polyploidy, Hybridization, shellfish reproduction: Endocrine control of reproduction, role of neurotransmitters.
7. Coastal aquaculture: Status of coastal aquaculture in India, Culture of prawn: major cultivable species, techniques of larval rearing, grow out technology. Culture of shrimp: major cultivable species, Reproduction, rearing and grow out of shrimp.

Suggested Literature:

- a) Chandler, A. C. and Read. C. P. (1961). Introduction to Parasitology, 10th ed. John Wiley and Sons Inc.
- b) Cheng, T. C. (1986). General Parasitology. 2nd ed. Academic Press, Inc. Orlando.U.S.A.Cox, F. E. G. (1993). Modern Parasitology. 2nd ed. Blackwell Scientific Publications. Lea and Febiger, Philadelphia.
- c) Noble, E. R. and Noble G. A. (1989). Parasitology. The Biology of animal Parasites. 6th ed.
- d) Roberts, L. S., Janovy, J. and Nadler S. (2013) Gerald D. Schmidt & Lary S. Roberts' Foundation of Parasitology. 9th ed. McGraw-Hill International.
- e) Bond, C. E. (1996). Biology of Fishes. 2nd ed. Saunders Pub.
- f) Evans, D. H. (1998). The Physiology of Fishes. CRC Press.
- g) Hoar and Randall. Fish Physiology, Volumes I-XV (1969-onwards, Academic Press)
- h) Encyclopedia of Fish Physiology. 2011. Anthony P. Farrell, E.D. Stevens, J.J. Cech &
- i) J.G. Richards (Eds). Academic Press, UK.
- j) Fish Physiology. (Series) W.S.Hoar and D.J. Randall (Series Eds). Academic Press, UK.

- k) The Physiology of Fishes. 2013. Evans, D. H. and Claiborne, J. D., Taylor and Francis Group, CRC Press, UK.

ZMNET-102: Forest and Agricultural Entomology

Course Objectives:

The Forest Entomology course describes the importance of forest, types and distribution of forest in India, the interaction of nature, plants and insects in order to understand the seriousness of pest problem on forest plants and timber yielding plants, highlights various control methods to ensure plant protection by controlling soil and plant insect pests of important timber yielding trees and plants. The course Agricultural Entomology describes the interrelationship of nature, plants and insects in order to understand the magnitude of pest infestation on field crops before and after harvesting, insect pest morphology, bionomics, and enlightenment on different management strategies to ensure plant protection by controlling insect pests. The course describes concept of economic decision levels for pest population, potentiality of natural enemies in pest management.

Course Learning Outcome:

Forest Entomology plays a major role in training students in understanding the importance of insects in forest ecosystem. Agricultural Entomology plays vital role in training students in understanding relationship of nature, plants and insects to ensure plant protection in agricultural field. The course study makes the students capable to identify different field crop pests and their damage symptoms, pest management techniques and beneficial role of natural enemies in pest management.

UNIT I: Forest entomology

1. Soil insects and their damage to forest plants and their management.
2. Role of insects in tropical forest ecosystem.
3. Management of tropical insect forest pests.
4. General issues in forest entomology: a) Insect damages in plantation vs natural forest, b) Pest problems in plantation of indigenous vs exotic species. c) Pest problems in monoculture and mixed plantations.
5. Indian forest types, their distribution and importance, forest insects (pests) - damage and sign categories.
6. Insect pests of timber yielding trees (Sal – *Shorea robusta*; Teak – *Tectona grandis*; Mahogany- *Swietenia macrophylla*). Bionomics and nature of damage of Borers – *Hoplocerambyx spinicornis*, Defoliators – *Hapalia machaeralis*.

UNIT II: Agricultural entomology

1. Important insect pests of cereals, pulses, vegetables, spices and condiments, beverages and fibre crops
2. Morphology, bionomics and management of: Rice Yellow stem bore (*Scirpophaga incertulas*); Rice brown plant hopper (*Nilaparvata lugens*); Sugar cane top borer (*Scirpophaga nivella*); Tea mosquito bug (*Helopeltis theivora*); Diamondback moth (*Plutella xylostella*); Brinjal fruit and shoot borer (*Leucinodes orbonalis*)
3. Plant protection techniques

4. Economic decision levels for pest population: concept of economic levels, dynamics of economic injury levels, calculation of economic decision levels using economic levels
5. Natural enemy diversity of agricultural pests and their potentiality in India
6. Precision Agriculture & Technology: Use of AI, drones, and remote sensing for pest monitoring and targeted interventions.

Suggested readings:

- a) Forests and Forestry, K.P. Sagreiya, (First edition 1 January 1967), National Book Trust, India.
- b) Indian Forestry, K. Manikandan S. Prabhu, (7th edition 1 February 2021); Jain Brothers-New Delhi; Jain Brothers.
- c) Agricultural insect pests of the tropics and their control, Hill, D. S., Cambridge University Press, UK
- d) Agricultural pests of South-East Asia and their management - A.S Atwal & G.S. Dhallwal
- e) Concepts of IPM, Norris, Caswell-Chen and Kogan, Prentice-Hall, USA
- f) Entomology & Pest Management, Pedigo, L. P., Prentice Hall, New Jersey, USA
- g) Insect Plant Biology, Schoonhoven, L. M., van Loon, J.A., & Dicke, M., Publisher Oxford University Press, USA.
- h) Interrelationship between insects and Plants, Jolivet, P., CRC Press, USA

ZMNET-103: Medical, Veterinary and Fish Parasitology

Course Objectives:

The course examines the general biology, life cycles, modes of transmission, and pathogenesis of major parasites on global human health. The students are exposed to parasites that not only infect humans but also those of fish and cattle animals.

Course Learning Outcomes:

Upon successful completion of this course the students would be able to learn pathological changes associated with parasite infections and achieved an analytical view on the role of vectors and intermediate hosts in parasite transmission.

UNIT I: Medical Parasitology

1. Malaria: Life cycle and epidemiology, mode of transmission, detection, immunity and immune evasion mechanisms: Coordinated switching for antigenic variation by malaria parasites, drug targets and mechanisms of drug resistance, malaria vaccines.
2. Leishmaniasis: Life cycle and epidemiology, role for sand fly gut microbiota in Leishmania development and transmission, detection, protective and pathologic immune responses in leishmaniasis. Immune evasion mechanisms, drug targets and mechanism of drug resistance, vaccine strategies.
3. Filariasis: Life cycle and epidemiology, pathology, role of host immunity in protection and pathology, drug targets and mechanisms of drug resistance, vaccine strategies

4. Primary amoebic meningoencephalitis.
5. *Trichuris trichiura*– biology, epidemiology, pathogenesis, diagnosis and treatment.
6. Life cycle, biology, pathogenesis, epidemiology and control of *Loa loa*, *Dyphyllobothrium latum* and *Paragonimus westermani*.

UNIT II: Veterinary and fish parasitology

1. *Trichomonas foetus* in cattle.
2. Structure, pathobiology prophylaxis and diagnosis of *Anaplasma* sp. and *Theileria* sp.
3. Kinetoplastid flagellates: Trypanosomes in domesticated animals.
4. Life cycle, biology, pathogenesis, epidemiology and control of *Haemonchus contortus*
5. Biology, pathogenesis, diagnosis and management of protozoan parasites affecting fish: *Trichodina* sp., *Ichthyophthirius* sp., *Myxobolus* sp.
6. Some common helminthes of freshwater fishes and their life cycle patterns: a) *Proteocephalus* sp., b) *Camallanus* sp.

Suggested readings

- a) Bogitsh, B. J. and Cheng, T. C. (2000). Human Parasitology. 2nd Ed. Academic Press, New York.
- b) Chandler, A. C. and Read. C. P. (1961). Introduction to Parasitology, 10th ed. John Wiley and Sons Inc.
- c) Cheng, T. C. (1986). General Parasitology. 2nd ed. Academic Press, Inc. Orlando. U.S.A.
- d) Cox, F. E. G. (1993). Modern Parasitology. 2nd ed. Blackwell Scientific Publications. Lea and Febiger, Philadelphia.
- e) Noble, E. R. and Noble G. A. (1989). Parasitology. The Biology of animal Parasites. 6th ed. Lea and Febiger, Philadelphia.
- f) Roberts, L. S., Janovy, J. and Nadler S. (2013) Gerald D. Schmidt & Lary S. Roberts' Foundation of Parasitology. 9th ed. McGraw-Hill International.

3. Discipline-specific vocational course

No of paper 01 Credit 0

ZVAC-101: Medical laboratory instrumentation and diagnostics

Course objective:

The objective of medical laboratory instrumentation and diagnostics is to give an hands on training to the students of Zoology for application in different field of medical biology.

Outcome of the course:

This course will empower the students with the methodology used in the application of biological knowledge in the field.

1. Determination of protein expression in cell lines and animal models for disease diagnosis and therapeutics.
2. Clinical hematology (MB): Blood, composition of blood, haematopoiesis and maturation of blood cells, plasma, serum, anticoagulants, blood collection, CBC profiling (BT and CT, TC of RBC and WBC, DC of WBC and their absolute counting,

Hb estimation, ESR, PCV, MCV/Hct, MCHC and platelets count) and diagnosis of hematological disorders (anemia, leukemia, Lupus erythromatosus, Sick cells).

3. Upliftment of societal development related to green pesticides.

Suggested readings

- a) Analytical techniques in biochemistry and molecular biology-Rajan Katoch, Springer (latest edition).
- b) Principles and techniques in biochemistry and molecular Biology- Keith Wilson and John Walker, Cambridge University press (latest edition).
- c) Biotechniques: Theory and Practice- SVS Rana, Rastogi publication (latest edition).
- d) Essentials of hematology-Shrish M. Kawthalkar, Jaypee Brothers, Medical publisher's (P) Ltd. (latest edition).
- e) Hematology: clinical principles and applications-E.M. Keohaena, M.M. Butina, K.M. Mirza and J.M.Walenga (latest edition).

4. Skill based course/Specialized lab (SEC)

No of paper **02** Credit **04**

ZSECT-101: Specialized laboratory course in Zoology

Course objective and outcome:

This course will give the students a vivid idea of the applications of artificial intelligence tools in the study and application of the knowledge in Zoology

1. Application of AI tools for drug designing and discovery
2. Use of AI tools for data analysis
3. Application of AI tools in genome analysis
4. Use of AI tools for studying biodiversity and conservation
5. Use of AI tools in agriculture

Practical

ZMJP-101: Anatomy and physiology of non chordates and Chordates

1. Grasshopper: Reproductive system; Air sacs.
2. Cockroach: Male and female reproductive system.
3. Crab: Digestive and Nervous systems.
4. Honey bee: Poison apparatus, Pollen basket.
5. Collection, fixation, staining and preservation of protozoa by wet and dry method.
6. Preparation for materials for identification of nematodes.
7. Estimation of Blood pressure and pulse rate - Effect of exercise.
8. Estimation of rate of O₂ consumption, CO₂ release and RQ in cockroach/mice.
9. Cranial nerves, arterial and venous system of teleosts.
10. Accessory respiratory organs of fish, dissection of carp showing interrelationship between gas (swim/ air) bladder and Weberian Ossicles
11. Laboratory notebook && Viva voce

ZMJP-102: Inheritance biology and Principles of Animal development

1. Observation and determination of mitotic index.
2. Demonstration of Mendelian laws of inheritance and demonstration of monohybrid and dihybrid crosses, test and back cross.
3. Study of meiosis in grasshopper testes by the squashing method.
4. DNA isolation and visualisation.
5. Preparation of Whole mounts of 24, 48 and 72 hours of Chick embryos.
6. Study of serial sections of chick embryo of 48 & 72 hours (emphasis to be given on brain, eye, heart, gut, limb and tail bud regions).
7. Identification of different developmental stages of fish.
8. Effect of teratogens during development of Drosophila/ Tilapia.
9. Laboratory notebook & Viva voce.

ZMJP 103: Endocrinology and Metabolism and Environmental toxicology

1. Identification of endocrine glands/ organs/ tissues.
2. Performance of castration and ovariectomy in rat /mice.
3. Determination of metabolic rate and respiratory substrate in rat/mice.
4. In vitro study of motility of epididymal spermatozoa and their counting.
5. Estrous Cycle Stages from rat/ mice: Preparation and Identification.
6. Determination of LC50 / LD50 and 95% Confidence limit of anytoxicant to a selected aquatic/ terrestrial organism.
7. Studies on the effect of toxicants on blood parameters of fish/rat, serum LDH assay.
8. AAS/ HPLC for residue analyses of toxicants
9. Laboratory notebook & Viva voce.

ZSECP 101 Specialized laboratory course in Zoology

As mentioned in syllabus of ZSECT 101

SEMESTER II

1.Discipline specific core (DSC)

No of paper 03 Credit 12

ZMJT-204: Economically important arthropods and advanced parasitology and vector biology

Course Objectives:

Arthropods, the largest group of animals with approximately 1.3 million species on earth, play significant role in maintaining ecosystem balance. Together, they constitute the most important animal group in the form pests, pollinators, nutrient recyclers and vectors of many diseases. The course aims to give an

overview of basic ideas of parasitism and parasitic lifestyles including host responses and parasite evasion. It will enable students to explore a number of important diseases, along with the diverse protozoans and worms responsible for them. The students learn about transmission, epidemiology, diagnosis, clinical manifestations, pathology, treatment and control of major parasites.

Course Learning Outcomes:

Knowledge on the morphology, bionomics, and control measures of various economically important arthropods, particularly insect pests and vectors, will be beneficial in planning better pest control strategies, economic growth, and management of insect vector borne diseases. Additionally, the knowledge on culture techniques like Apiculture, Sericulture, Lac culture will assist in the development of entrepreneurship. Upon successful completion of this course the students would be able to learn about transmission, epidemiology, diagnosis, clinical manifestations, pathology, treatment and control of major parasites.

UNIT I: Economically important arthropods

1. Pest management: Mechanical, chemical, biological, integrated
2. Insect pests: Morphology, bionomics and control of - i) Stored grains: Stored rice grain moth (*Corcyra cephalonica*) and stored pulse beetle (*Callosobruchus chinensis*)
3. Field insect pests: Fall army worm (*Spodoptera frugiperda*), cardamom capsule borer (*Conogethes punctiferalis*), jute semilooper (*Anomis sabulifera*).
4. Lac culture: Life history of lac insect, culture method, lac processing, lac products, natural enemies of lac insect and their control.
5. Sericulture: Indigenous races, pure races and commercial races of mulberry silk moth; rearing of mulberry silk moth.
6. Apiculture: Modern artificial bee rearing (Langstroth method), classification of honey. Chemical composition and medicinal value of honey, by products of apiculture
7. Arthropods as blood suckers and disease transmitters.
8. Parasitic insects: General remarks on *Phlebotomous* sp., *Glossina* sp., *Tabanus* sp. and head louse in relation to morphology, habit, habitat, mode of transmission, life cycle and diseases caused by them.
9. General remarks on mites and ticks in relation to morphology, habitat, life cycle and diseases caused by them.

UNIT II: Advanced parasitology and vector biology

1. Host-parasite interaction: Animal associations and evolution of host-parasite relationship, Immune response and self- defence mechanisms, immune evasion and biochemical adaptations of parasites.
2. Mode of transmission of *Plasmodium*, *Trypanosoma* and *Piroplasm*.
3. Zoonosis with particular reference to Toxoplasmosis and Schistosomiasis.

4. Biology, pathogenesis, epidemiology, immunity and immune evasion mechanisms, drug targets and mechanisms of drug resistance of *Trichinella spiralis* and *Dracunculus medinensis*.
5. Salient features of plant parasitic nematodes and life cycle patterns of i) *Meloidogyne hapla*, ii) *Anguina tritici*.
6. Mode of transmission, pathogenicity and prevention of tuberculosis, cholera, tetanus, rabies and dengue.
7. Life cycle, medical importance and control of disease-causing vectors: *Anopheles* sp., *Culex* sp., *Aedes* sp. Black fly.
8. Vector-microbe interaction: a. Symbiotic association of microbes with vectors, b. Role of microbes as controlling agents of vectors.

Suggested readings

- a) Atwal, A. S. and Dhaliwal, G.S. (2002). Agricultural pests of South Asia and their management. Kalyani Publishers, New Delhi.
- b) David, B. V. and Ananthakrishnan, T. N. (2006). General and Applied Entomology. Tata McGraw-Hill Publishing.
- c) Kettle, D. S. (1995). Medical and veterinary Entomology. 2nd Ed. CAB International.
- d) Mullen, G.R. and Durden, L.A. (2009). Medical and Veterinary Entomology. 2nd ed. Academic Press.
- e) Rechill J. E. and Rechill, N. A. (1998). Biological and Biotechnological control of Insect pests. Lewis Publishers.

ZMJT 205: Animal behaviour and Ecology

Course Objectives:

The major objective of this core paper is to understand languages of animals by means of their behavioral study. Students will be exposed to the fundamental aspects of ecology.

Course Learning Outcomes:

After successful completion of this course the students will be able: to understand animals' complicated behaviour, degree of inter-specific and intra-specific relationship among the animals, to know the facts behind learning and memory.

UNIT I: Animal behaviour

1. Introduction to animal behavior: History, foundation, approaches and methods.
2. Learning and memory: Definition and forms of learning and memory, anatomy of memory, learning and habitat selection - migration, navigation and orientation.
3. Kinship: altruism, reciprocity, kin selection and altruism, relatedness, inclusive fitness, selfishness and eusociality.
4. Conflict: Sexual selection, aggression, competition dominance, Infanticide.
5. Game theory - Models and strategies.
6. Communications: Channels, functions, origin and modification of signal, signal receiving mechanism.

7. Bee Behaviour: Colony organization, Foraging behaviour, Communication in Bees, Pheromone for Navigation

UNIT II: Ecology

1. The Ecosystem: Gaia hypothesis, cybernetic nature and stability of the ecosystem, ecosystem management and optimization. Macroecology: concept and consequences. Principles of Thermodynamics, energy flow and ecological energetics.
2. Niche theory: Concept of habitat and niche; niche width and overlap; fundamental and realized niche; resource partitioning; character displacement. (Lotka-Volterra model, Isoclines, Niche prediction).
3. Community: Structure and Gradient analysis, Structure of biotic community. Community patterns: diversity and stability. Community boundary: Ecotone and edge types, Edge effect and edge species, Leibig's Law of the minimum.
4. Population attributes: Growth forms and mathematics of growth, Life Table - (Cohort and Static); survivorship curves, generation time, net reproductive rate, gross reproductive rate, vital index. Life history strategies: Evolution of life history traits, strategies related to longevity, clutch size; life history optimization.
5. Metapopulation: Concept, models, structure and dynamics
6. Major terrestrial biomes: Theory of island biogeography, Biogeographical zones of India.

Suggested reading

- a) Animal Behavior. Alcock J. Sinauer Associate Inc. USA (latest edition)
- b) Animal behavior. Drickamer LC. Vessey SH. Mc. Graw-Hill (latest edition).
- c) Recent trends in animal behavior. Ruhela A and Sinha M. Oxford (latest edition).
- d) Animal Behavior. Mathur. Rastogi Pub (latest edition).
- e) Begon, M., Harper, J. L. and Townsend, C. R. (2006). Ecology: Individuals, Populations and communities. 4 th ed. Blackwell science.
- f) Enger, E. D. and Smith, B. F. (2008). Environmental Science: A study of Interrelationships. 11th ed. McGraw-Hill Higher Education.
- g) Kormondy, E. J. (2002). Concepts of Ecology. 4th Indian Reprint, Pearson Education.
- h) Odum, E. P. and Barret, G. W. (2005). Fundamentals of Ecology. 5th ed. Thompson Brooks/Cole.
- i) Smith, T. M and Smith, R. L. (2006). Elements of Ecology. 6th ed. Pearson Education.

ZMJT -206: Immunology and human genetics

Course Objectives:

The course has been developed to provide the basics of immunology and understanding the structure, components and function of an immune system so that necessary skills are provided for the critical analysis of contemporary literature on topics related to health and disease and the role of immune system. The course will also enable the students to learn broad knowledge on the structural and functional aspects of human chromosomes and enhance the understandings on human genetics and related human genetic disorders, thereby paving the way for possible treatment and management

Course Learning Outcomes:

Upon completion of the course, the students will have a good knowledge of the essential elements of the immune system, preparing them to engage further in this rapidly evolving field. Human genetics will impart knowledge about the human chromosome constitution that would help in applying basic principles of chromosome behaviour to disease context.

UNIT I: Immunology

1. Introduction & Overview of Immune System: a. History and scope of immunology; types of immunity: innate and adaptive, Lymphoid organs: primary (bone marrow, thymus) and secondary (spleen, lymph nodes, MALT/GALT/BALT); b. Cells of immune system: neutrophils, macrophages, dendritic cells, NK cells, B and T lymphocytes
2. Innate Immunity: Physical/chemical barriers; normal microbiota and innate defense, Pattern recognition receptors (PRRs): TLRs, NLRs (concept) and PAMPs/DAMPs, Phagocytosis: opsonization, respiratory burst, microbicidal mechanisms
3. Complement system: pathways (classical, lectin, alternative), biological roles, regulation
4. Adaptive Immunity: Antigen recognition; Organization; T cell and B cell biology and immune response.
5. Antigen presentation: Major Histocompatibility Complex (MHC I & II): structure, peptide presentation, polymorphism
6. Vaccination and Immunization: Natural and artificial immunization; active immunization; Vaccines: types and mode of functions
7. Immune system in health and diseases: Allergy; Hypersensitivity; Chronic inflammations; Tolerance; Autoimmunity. Infection and Immunity: Leishmaniasis; tuberculosis; rabies.

UNIT II: Human genetics

1. Human Karyotype: Chromosome types and Karyotyping; Chromosome banding and Nomenclature of Metaphase chromosome.
2. Chromosome Variations: Chromosome Anomalies and Structural Variants.
3. Molecular Pathology: Loss of function, Gain of function; Mitochondrial disorders.
4. Mapping and Analysis: Human Gene mapping strategies; Mapping and identifying genes of monogenetic disorder; Genetic analysis of complex traits and disease.
5. Human Pedigree: Pedigree analysis and genetic disorders.
6. Population Genetics: Quantitative Genetics; Variance; Heritability and its measurement; Inbreeding and cross breeding; QTL.
7. Molecular Evolution and Sociobiology: Polymorphism in protein coding genes, SNP, Polymorphism in Y-Chromosome and Mitochondrial DNA, transposon origin of functional sequences, Regulatory sequence evolution; Molecular Phylogenetics; Sociobiology, Altruism, Kin selection and inclusive fitness, Haplodiploidy, Imprinting phenomena.

8. Human Genome: Human Genome Project, Sequencing Genome, Structure of Human Genome, Genome Variations, ENCODE Project; Concepts and Application of Bioinformatics and Genome Databases.

Suggested readings

- a) Roitt's Essential Immunology
- b) Judy Owen, Jenni Punt, Sharon Stranford-Kuby Immunology
- c) Strachan, T and Read, A (2018) Human Molecular Genetics
- d) Introduction to Genetic Analysis (12 Edition)-Anthony J.F. Griffiths et.al
- e) Genetics: From Genes to genome-Michael L Goldberg et.al.
- f) William S. Klug, Michael R. Cummings, Charlotte A. Spencer, Michael A. Palladino, Darrell Killian - Concepts of Genetics

2. Discipline specific minor and General elective

No of paper 02 Credit 04

ZMNE-204: Developmental dynamics and Medical embryology and therapeutics

Course Objectives:

To inculcate the essence of developmental biology with special emphasis for point to point understanding of the application of subject core in advance biological intervention. The course has been design to cover several diagnostics and treatment strategies used in medical sciences in the light of embryological perspectives

Course Learning Outcomes:

After completing the course the students shall be able to elucidate the relationship of developmental biology strategies and their applicability in different forms of biology. The students shall have an overall idea in the area of medical sciences which have been explored in diagnostic and therapeutic application in embryologic stage.

UNIT I: Developmental dynamics

1. Common features of development: Genomic equivalence; cytoplasmic determinants; imprinting, Cloning of animals.
2. Techniques for the study of development: i) Cell labeling and tagging ii) Cell sorting.
3. Genetic errors of human development- Down syndrome, Fragile X syndrome, Turner's Syndrome.

UNIT II: Medical embryology and therapeutics

1. Techniques used in Medical Embryology :i) Amniocentesis ii) Chorionic villus sampling iii) Ultrasonography iv) DNA Fingerprinting v) Karyotyping
2. Future of medicine: Differentiation therapy, gene therapy (Ex Vivo and In vivo), germ line gene therapy,
3. Nanotechnology in medical embryology and therapeutics.

Suggested Literature:

- a) Developmental Biology: Michael J.F. Barresi Scott F. Gilbert,(12 th Ed).

- b) Principles of Development: Lewis Wolpert and Cheryll Tickle (4th Ed.).
- c) Principles of Genetics. 3rd Ed. D. Peter Snustad and Michael J. Simmons. Wiley Publication.
- d) iGenetics: A molecular approach. 3rd Ed. Peter J. Russell. Pearson International Edition.

ZMNE-205: Cell signalling and Reproductive Biotechnology

Course Objectives:

The course is planned to give comprehensive understanding of the technologies that are applicable to make better options as far as reproductive successes are concerned. This course will provide an overview of the reproductive health, the problems associated and the technologies that might be applied to overcome the problems.

Course Learning Outcomes:

Students of this class will be able to understand the importance of technology in the maintenance and upgradation of reproductive health in human and animals. This course will make them suitably knowledgeable about cell culture techniques, cloning techniques, preservation of eggs and sperms, artificial reproductive technologies to undertake the therapeutic research jobs in various pharmaceutical companies as well as in hospitals in addition to the IVF centres.

UNIT I: Cell signaling

1. Cell communication: autocrine, paracrine, endocrine, synaptic, juxtacrine signalling
2. Ligands and receptors; specificity, sensitivity, amplification, adaptation/desensitization
3. Receptor regulation: up/down regulation, internalisation, receptor recycling
4. Comparison between cell surface receptor signalling and intracellular receptor signalling
5. Second messengers and their significance: Ca^{2+} , IP_3 , DAG, cAMP, cGMP; PKC; Ca^{2+} -calmodulin
6. Cross-talk between pathways; feedback control; signalling networks
7. Developmental signalling: Wnt, Hedgehog, Notch, TGF β /SMAD
8. Clinical/applications: cancer signalling (oncogenes/tumor suppressor), drug targets in signalling pathways
9. Neuroendocrine regulation of immune system : Influence of ANS on the immune system, stress hormones and immune response, pituitary hormones and regulation of lymphoid tissue and immune function.
10. Melatonin : Chemical nature, biosynthesis, metabolism and functions.
11. Neuroendocrine disorders: Genetic and environmental causes

UNIT II: Reproductive biotechnology

1. Medical implications of infertility: Diagnostic infertility, types of infertility, common causes and risk factors influencing infertility.
2. Assisted reproductive technology: AI, GIFT, ICSI, IVC, IVF, ET, PGD, AH, micromanipulation (ICSI, SUZI and ROSNI), cryopreservation and cryobank.

Suggested readings

- a) An introduction to neuroendocrinology-Michael Wilkinson and Richard E. Brown, Cambridge University Press (latest edition)
- b) Endocrinology-Mac E. Hadley and Jon E Levine, Pearson (latest edition).
- c) Endocrine physiology-Molina PE, McGraw Hill Lange (latest edition).
- d) Growth development and reproduction-Dannis taylor, Cambridge University press (latest edition).
- e) Endocrine and reproductive physiology edited by Bruce A-White and Susan P, Elsevier Inc.(latest edition).

ZMNE -206: Molecular Genetics and Cancer Biology

Course Objectives:

This course is designed to provide an invaluable foundation of human genome and genetic diseases at the molecular and biochemical level. The course aims to provide comprehensive look at the human genome through evolutionary studies and forensic science by learning concepts of Polymorphism, molecular phylogenetics, RFLPs and Bioinformatics etc. The objective of this course is to give a basic knowledge on molecular basis of cancer in general to the students of this paper. In addition to that this course will give a vivid idea on pharmacogenomics , a field of medical science where genomic understanding will meet the need of pharmacology and strategic approach to deal different diseases including cancer. The last item is based on the most recent development of material science i.e. nanotechnology and its application in dealing with drug delivery and disease management by using nanoforms.

Course Learning Outcomes:

This course is expected to deliver knowledge of how organisms, populations and species evolve, besides providing answer some of the most fundamental questions on human genome, disease and functions of gene. This course will decipher current knowledge on disease treatment including cancer.

UNIT I: Molecular genetics

1. Human disease diagnosis and treatment: Application of medical genetics; Genetic Testing, Genetic screening and Gene therapy, Genetic Counseling and Human rights Human Disease-Autosomal (Cystic fibrosis), X-linked (hemophilia A), Metabolic disorders (phenylketonuria);
2. Genetics in Forensic Science: Protein comparisons, DNA comparisons, RFLPs, genetic fingerprinting, VNTRs, Genetic profiles.
3. Pharmacogenomics: Concepts of Pharmacogenomics; Pharmacogenetics in disease prognosis and treatment, response and toxicity; Nutrigenomics; Personalized medicine.
4. Nanotechnology: Concept of Nanotechnology, Nanomedicine and applications.

UNIT II: Cancer Biology

1. Cancer Genetics: Cancer types and Stages; Cancer cells Hallmarks; Cellular immortalization; Multistep tumorigenesis; Age and Incidence of cancer
2. Mechanism of Cancer: Carcinogens, Oncogene, Tumor Suppressor gene, Chromosomal abnormalities in cancer.
3. Cancer epigenetics: Epigenetic mode of cancer

4. Nanomedicine in the treatment of cancer

Suggested readings

- a) Robert A. Weinberg-The Biology of Cancer-Garland Science
- b) Genetics Analysis and Principles: Robert J Brooker
- c) Introduction to Genetic Analysis (12th Edition)-Anthony J.F. Griffiths et.al
- d) Genetics: From Genes to genome-Michael L Goldberg et.al.
- e) William S. Klug, Michael R. Cummings, Charlotte A. Spencer, Michael A. Palladino, Darrell Killian - Concepts of Genetics
- f) T.A. Brown - Genomes 4
- g) Bruce Alberts, Rebecca Heald, Alexander Johnson, David Morgan, M - Molecular Biology of the Cell
- h) Strachan, T and Read, A (2018) Human Molecular Genetics

3. Interdisciplinary Zoology

Paper 01 Credit 2

ZIDS 201 (Interdisciplinary Zoology for the students of other subjects)

Course Objectives:

We are living in a golden age of biology. There is a vast domain of knowledge to teach and learn about biology especially zoology and its applications for the welfare of society. This optional paper caters to a wide domain including applied zoology, wild life ecosystem, ecology and medical zoology which have a significant contribution in recent times.

Course Learning Outcomes:

This part is a culmination of basic and applied skill-based zoology that has emerging scopes of jobs as biologist.

A. Concept of Wildlife and its Conservation

1. Categories of wild life.
2. Wild life and wild life habitat in India: Wild life wealth of India.
3. Wild life management: Distribution, status, habitat utilization pattern, threats and survival of – Royal Bengal Tiger, Rhinoceros, Olive Ridley Turtle.
4. National and International efforts for conservation: CITES, IUCN, CBD, Protected area concept.
5. Conservation of natural enemies of insect pest.

B Ecological Principles and Application

1. Concept of habitat and nich
2. Ecological principles.
3. Community ecology: nature of communities; levels of species diversity and its measurements.
4. Biogeographical zones of India.
5. Environmental management: Solid waste management; Bioremediation Bioreactors in Environment monitoring.
6. Organic farming and vermicomposting.

7. Insect pollinators: Types and role in agriculture.

C. Medical Zoology

1. Genetics of Human Diseases. Nutrigenomics, Pharmacogenomics and their applications.
2. Preliminary knowledge on zoonotic diseases.
3. Immunodiagnostics: Concepts of Innate and Humoral Immunity, Antigen
4. Presentation, Antigen-antibody interactions, its application in medical diagnosis (Western Blot, ELISA, RIA, Elispot, FACS, Immunofluorescence)

Suggested Literature:

1. The Wisdom of the Hive. Thomas D. Seeley, Harvard University Press, 1995
2. Review articles published in various journals.
3. Bardach, J. E. and Ryther, J. H. (1972). Aquaculture. John Wiley and Sons.
4. Pillay, T. V. R. and Kutty, M. N. (2005). Aquaculture Principles and Practices. 2nd ed. Blackwell Publishing Ltd.
5. Bond, C. E. (1996). Biology of Fishes. 2nd ed. Saunders Pub.
6. Pillay, T. V. R. and Kutty, M. N. (2005). Aquaculture: Principles and Practices. 2nd ed. Blackwell Publishing Ltd.
7. Parker, R. (2012). Aquaculture Science. 3rd ed. Delmar, Cengage Learning, USA.
8. Cunningham, W. P. and Cunningham, M. A., (2007). Principles of Environmental Science: Inquiry and Applications. 4th ed. Tata McGraw-Hill Company.
9. Dash, M. C., (2001). Fundamental of Ecology. 2nd ed. Tata McGraw-Hill Company.
10. Kormondy, E. J. (2002). Concepts of Ecology. 4th Indian Reprint, Pearson Education.
11. Odum, E. P. and Barret, G. W. (2005). Fundamentals of Ecology. 5th ed. Thompson Brooks/Cole.
12. Santra, S. (2005). Environmental Science. New Central Book Agency (P) Ltd.
13. Smith, T. M and Smith, R. L. (2006). Elements of Ecology. 6th ed. Pearson Education.

4. Discipline specific vocational course

Paper 01 Credit 0

Course objectives and outcome:

This swayed courses will allow students to be exposed to numerous interdisciplinary subjects to enrich their biological, societal knowledge.

ZVAC-201: SWAM courses available on website.

5. Skill based course / specialized lab (SEC)

Paper 02 Credit 04

ZSECT-201: Specialized laboratory courses (Both theory and practical)

Course objectives and outcome:

This course will give subject-specific hands-on training to the students for application in different field of research as well as medical biology

1. Pesticide formulation and pest trap formation.
2. Histochemistry and immunohistochemistry for FFPE tissue (MB): Tissue processing (collection, fixation and embedding), microtomy and staining and mounting of tissue.
3. Determination of protein expression in cell lines for disease diagnosis and therapeutics.
4. Environmental microbiology and antimicrobial testing: a. Water quality assessment: Determination of bacterial load in water sources, determination of potability of water (physical, chemical, biological parameters), b. Antimicrobial testing: Antibiotic sensitivity test- determining bacterial susceptibility to antibiotics.

6.Research based course: Research methodology (RM) Paper 01 Credit 02

ZRM-201: Research methodology

Course objectives and outcome:

The objectives of this course is to provide the theoretical background for the knowledge the researchers should have to start any research activities in future. This course will give knowledge on methodological designing, good laboratory practices and statistical analysis of data processing etc.

1. Research Methodology Overview: Research – Definition, Objectives, Types, Process, Ethics, Importance and Characteristics; Research design – developing a research plan; Research question; Survey of Literature; Formulation of hypothesis and types of hypotheses; Research Methods vs Research Methodology.
2. Scientific Reports, Project, Publication and Thesis: Contents and Structure, Importance, Types of Publication, Review System, Publication ethics, Journal Rankings and Metrics; Citation Index; Referencing Styles and Tools, Poster and Seminar Presentation.
3. Good Laboratory Practice: Principles of GLP, OECD guidelines, Scope and Components, Data storage and retention.
4. Molecular Diagnostics: DNA Amplification-PCR; Molecular Separation- SDS-PAGE, Agarose Gel; Molecular Interactions; Sequencing strategy.
5. Model Organisms: Importance and Application to Human Biology- E. coli, C. elegans, Drosophila, Danio rerio and Mus musculus.
6. Research data and sampling: Types of data, sources of data, methods of collecting data, presentation of data, sampling and sampling methods.
7. Descriptive statistics: Measures of central tendency (mean, median, mode), and measures of dispersion (range, QD, MD, SD and variance).

8. Inferential statistics: Test of hypothesis (statistical hypotheses, level of significance, p-value, critical and acceptance regions, one-tail and two-tail tests, errors in statistics, power of the test, degree of freedom and confidence level), parametric tests (z-test, t-test, F-test and test for correlation coefficient) and non-parametric tests (Chi-square test, rank correlation test, sign test and Wilcoxon-signed rank test).
9. Publication ethics through COPE, WAME
10. Quantitative analysis of biological samples: spectroscopic technique

Suggested readings

- a) Vinayak Bairagi_ Mousami V. Munot - Research Methodology_ A Practical And Scientific Approach
- b) Surbhi Jain - Research Methodology In Arts, Science And Humanities-Society Publishing
- c) Essential Biostatistics: A concise and applied digest with computer applications-Dr. Maharaj Biswas, Walnut publication, India, UK and USA (latest edition).
- d) Biostatistics for the Biological and Health Sciences- M. M. Triola, M.F. Triola and J. Roy, Pearson (latest publication).
- e) Statistical methods in biology-N.T.J. Bailey, Hodder and Stoughton (latest publication).
- f) Mathematics and Statistics for Life Scientists- Aulay Mackenzie, Taylor & Francis (latest edition).
- g) Biostatistics-Veer Bala Rastogi, MedTech Science Press (latest edition)

Practical

ZMJP 204: Economically important arthropods and advanced parasitology and vector biology

1. Identification of -
 - i) Pests and their damage symptoms of agricultural crops and stored grains from theoretical course.
 - ii) Insect predators/parasitoids of economically important insects (Honey bee/ Silkworm).
2. Sericulture (Mulberry): Silk worm, silk cocoon.
3. Whole mount preparation of mosquito vectors
4. Grasshopper: Reproductive; Air sacs.
5. Cockroach: Male reproductive.
6. Crab: Digestive and Nervous.
7. Protozoan parasites of freshwater fish and insects of economic importance.
8. Staining of ciliate parasites by Kohn's silver impregnation technique.
9. Collection, fixation, preservation and staining of endoparasitic helminths.
10. Identification of parasitic protozoans.

ZMJP 205: Animal behaviour and Ecology

1. Introduction to animal behavior: History, foundation, approaches and methods
2. Learning and memory: Forms of learning and memory, learning and habitat selection - migration, navigation and orientation
3. Kinship: Relatedness, inclusive fitness. selfishness, altruism

4. Conflict: Sexual selection, aggression, competition dominance, Infanticide.
5. Game theory - Models and strategies.
6. Communications: Channels, functions, origin and modification of signal, signal receiving mechanism.
5. Evolution of feeding behavior: optimal foraging theory
6. Demonstration of behavioral change of fish /chick in relation to toxicant / chemicals.
7. Study of habituation to light stimulus in the earthworm.
8. Demonstration of phototactic response of house fly.
9. Huddling behaviour of rat/mice
10. Marble burrowing behaviour of animals in relation to toxicants/chemicals.

ZMJP 206 : Immunology and human genetics

1. Analysis of blood group A, B, AB, O and Rh factor.
2. Antigen antibody reaction; immunodiffusion.
3. Raising of antibody.
4. Identification of lymphoid organs.
5. Absolute eosinophil count (AEC)- immunological perspective.
6. Demonstration of peptide designing and raising antibody
7. Demonstration of human chromosomes and preparation of karyotypes.
8. Study of chromosomal aberrations with respect to number, translocation, deletion etc. from the images provided.
9. Study of Micronuclei and sperm head anomaly.
10. Solving problems on linkage and chromosomal mapping; population genetics
11. Paired T-test on experimental data.
12. Chi square test for goodness of fit with a Mendelian frequency distribution.
13. Pedigree analysis
14. Laboratory note book & Viva voce.

ZSECP-201: Specialized laboratory courses (as per syllabus of ZSECT201)