

## **SCHEME OF STUDIES FOR PhD ZOOLOGY**

In order to qualify for a PhD degree, a student must successfully complete 18 credit hours of course work (graduate level) in addition to 24 credit hours of course work at the MS/ M.Phil level and must successfully complete his/ her PhD thesis. The students should have up to 50% of the elective courses in his/ her field of research specialization. The courses will be offered according to availability of experts/specialists in University from the pool of PhD subjects.

**Eligibility Criteria:** MPhil (Zoology) or relevant field of basic Zoology subjects with Minimum 3CGPA or 60% obtained marks of the total.

### **Semester-I**

<b>Course Title</b>	<b>Cr hrs</b>
Optional-Course-1	<b>3</b>
Optional Course-2	<b>3</b>
Optional Course-3	<b>3</b>
<b>Total</b>	<b>9</b>

### **Semester-II**

<b>Course Title</b>	<b>Cr hrs</b>
Optional Course-4	<b>3</b>
Optional Course-5	<b>3</b>
Optional Course-6	<b>3</b>
<b>Total</b>	<b>9</b>

- The minimum and maximum duration of PhD in Zoology is 3-8 years from the date of admission.

**NOTE: Details of PhD courses are given in Annex-C.**

## Department of Zoology PhD Courses

Course Code	Title	Cr Hrs
ZOO 901	Molecular immunology	3
ZOO 902	Molecular Virology	3
ZOO 903	Advances in Immunology	3
ZOO 904	Applied Parasitology & Pathogen Biology	3
ZOO 905	Advanced Insect Ecology	3
ZOO 906	Advanced Physiology	3
ZOO 907	Advanced Cell Biology	3
ZOO 908	Biological Control of Insect Pests	3
ZOO 909	Insects of Economic Importance	3
ZOO 910	Insecticide Resistance and Management	3
ZOO 911	Advanced Molecular Entomology	3
ZOO 912	Skills and Research Methods	3
ZOO 913	Advanced Molecular Biology	3
ZOO 914	Fish Breeding and Hatchery Management	3
ZOO 915	Fisheries Extension and Education	3
ZOO 916	Fish Nutrition and Feed Technology	3
ZOO 917	Water Quality and Fish management	3
ZOO 918	Etiology of Fish diseases	3
ZOO 919	Aquaculture and Fisheries Economics	3
ZOO 920	Venomous Reptiles of the World	3
ZOO 921	Economic Herpetology	3
ZOO 922	Veterinary vaccinology	3
ZOO 923	Poultry vaccinology	3
ZOO 924	Fish vaccinology	3
ZOO 925	Forensic Entomology	3
ZOO 999	Research	9

**Course Objectives and Learning Outcomes:**

The objectives of the course are:-

1. To impart knowledge about the molecular basis of innate immunity, acquired immunity, antigenicity, and immune complexes.
2. To develop critical thinking about the mechanisms of autoimmune disorders and hypersensitivity reactions.
3. To develop an analytical approach about the rejection of tissue graft and the formation of infinite antibodies from the finite source of DNA.

Upon successful completion of the course, the student will be able to:

- **ACQUIRE** knowledge about the molecular basis of antigenicity and immune complexes.
- **UNDERSTAND** the concepts of transplantation immunology and tumor immunology.
- **ANALYZE** the histological feature of immune response in allergy and hypersensitivity cases.
- **DEMONSTRATE** individually mechanism of immunization at the molecular level and histological features of an exaggerated immune response.

**Course Outline:**

Immunology, Immunobiology, Immunophysiology, Immunopathology, Immunity, Natural and acquired immunity, Active and passive immunity, Antigens and elicitation of the immune response,

Molecular basis of cell-mediated and humoral immunity, Immunoglobulins, Synthesis of antibodies, and theories of antibody synthesis. Antigenicity, Interaction of antigens and antibodies, Factors affecting immune response, Nature of antigens, Genetic constitution of individuals, and route of administration. Detection and application of antigen-antibody reactions in vivo and in vitro. Monoclonal antibodies, Major histocompatibility complex, and conservation of the antigen-binding site. Cellular basis of the immune response. Specific response of individual lymphocytes to antigenic stimulation. Histological features of the immune response. Hypersensitivity, anaphylactic, antibody-dependent cytotoxicity, immune complex-mediated, delayed-type hypersensitivity, and stimulatory hypersensitivity. Histological feature of allergic reactions and changes in immune response at the molecular level,

Immunological tolerance and autoimmunity, Immuno potentiation, and immunosuppression. Transplantation Immunology, Tumor immunology. Immunity against infectious diseases. Immunodeficiency diseases,

Immunization. Immunization procedures, vaccines, and their development.

**Text and Reference Books:**

1. Bain, B., Bates, I., Laffan, M. and Lewis, M., 2012: Decie and Lewis Practical Hematology. 11th Ed. Churchill Livingstone
2. Montanaro, A., 2015: Primary immunodeficiency Disorders. 1st Ed. Elsevier
3. O'Hehir, R.E., Holgate, S. T. and Sheikh, A., 2016: Middleton's Allergy Essentials. 2nd Ed. Elsevier
4. Park, K., 2002: Park's textbook of Preventive and Social Medicine. 2nd ed. MIS Barnarsid, India.
5. Richard, A. Goldsby, Thomas and Barbra, A. Kuby., 2007: IMMUNOLOGY. 6th edition. W.H Freeman and company NewYark USA.

ZOO 902

MOLECULAR VIROLOGY

3 (3+0)

**Course Objectives:**

The objectives of the course are:-

1. To provide expertise in Molecular virology.
2. To achieve in-depth knowledge and understanding of viruses at molecular level.
3. Develop an understanding of the scientific basis of concepts, molecular virology.

**Course Outline:**

**Introduction:** Viruses are Distinct from Living Organisms, The History of Virology, Living Host Systems, Cell Culture Methods, Serological/Immunological Methods, Ultrastructural Studies.

**Particles:** The Function and Formation of Virus Particles, Capsid Symmetry and Virus Architecture, Enveloped Viruses, Complex Virus Structures, Protein–Nucleic Acid Interactions and Genome Packaging, Virus Receptors: Recognition and Binding.

**The virus Genome:** The Structure and Complexity of Virus Genomes, Molecular Genetics, Virus Mutants, Suppression, Genetic Interactions between Viruses, Nongenetic Interactions between Viruses, ‘Large’ DNA Genomes, ‘Small’ DNA Genomes, Positive-Strand RNA Viruses, Negative-Strand RNA Viruses, Segmented and Multipartite Virus Genomes, Reverse Transcription and Transposition

**Replication:** Overview of Virus Replication, Investigation of Virus Replication, The Replication Cycle

**Expression:** Expression of Genetic Information, Control of Prokaryote Gene Expression, Control of Expression in Bacteriophage, Control of Eukaryote Gene Expression, Transcriptional Control of Expression, Posttranscriptional Control of Expression

**Infection:** Virus Infections of Plants, Immune Responses to Virus Infections in Animals, Viruses and Apoptosis, Interferons, Evasion of Immune Responses by Viruses, Virus–Host Interactions, The Course of Virus Infections, Virus Vectors and Gene Therapy, Chemotherapy of Virus Infections

**Pathogenesis:** Mechanisms of Cellular Injury: Viruses and Immunodeficiency: Virus-Related Diseases, Bacteriophages and Human Disease, Cell Transformation by Viruses, Viruses and Cancer, New and Emergent Viruses, Zoonoses, Bioterrorism.

**Recommended Books**

1. Alan Cann. 2012. Principles of Molecular Virology 5<sup>th</sup> Edition. Academic Press Elsevier.
2. Susanne Modrow, Dietrich Falke, Uwe Truyen, Hermann Schätzl. 2013. Molecular Virology. Springer Berlin Heidelberg
3. Wang-Shic Ryu. 2016. Molecular Virology of Human Pathogenic Viruses. Elsevier Science.

ZOO 903

ADVANCES IN IMMUNOLOGY

3 (3+0)

**Course Objectives and learning outcomes:**

The objectives of the course are:-

1. To provide knowledge about the components and role of the immune system.
2. To provide students with knowledge of different mechanisms of the immune system.
3. The students will be able to describe immunological response and how it is triggered and regulated.

4. To describe the roles of the immune system in both maintaining health and contributing to diseases.

Upon successful completion of the course, the student will be able to:

- **Explore** the basic knowledge of the mechanisms of the immune system
- **Describe** the concepts about the role of the immune system.
- **Interpret** the problems using immunological techniques for the diagnosis of immune disorders.
- **Identify** the problems using immunological diagnostic tools.
- **Detect** the problems using the same techniques for other disorders.
- **DEMONSTRATE** individually the ELISA and other Assays/Tests.

### **Course Outline:**

**Introduction:** a. Components of the immune system, b. Antigens and Pathogens

**Innate Immunity and Inflammation:** a. Different types of leukocytes, b. Inflammation and Fever

**Recognition and Responses to foreign antigens:** a. Pattern recognition receptors, b. Innate immune signaling, c. The complement system

d. Complement activation pathways,

**Antibodies:** a. B lymphocytes, b. Antibody structure and function, c. Monoclonal and polyclonal antibodies, d. Hybridoma technology.

**Lymphocyte Development and Diversity:** Lymphocyte development, Clonal selection, and expansion, Differences between B and T lymphocytes, The generation of lymphocyte receptor diversity

**T Cell Activation by Antigens:** a. Antigen presentation, b. The role of dendritic cells c. The lymphatic system and delivery of antigen to lymph nodes d. Adaptive immune activation in secondary lymphoid tissues

**T Cell-Dependent B Cell Responses:** a. T Cell activation of B cells

b. Isotype switching and affinity maturation c. Helper T cell functions

d. The role of helper T cells in disease e. Cytotoxic T cell functions f. Selection and expansion of cytotoxic T cells g. Therapies that target cytotoxic T cell functions.

**Tumor Immunology:** a. Detection and identification of Tumor Antigens b. Immune Escape Mechanisms of Tumor Antigens c. Immunotherapeutic Strategies (I) d. Immunotherapeutic Strategies (II)

### **Text and Reference Books:**

1. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter. Molecular Biology of the Cell (5th ed. 2008, Garland)
2. Thomas J Kindt, Richard A Goldsby, Barbara A Osborne, Janis Kuby: Immunology (2003, Freeman).
3. Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt: Roitt's Essential Immunology (12th ed. 2012, Blackwell)
4. Abul Abbas, Andrew H. Lichtman, Shiv Pillai. Cellular and Molecular Immunology, 9th edition, 2017. Elsevier Pub Co.
5. Gerd R. Burmester, Antonio Pezzutto Color Atlas of Immunology, 2006. Thieme Stuttgart, New York.

## **ZOO 904 Applied Parasitology & Pathogen Biology 3 (3+0)**

### **Course Objectives and Learning Outcomes:**

The course objectives are:

1. To facilitate students in understanding important humans and zoonotic parasitic infections
2. Including their life cycles, vectors of transmission, distribution and epidemiology, pathophysiology and clinical manifestations, treatment, and prevention and control
3. Their economic and medical importance.

This course introduces students to the field of parasitology. Topics covered include parasite diversity, life cycles, host defense mechanisms, parasite evasion, host pathology, ecology, evolution, and control. The laboratory component of the course will examine parasites of medical and veterinary importance.

### **Course Outline:**

Introduction: Basic Principles & Concepts, Parasitic Protists: Form, Function, Classification, Kinetoplastids & other Flagellated Protists, Amoebas & Apicomplexans, Parasitic Ciliates

**Consumable used in preservation of parasitic materials:** Collection, processing and preservation of parasites, Isolation of parasite eggs, oocysts and larvae from faecal specimens, Identification of parasite using microscopy and molecular techniques.

**Chemotherapeutic agents and Vaccine Development Against Parasitic Infections:** The mode of action of chemotherapeutic agents, The mechanisms of parasite resistance to drugs. Various approaches will be discussed the methods of vaccine development.

### **Text and Reference Books:**

1. Loker, Eric S. and Bruce V. Hofkin 2015. Parasitology: A Conceptual Approach, Garland Science, Taylor & Francis Group, New York and London. ISBN 978-0-8153-4473-5
2. William Charles Marquardt, Richard S. Demaree, Jr., Robert Burton Grieve., 2000. Parasitology & Vector Biology. 2nd Edition.
3. Desowitz, R.S. 1987. New Guinea Tapeworms and Jewish Grandmothers: Tales of Parasites and People, W.W. Norton and Company, New York. ISBN 978-0-393-30426-8
4. Zimmer, C. 2000. Parasite Rex: Inside the Bizarre World of Nature's Most Dangerous Creatures, The Free Press, New York. ISBN 978-0-7432-0011-0
5. Chandler, A.C. and Read, C.P. 1961. Introduction to Parasitology. 10th ed. Wiley Toppan, New York, USA
6. Handler, A. M. James, A.A. (Eds.). 2004. Insect Transgenesis: Methods and Applications, Comprehensive review of insect gene transfer, its methodologies, applications and risk assessment and regulatory issues. CRC Press.

**Course Objectives**

The objectives of the course are:-

- To provide a synthesis of ecological principles with an applied interpretation.
- To explore the roles of insects in delivery of ecosystem services and applications to pest management and conservation.
- To demonstrate the intra and inter specific interactions of insects thus highlighting their ecological niche.

**COURSE LEARNING OUTCOMES:**

Upon successful completion of the course, the student will be able to:

- **UNDERSTAND** how insects engineer our global ecosystem as well as how they respond to environmental changes.
- **DESCRIBE** the reasons of insect abundance and diversity in any ecosystem.
- **APPRAISE** the principles of ecology at four levels of integration i.e. populations, communities, ecosystems, and landscapes.
- **EXPLORE AND ESTABLISH** the links between different levels of integration.

**COURSE OUTLINE:**

- Scope of Insect ecology.
- Introduction to insect ecology: Insects in ecosystems, Adaptations of Insects, Life history strategies.
- Responses to abiotic conditions.
- Resource acquisition.
- Insects and Landscape: affects of landscape modification on insects.
- Insects and Climate: affects of climate change on insect species, Insect invasions & climate change.
- Biodiversity: Insect conservation, Insect extinctions.
- Insect populations: Population Dynamics, Population sampling methods.
- Insect communities: Community Interactions: (1) Insect-plant interactions, Plant defenses and insect counter-defenses, Insect herbivores, Natural Enemies of insect herbivores with emphasis on Ichneuomonidae and Braconidae, Insect defenses against enemies (2) Predator-prey interactions (3) host-parasite interactions (4) Mutualisms (5) Pollinators-plant interactions: co-evolution of plants & pollinators (6) Insect and pathogens (7) Ecology based Insect pest management.
- Behavioral ecology: Social organization in insects, Insect communication, Insect societies (with emphasis on societies of ants, termites and bees).

**TEXT AND REFERENCE BOOKS:**

1. Schowalter, T.D., 2017. Insect Ecology: An Ecosystem Approach. Academic Press.633pp.
2. Price, P.W., Denno, R.F., Eubanks, M.D., Finke, D.L., and Kaplan, I., 2011. Insect Ecology: Behavior, Populations, and Communities. Cambridge University Press.
3. Speight, M.R., Hunter, M.D., & Watt, A.D. (2008). Ecology of Insects: Concepts and Applications. Wiley-Blackwell.
4. Denno, R. F. and Eubanks, M. D. 2011. Insect Ecology: Behavior, Populations and Communities. Cambridge University Press, New York.USA.
5. Gullan, P. J. and Cranstan, P. S., 2014. The Insects: An Outline of Entomology. 4<sup>th</sup> edition. Wiley-Blackwell. A John Wiley & Sons, Ltd., Publication, UK.

6. Ambrose, D.P., 2015. The Insects: Structure Functions and Biodiversity. Kalyani publishers, Ludhiana, India.
7. Rockwood, L.L. 2006. Introduction to Population Ecology. Wiley, John and Sons.
8. Bourtzis, K. and Miller, T. 2003. Insects Symbiosis. CRC Press.
9. Vandermeer, J.H. and Goldberg, D.E. 2003. Population Ecology: First Principles, Princeton University Press.
10. Southwood, T.R.E. and Henderson, P.A. 2000. Ecological Methods. 3rd Ed. Blackwell Science.

**ZOO 906**

**ADVANCED PHYSIOLOGY**

**3 (3+0)**

### **Course Objectives and Learning Outcomes:**

The objectives of the course are:-

1. To impart knowledge about permeation machinery of membrane channels and channel blockers.
2. To develop critical thinking about the mechanisms of integration in the different functional systems of the animals.
3. To develop analytical approach about the mechanism of membrane potentials and synaptic transmission.

Upon successful completion of the course, the student will be able to:

- **ACQUIRE** the basic knowledge of membrane channels, membrane potentials and physiological changes by diminished receptor and hormonal activity.
- **UNDERSTAND** the concepts of basic mechanism of action potential and its propagation.
- **ANALYZE** the physiological changes due to stress, loss of synapses, hormonal problem, respiratory arrest and cardiovascular problems.
- **DEMONSTRATE** individually permeation machinery of membrane channels and synaptic transmission and factors responsible for physiological stress.

### **Course Outline:**

**Membrane Potentials:** a. Membrane channels and their permeation machinery. b. Channel blockers c. Mechanisms in resting membrane potentials. Local circuit current flow d. Electrogenic ion pump and ionic mechanism in action potentials. **Synaptic transmission**

a. Structure and function of electrical synapse structure and function of chemical synapse, b. Mechanism of Docking, priming and fusion of synaptic vesicles, snare complex, c. Role of MUNC-18 and MUNC-13 in synaptic transmission and limitations of electrical synapses. d. Non synaptic Chemical transmission through varicosities. e. Neurotransmitters (Biogenic amines, neuropeptides and opiates) Synaptic receptors; excitatory f. Postsynaptic potentials. g. Inhibitory postsynaptic potentials. h. Presynaptic inhibitions, afferent collateral inhibition, i. Recurrent inhibition, j. Integration at synapses. k. Facilitation, Posttetanic Potentiation.

**Receptor Physiology:** a. Spinothalamic tract, ascending and descending neural tracts. b. Mechanoreception and hair cell mechanism. c. pain receptors and ascending and descending pathways for pain signal. d. Ultra structure of photo receptors, photochemistry, color vision. e. Structure and physiology of taste receptors and olfactory receptors f. Physiological stress due to diminished receptor activity.



**Hormones:** a. Mechanism of hormone action. b. Steroid hormones and their action. c. Non steroid hormones and their action. d. Role of insect hormones in molting. e. Negative feedback mechanism of hormonal control (Insulin, Glucagon, regulation of blood calcium level) f. Mechanisms of hormonal stress. g. Cyclic AMP as secondary messenger.

**Respiration:** a. Neural and chemical control of respiration. Role of nucleus of tractus solitaries and other nuclei of brain stem in the regulation of respiration.

b. Bohr's effect and Haldane effect c. Oxygen –hemoglobin dissociation curve and factors affecting this curve d. Respiratory responses in extreme conditions as hypoxia. e. Hypercapnia in air breathing divers. f. Anaesthesia and periodic breathing, Shunt pathways and effect of anesthesia on hemodynamics.

**Osmoregulation and Excretion:** a. Osmoregulation in aquatic and terrestrial environment. b. Vertebrate nephron as osmoregulatory organ. c. Physiological anatomy of excretory system. d. Glomerular filtration, Tubular absorption and secretion. e. Nitrogenous waste products. f. Patterns of nitrogenous excretion and their phylogenetic development. g. Renal lesions and glomerular nephritis.

h. Role of kidneys in long term regulation of blood pressure. i. Hypertension and renal lesions.

**Muscle contraction:** a. Structural basis of muscle contraction of skeletal, smooth and cardiac muscle fiber b. Molecular structures of contractile components and their interaction. c. Sarcoplasmic reticulum and voltage sensors in T-tubule.

d. Cross bridge chemistry, sliding filament model and walk long theory.

**Temperature relations:** a. Stages of sleep and mechanism of sleep induction

b. Physiology of torpor and stress level during torpor and hibernation and arousal problems.

**Physiology of Digestion:** a. Movements in GIT. b. Absorption of water and nutrients in GIT. Malabsorption syndrome, Tropical sprue c. Regulation of digestive secretions. d. Neural control of GIT potential.

#### **Text and Reference Books:**

1. Guyton, A.C. and Hall, J.E. 2010: Text book of Medical Physiology, 11th Edition. W.B. Saunders Company, Philadelphia
2. Hill, R.W., Wyse, G.A. and Anderson, M., 2016: Animal Physiology. 4th Ed. Sinauer Associates, Inc. New York
3. John E. Hall., 2015: Guyton and Hall textbook of Medical Physiology. 13th Ed. Elsevier
4. Moyes, C.D. and Schulte, P.M. 2015: Principles of Animal Physiology. 3rd Ed. Pearson New York
5. Randall, D., Burggren, W., French, K. and Fernald, R. Eckert. 2002: Animal Physiology. 5th Edition. W.H. Freeman and Company, New York
6. Widmaier, E., Raff, H. and Strang, K. 2013: Vander's Human Physiology: The Mechanisms of Body Function. 13th Ed. McGraw-Hill Education

**ZOO 907      ADVANCES IN CELL BIOLOGY**

**3 (3+0)**

#### **Course Objectives and Learning Outcomes:**

The objectives of the course are:-

1. To develop an advanced understanding of cell biology.
2. Focusing on the major processes within cells, including: cell signaling, regulation of cell shape, cell division, apoptosis and the functions of the endomembrane system.

3. To learning about how all living organisms develop, survive, evolve and work. Upon successful completion of the course, the student will be able to:

- Explain the main processes that occur within a eukaryotic cell.
- Develop an ability to summarize, integrate and organize information.
- Describe the tools with which cells are studied.
- Describe research problems in other disciplines such as genetics, oncology and in terms of molecular biology.

### **Course Outline:**

**Introduction to Growth Control and Cell Cycle:** a. Mitotic spindle formation and centrosome biology Contractile ring formation and ingression (actin polymerization and/or myosin activation). b. Prokaryotic division (i.e. ftsZ ring formation, mreB in sculpting cell shape). c. Mitotic exit network Plant cell division Cell migration and its regulation. d. Epigenetic mechanisms. e. Cellular polarity (e.g. mechanisms of planar cell polarity, epithelial organization). f. Organelle division (mitochondria or lysosomes). g. Organelle fragmenting during division (ER or golgi). h. Membrane remodeling (changes in curvature during cell rounding/division, secretory 3 events to add new membrane or changes in phospholipid composition). i. Cell Differentiation and development. j. Apoptosis.

**Nucleic Acid and Protein Structure and Function:** a. Chromatin structure Chromatin modifications (changes upon during M phase). b. Regulation of cellular functions by ubiquitination. Selected examples of regulation of cellular function by protein phosphorylation or other post-translational modifications. c. Signal transduction. d. DNA replication/repair.

**Cell Membranes and Cytoskeleton:** a. Cytoskeleton, cell signaling.

b. Compartments and protein sorting. c. Regulation of cell shape and migration.

d. Cell division, apoptosis and autophagy. e. Cell-cell interactions, the secretory pathway. f. Phagocytosis, nuclear import and export.

**Structure and Function of the Eukaryote Cell Nucleus:** a. Regulation of the gene expression to the changes in chromatin associated with the activation and silencing of genes. b. Three-dimensional organization of the nucleus. c. Signal transduction through reversible phosphorylation.

**Introduction to Cancer Cell Biology:** a. Regulation of the cell cycles in normal and cancer cells. b. Control of angiogenesis in cancer. c. Autophagy.

**Biological Transport Mechanisms:** a. The role of ion canals and Ca<sup>2+</sup> signaling in synapse. b. Sensory neurons and the regulation of contraction. c. Exocytosis; lipid second messengers. d. Analysis of structure-function relationships of canals.

e. Molecular biology of the beta cells of the pancreas. f. Protein Sorting and transport. g. Cell Adhesion and motility.

### **Books Recommended:**

1. Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K., Watson, J.D. 2017. Molecular Biology of the Cell. 6th Edition. Garland Publishing Inc., New York.
2. Harvey Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger, Anthony Bretscher, Hidde Ploegh, Angelika Amon, Kelsey C. Martin. 2016. Molecular Cell Biology. W. H. Freeman Publishers, Scientific American Inc.
3. De Robertis, E. D. P. 2017. Cell and Molecular Biology, 8th edition, Lea & Febiger, New York.
4. E. Edward Bittar and Michael Pusch. 2006. Advances in Molecular and Cell Biology. Volume 38

5. 5. K.R. Miller 1987. Advances in Cell Biology, 1st Edition. Elsevier Science.

**ZOO 908      BIOLOGICAL CONTROL OF INSECT PESTS      3(3+0)**

**AIMS AND OBJECTIVES**

To enable the students know about principles and practices of biological control.

**COURSE CONTENTS**

Introduction, concept, history and scope; ecological basis of biological control; natural enemies: predators, parasitoids and insect pathogens (mode of action, application, epizootics); advantages and disadvantages, characteristics of bio-control agents; procedure of biological control: introduction; enhancement of bio control agents (introduction, conservation, mass culture, augmentation, release, monitoring and importation); rearing techniques of bio-control agents and their host insects; role of biological control in IPM. Commercialization of biocontrol agents, Quality management in biological control agent rearing, establishment of biological control system.

**Books Recommended**

1. Barbosa, P. 1998. Conservation Biological Control. Academic Press.
2. Bellows, T.S. Fisher, T.W. Caltagirone, L.E. Dahlsten, D.L. Huffaker, C. and Gardh, G. 1999. Handbook of Biological Control: Principles and Applications of Biological Control. Academic Press, USA.
3. Copping, L.G. 2004. The Manual of Biocontrol Agents. BCPC
4. De Bach, P. and Rosen, D. 1991. Biological Control by Natural Enemies. CUP Archive.
5. Hajek, A. 2003. Natural Enemies: An Introduction to Biological Control. Cambridge University Press
6. Hawkins, B.A. and Cornell, H.V. 1999. Theoretical Approaches to Biological Control. Cambridge University Press
7. Heikki, M.T. Hokkeanen, J. Lynch, M. 1996. Biological Control: Benefits and Risks. Cambridge University Press.
8. Irshad, M. 2008. Biological Control of Insects and Weeds in Pakistan. Higher Education Commission, Islamabad, Pakistan.

**ZOO 909      INSECTS OF ECONOMIC IMPORTANCE**

**AIMS AND OBJECTIVES**

- Provide knowledge about insect vectors, disease borne pests of veterinary and human importance
- Understand their life cycles as they carry viruses and other organisms during transmission of diseases

**COURSE CONTENTS**

General introduction to medical and veterinary entomology: phylum arthropoda, salient features of insects, classification, general morphology and physiology of insects, modifications in mouthparts and

appendages of insects, metamorphosis and its types.

Insects of medical and veterinary importance: mosquitoes, human louse, houseflies, fleas, bugs, mites and ticks: life cycles, diseases and their control. Insect venoms; bees, wasps, ants. Insect toxins, arthropod allergens. Insect pest management: definition, principles and methods of insects control, components of pest management, techniques, general measures to control insects, economics of pest management.

### **Books Recommended**

1. Roy, D. N. and Brown, A.W.A .2004. Entomology. Biotech .Books, New Delhi.
2. Chandler, A.C. and Read, C.P. 1961. Introduction to Parasitology. 10th ed. Wiley Toppan, New York, USA
3. Rozendael, J. A. 1999. Vector ConlJ19l. A I. T. B. S. publishers, New Delhi.
4. Service, M.W. 1996. Medical Entomology. Chapman and Hall, USA
5. Pedigo, L. P. 2003. Entomology and Pest Management. 4th ed. Pearson Education, Singapore, Pvt. Ltd.

## **ZOO 910      INSECTICIDE RESISTANCE AND MANAGEMENT      3(3+0)**

### **AIMS AND OBJECTIVES**

To provide the modern concepts of insecticide resistance in various insect populations.

### **COURSE CONTENTS**

Introduction; development and types of resistance; mechanism of resistance: physiological, behavioural, biochemical and genetic; metabolism of insecticides; detoxification mechanism in insects: phase-I reactions such as oxidation, hydrolysis, reduction and dehydrochlorination; phase-II reaction such as conjugation; multiple pathways, induction of detoxification enzymes; management of resistance; case histories of insecticide resistance management (IRM).

### **BOOKS RECOMMENDED**

1. Denholm, I. 1999. Insecticide Resistance from Mechanism to Management. Prentice Hall. London.
2. Gupta, H.C.L. 1999. Insecticides: Toxicology and Uses. Agrotech Publishing Academy, Udaipur.
3. Onstand, D.W. 2007. Insect Resistance Management. Academic Press.
4. Pedigo, L.P. and Marlin, E. R. 2009. Entomology and Pest Management, 6th Edition, Person Education Inc., Upper Saddle River, New Jersey 07458, U.S.A.
5. Peshin, R. 2009. Evaluation of Insecticide Resistance Management Program: Theory and Practice.
7. Saleem, M. A. 2005. Insecticides Resistance and Management. B.Z. University Press, Multan.
9. Tlo, D. and Webbler, B. 1992. Insecticides Mechanism of Action of Resistance. Intercept Ltd. UK.
11. Watson, D.L. and Brown, A.W. 1997. Pesticide Management and Insecticide Resistance. Academic Press Inc. USA.
12. Wilkinson, C.F. 1976. Insecticides Biochemistry and Physiology. Heyden, London, New York, Rheine.
13. Onstad D. W. 2008. Insect Resistance Management: Biology, Economics, and Prediction. Academic Press, Elsevier Ltd. Jamestown Road, London UK.

**AIMS AND OBJECTIVES**

To provide the modern molecular concepts of Insect Genome System and its applications in Bio-diversity studies.

**COURSE CONTENTS**

Introduction; insect genomes; nucleus, chromosomes, DNA and RNA; Gene structure and function; gene transcription and translation; concept of introns 123 and exons; central dogma of molecular biology; polymerase chain reaction (PCR), gene cloning and sequencing; restriction analysis, gene libraries; DNA for insect species identifications and insect population diversity; DNA for phylogenetic analysis and construction of phylogenies; RAPD, RFLP and PCR-RFLP; linkage and chromosomal mapping, genes regulatory processes, mutagenesis; molecular basis of insect functions (insect behavior, insecticidal resistance), gene knock-ins and knock-outs by RNA interference, DNA and protein sequence alignments and use of bioinformatics tools.

**BOOKS RECOMMENDED**

1. Gilbert, L. 2005. Comprehensive Molecular Insect Science.1-7 Vol.
2. Glick, B.R. and Pasternek, J..J. 1998. Molecular Biotechnology:
3. Principles and Applications of Recombinant DNA.ASM Press. Washington D.C.
4. Hall, B.G. 2007. Phylogenetic Trees Made Easy: A How to Manual. 3<sup>rd</sup> Ed. Sinauer Associates.
5. Handler, A. M. James, A.A. (Eds.).2004. Insect Transgenesis: Methods and Applications, Comprehensive review of insect gene transfer, its methodologies, applications and risk assessment and regulatory issues. CRC Press.
6. Hoy, M.A.2000. Insect Transgenesis: Methods and Application. CRC Press.

**AIMS AND OBJECTIVES**

The course progresses through the key phases of research design and implementation, research questions, data collection and analysis techniques; It will provide formative hands-on opportunities for skills development. It will help to facilitate both conceptual learning and the development of applied research skills.

**COURSE CONTENTS**

Overview of scientific research; improvement through research; nature of scientific inquiry; applications of research; choosing a project; development of a research project; writing a research grant application; writing a research publication; role of students in research; supervisor's role in research; research project design and investigation; deciding on techniques to be employed; analysis of results; data analysis tools; control, samples and replications; reviewing the literature; primary and secondary reference sources; scientific record keeping; use of microorganisms, animals, plants and humans in experimentation; use of pathogens in experiments; conflict of interests; research ethics; ownership of data; writing, presentation and publishing the scientific papers; filing patent application.

**Books Recommended**

1. Bryman A, 2003. Social research methods. Second Edition; Oxford University Press
2. Awan JA, 2003. Scientific Presentation.Unitech Communication, Faisalabad, Pakistan.

3. Kumar R, Kindersely D, 2010. Research Methodology: a step by step guide for beginners. Third Edition; SAGE Publication.
4. Kothari CR, 2004. Research Methodology: Methods and Techniques. Second Revised Edition; New Age International Publishers, New Delhi.
5. Durrani SA, 2004. Technical Writing. Higher Education Commission, Islamabad.

**ZOO 913**

**ADVANCED MOLECULAR BIOLOGY**

**3 (3+0)**

**AIMS AND OBJECTIVES**

- Comprehend in details the cell macro molecules role in cell function
- Know the methods of DNA replication, transcription, protein synthesis and enzymology
- To understand the use of molecular technology in life process.

**COURSE CONTENTS**

Molecular concept of Gene, structure of gene, Types of genes, jumping gens, Control of gene expression in prokaryotes, control of gene expression in eukaryotes, transcription level of gene control, processing level of gene control, translational level control, molecular mechanism of hormonal action, molecular mechanism of cell cycle control, genes involved in mitosis and meiosis cell division, molecular mechanism of muscle contraction. Gene silence mechanism, Cre-loxgene knock out, Crisper 9 gene mechanism, Site directed mutagenesis, RNA interference technique (RNA i). Recombinant DNA Technology, Restriction enzymes, types of restriction enzymes and their mode of action. Cloning vectors, Plasmids as cloning vectors, bacteriophage lambda as cloning vector, Cosmids as cloning vectors and shuttle vectors. Synthesis of cDNA, Cloning in Ecoli, Yeast and in Higher eukaryotes. Methods of transfection, (Ca<sup>++</sup> phosphate co-precipitation method, DEAE-Dextran method, Electroporation, Protoplast fusion. Liposomes as vectors for gene transfer, Direct transformation of mammalian cells; Microinjection. Requirement for gene expression. Expression of mammalian genes in prokaryotic and eukaryotic, Chip technique, microarray technology, DNA finger printing, DNA foot printing, Anti-sense RNA, Tripple helix DNA and chromosomal walking. Applications of recombinant DNA technology.

**BOOKS RECOMMENDED.**

1. Khalid Z. M, Sameena M.L, Rovidha , Saba.R. Advanced Methods in Molecular Biology and Biotechnology, Elsevier Science, 2020 -
2. Lodisch, H., Baltimore, D. Molecular Cell Biology, Scientific American Inc. N.Y 2013.
3. Gildroy S. Advanced Molecular Biology: Volume I, 2015
4. Wilson. K , Hofmann. A, Walker.J.M. Principales and techniques of biochemistry and molecular biology eight edition. Cambridge university press. 2018

**ZOO 914**

**FISH BREEDING AND HATCHERY MANAGEMENT**

**3 (3+0)**

**Course Objectives:**

The objectives of the course are to

1. Enable students to produce quality fish seeds (fry, fingerlings and juveniles)
2. Exchange necessary skills with students in site selection, design, construction and management of fish hatchery
3. Transfer basic knowledge for transportation of fish seeds and control of diseases in fish hatchery
4. Provide students with opportunities to develop fish seeds production skills such as brood stock

management, fertilization and incubation of eggs, larval and fingerlings rearing.

### **Course Learning Outcomes:**

Upon successful completion of the course, the student will be able to:

1. Explain different methods of artificial propagation of fish and its importance
2. Demonstrate various types of fish hatcheries and their management
3. Describe various techniques of rearing fry, fingerlings and juveniles and their management
4. Use of synthetic and non-synthetic hormones to stimulate maturation and ovulation in fertilization and incubation of fish eggs.

### **Course Outline:**

#### **1. Fish Breeding**

- a. Sex identification in fishes, Sexual dimorphism
- b. Reproductive cycle
- c. Courtship and mating
- d. Fecundity and spawning
- e. Natural and Artificial propagation of fishes
- f. Gonad anatomy and reproductive mechanisms
- g. Development of gametes in male and female fish
- h. Hormonal control of reproduction
- i. Spawn quality and quantity indices
- j. Sexual maturity and breeding season of various cultivable species
- k. Fish egg and embryonic development

#### **2. Brood Husbandry:**

- a. Brood availability, transport
- b. Selection of brood stock for rearing
- c. Brood captive rearing and maturation
- d. Nutritional and environmental requirement for brood stock
- e. Nutritional and environmental manipulation for early maturation of brood stock
- f. Brood healthcare and stress management

#### **3. Methods of breeding**

- a. Criteria for selection of mature brood fish for induce spawning
- b. Wet and dry method of breeding
- c. Factors affecting maturation and spawning in fishes
- d. Fish pituitary gland, its structure, collection, preservation and preparation of extract for injection.
- e. Synthetic hormones used for induced breeding of carps
- f. Dosages and methods of injection
- g. Collection, care and hatching of egg
- h. Causes of mortalities of eggs and spawn and their remedies
- i. Improvement of seed quality

#### **4. Fish Hatchery Management**

- a. Criteria for site selection of hatchery and nursery
- b. Types of hatchery
- c. Design and construction of modern hatchery
- d. Operation, management and hatchery technology for seed production of important fish species
- e. Spawn rearing techniques and its nutritional requirements
- f. Monitoring of different water quality parameters in fish hatcheries
- g. Hatchery standards and bio-security
- h. Disease management and their control in fish hatcheries
- i. Better management practices
- j. Use of anesthetics in fish breeding and transport

- k. Seed packaging and transportation methods
- l. Economics of seed production

#### **RECOMMENDED BOOKS:**

1. Gilbert, G., 2019. Aquaculture: Principles and Practices, Syrawood Publishing House, US.
2. Sharma, O. P. 2009. Handbook of Fisheries and Aquaculture. Agrotech Publishing Academy, Udaipur, New Delhi, India
3. Pillay, T.V.R. and Kutty, M.N., 2005, Aquaculture- principles and practices, Blackwell sciences, UK
4. Thomas, P.C. et al, 2003. Breeding and seed production of finfish and shellfish, Daya Publishing House, New Delhi
5. Jhingran VG and Pullin R S V, 1985, Hatchery Manual for the Common, Chinese and Indian major carps, ICLARM

**ZOO 915**

**FISHERIES EXTENSION AND EDUCATION**

3 (3+0)

#### **Course Objectives:**

The objectives of the course are:

1. To familiarize students about fisheries & aquaculture sector and various stakeholders.
2. To impart knowledge on participatory approaches in fisheries extension programmes.
3. Insights into different concepts, principles, recent changes, and emerging challenges in fisheries extension.
4. To acquire skills required to practice various fisheries extension approaches.

#### **Course Learning Outcomes:**

Upon successful completion of the course students will be able to:

1. Express knowledge about fisheries and aquaculture sector and various stakeholders.
2. Describe about participatory approach and onsite training demonstration, discussion with fish farmers and fishermen.
3. Explore ways to increase the awareness of fisheries and aquaculture through extension services.
4. Identify loopholes in communications about the sector with stake holders.
5. Solve problems of appropriate community groups dealing with fisheries and aquaculture.
6. Share practical experience of community based fisheries management and co-management.

#### **Course Outlines:**

1. Overview of fisheries and aquaculture sector in Pakistan and world.
2. Scope and importance of fisheries and aquaculture extension.
3. Special characteristics of fisheries sector and its stakeholders.
4. Introduction to extension education, research, and service.
5. Overview of fisheries research, development, and extension systems in Pakistan.
6. Critical review of philosophy, principles, concepts, and practices of fisheries extension systems and approaches.
7. Teaching, learning and co-learning.
8. Fisheries extension – advantages and limitations of present welfare and subsidy oriented extension systems.
9. Development of extension approaches as practiced by public agencies like Department of Fisheries, NGOs, FAO, and by the private sector.
10. Participatory approaches in fisheries extension for aquatic resources management and development: need, importance and guiding principles.
11. Public-Private and Community Partnership.
12. Social change; social control, social problems and conflicts in fisheries; gender issues in fisheries; theories of learning, learning experience, learning situation.
13. Reviewing national and international case studies on participatory approach in aquaculture research and development.



**RECOMMENDED BOOKS:**

1. Malhotra, S.P. & Sinha, V.R.P., 2007. Indian Fisheries and Aquaculture in a Globalizing Economy. Part II. Narendra Publishing House.
2. Ray, G. L., 2006. Extension, Communication and Management. 6<sup>th</sup> Ed., Kalyani Publication
3. Brown, D., Derek, S. & Simon, F.S., 2005. Mainstreaming Fisheries Co-Management in the Asia-Pacific. Asia-Pacific Fishery Comm. Rep. Publ. 2005/24, FAO, UN Regional Office for Asia and the Pacific, Bangkok.
5. Robert, S.P., 2005. Fisheries Co-Management: A Practical Handbook. CABI.
6. Chandrasekhar C.S. (Ed.). 2004. Privatization of Agricultural Extension in India. MANAGE, Hyderabad.

**ZOO 916      FISH NUTRITION AND FEED TECHNOLOGY      3 (3+0)****Course Objectives:**

The objectives of the course are:

1. To teach about basic concepts of fin fish feed requirements and recent trends in feed formulation and manufacturing.
2. To provide information about nutrient requirements of different commercially important fish species under variable environmental conditions.
3. Enable the students to understand recent trends in fish feed technology for economical fish production/

**Course Learning Outcomes:**

Upon successful completion of the course, the student will be able to:

1. Describe basics of artificial fish feed ingredients and feed requirements of various fin fish species.
2. differentiate between Formulation and manufacturing technology of various types of fish feed (floating and sinking pellets).
3. Explain recent advances in finfish feed preparation and manufacturing technology to increase fish yield with minimum cost.

**Course Outlines:**

1. Introduction to fish nutrition.
2. Digestion and absorption of nutrients.
3. Feeding types and anatomy.
4. Energy, protein, lipids, carbohydrate, mineral and vitamin requirements of fish.
5. Factors affecting nutrient requirements of fish.
6. Energy losses and partitioning in fish.
7. The role of other dietary components viz. water, fiber, hormones, antibiotics, antioxidants, pigments, pellet binders and feeding stimulants.
8. Anti-nutrients and toxins in feed.
9. Forms and size of feed, feeding rates and feeding practices for different fish species.
10. Special purpose feeding.
11. Feed calculations, feed requirements and feed conversion ratios.
12. Feed ration and frequency, judging feeding response of cultured species, methods of feeding.

**RECOMMENDED BOOKS:**

1. Fitzsimmons, K., Janjua, R.S.N. and M. Ashraf, 2015. Aquaculture Handbook—Fish Farming and Nutrition in Pakistan.
2. John Halver. 2013. Fish Nutrition, ELSEVIER.
3. Lovell, T., 2012. Nutrition and Feeding of Fish. 2nd Ed. Springer Science, USA
4. Hopher, B., 2010. Nutrition of Pond Fishes. Cambridge University Press, UK.
5. Halver, J.E., Ronald, W.H. and Daniel, M.H. 2004. Fish Nutrition 4<sup>th</sup> Ed. Academic Press, NY

**ZOO 917      WATER QUALITY AND FISH MANAGEMENT      3(3+0)**

**Course Objectives:**

The objectives of the course are:

- 1- To give an understanding of the importance of water quality management in fisheries and methods of achieving it.
- 2- To equip the students with good knowledge of ecosystem dynamics; nutrient cycles etc.
- 3- To provide information how pollution can affect fish production.
- 4- To enable the students to understand methods of prevention and control of pollution in aquatic environments.

**Course Learning Outcomes:**

Upon successful completion of the course, the student will be able to:

- 1- Describe the importance of water quality management in aquatic bodies.
- 2- Explain the dynamics of ecosystem especially nutrient cycles
- 3- Describe the effect of pollution on fish biology
- 4- Devise strategies of pollution prevention and control in aquatic bodies.

**Course Outlines:**

1. Physical properties of water bodies: Physico-chemical characteristics of water, nutrient cycles and aquatic productivity; sampling methods and analysis.
2. Water sampling and preservation techniques: Determination of DO, light penetration, total alkalinity, pH, hardness and chlorides.
3. Limnology of ponds, streams, lakes, rivers, lagoons, estuaries. Freshwater and marine water quality and methods of water analysis. Water chemistry of ponds in relation to fisheries or aquaculture facility.
4. Effect of water quality on Environment and Fish Communities:
  - a- Effects of metal and industrial contaminants on fish. Eco-toxicology, responses of aquatic species particularly fish to excess nutrients, diseases and chemical stressors.
  - b- Pollution and its effects on aquatic life, ecological characteristics of polluted waters and methods for maintaining and improving water quality (chemical, mechanical, biological).
  - c- Fate, bio-accumulation and bio-magnification of water contaminants, Nutrients, plankton, phytoplankton, zooplankton and algal blooms.

**BOOKS RECOMMENDED**

1. Patrick O. S. and Reaywards, C.S. (2008). The Lakes: Hand Book of Limnology and Lentic Ecology. 3rd Ed. Springer, USA.
2. Heike, B. (2005). Heavy Metals in the Environment: Origin, Interaction and Remediation. Elsevier/Academic Press, London.
3. Wetzel, R.G. (2000) Limnological Analysis. 3rd Ed. Springer, USA.
4. Boyd, C.E. and Graig, T. (1998). Pond Aquaculture, Water Quality Management. Kilmer Academic Publisher.

**ZOO 918      ETIOLOGY OF FISH DISEASE      3(3+0)**

**Course Objectives:**

The objectives of the course are:

- 1- To aware the students of different common fish diseases and their interaction with the immune system.

- 2- To equip the scholars with basic knowledge of various bacterial, viral, fungal and parasitic infections in fish.
- 3- To give practical knowledge about treatment of diseases.

**Course Learning Outcomes:**

Upon successful completion of the course, the student will be able to:

- 1- Differentiate between a healthy and diseased fish.
- 2- Describe the symptoms of different bacterial, viral, fungal and parasitic diseases.
- 3- Explain the methods of treatment of the diseased fish
- 4- Suggest prophylactic measures for prevention of diseases in fish.

**Course outlines**

- 1- Prophylactic measures for disease prevention in fish culture
- 2- Symptoms of a diseased fish.
- 3- General etiology of fish diseases.
- 4- Pathogenic fish diseases and the response of immune system
  - a. Viral diseases
  - b. Bacterial diseases
  - c. Fungal diseases
  - d. Parasitic diseases
- 5- Nonpathogenic fish diseases
  - a- Gas bubble disease
  - b- Thermal stress
  - c- stress due to oxygen deficiency and excessive carbon dioxide
  - d- White spot disease
  - e- Acidosis and alkalosis
  - f- Yolk sac dropsy
  - g- Poisoning, inflammation of stomach and intestine, formation of tumors etc.

**BOOKS RECOMMENDED**

1. Kabir, W. (2005). Handbook on Fish and Crustacean Diseases in the SAARC Region.SAARC Agricultural Information Center.
2. Pandey B.N.(2004). Fish Research.APH Publishing, India.
3. Wedemeyer, G.A., Meyer, F.P. and Smith, L. (1999). Environmental Stress and Fish Diseases. Narendra Publishing House, New Delhi.
4. Schaperclaus, W. (1991). Fish Diseases. Oxonian Press Pvt. Ltd., New Delhi.

**ZOO 919      AQUACULTURE AND FISHERIES ECONOMICS      3(3+0)**

**Course Objectives:**

The objectives of the course are:

- 1- To make the scholars understand that economics is an integral part in aquaculture management.
- 2- To aware the students about the vital role of commercial application of this field.
- 3- To know about the prospects and problems of fish and fisheries business in Pakistan.
- 4- To review the role of capture and culture fisheries in the economy of a country.

**Course Learning Outcomes:**

Upon successful completion of the course, the student will be able to:

- 1- Develop an understanding of the role of economics in aquaculture and fisheries.
- 2- Describe the economics of international and national fish business.
- 3- Evaluate the reasons of meager share of Pakistan in the international business and trade of fish and fisheries products.

- 4- Differentiate between the economic issues of capture and culture fisheries

#### **COURSE OUTLINES**

- 1- The food supply chain (from producers to consumers)
  - a- Harvesting, transportation, storage
  - b- Marketing and equitable distribution; impact of changing environment and climate on equitable distribution of Aquaculture products.
- 2- Fundamentals of Economics and foundation of fish economics.
- 3- Economic issues that arise with wild fisheries and the economic implications of different ways of managing wild fisheries
- 4- Aquaculture
  - a- Reasons of aquaculture (fish farming) development
  - b- Factors that affecting its success, its economic implications, and the policy issues associated with regulating aquaculture.
- 5- Sea food business
  - a- Other industries in the seafood “value chain”: processing, transportation, distribution, retailing and food service, and how they are affected by fisheries management and aquaculture regulation.
  - b- Short-term and the long-term determination of the prices of fish and seafood products.
  - c- what determines relative prices in the seafood value chain, how different factors affect fish prices, and why prices change over time.
  - d- Food certification and quality assurance
- 6- Economic Impact of Fish business
  - a- Marketing and its importance for the fish business, marketing strategies, and new developments in fish marketing
  - b- How the fish business affects the broader economy, and approaches for measuring the economic significance of the fish business?
  - c- Economic benefits and effects of sport fisheries, and issues associated with managing sport fisheries and allocating fish between sport and commercial fisheries.

#### **BOOKS RECOMMENDED**

1. Bjorndal, T., Gordo n, D., Arnason, R. and Sumaila, U. R. (Editors). 2007. Advances in Fisheries Economics 1st Ed. Wiley-Blackwell
2. Grafton, R. Q., Kirkley, J., Kompas, T. and Squires, D. (Editors). 2006. Economics for Fisheries Management. Ashgate Publishing Company, Darlington, USA
3. Ali, S. M. 1996. Marine Fisheries Economics and Development in India. M.D. Publications, New Delhi, India.
4. Anderson, L.G. 1986. The Economics of Fisheries Management (2<sup>nd</sup> Ed.). The Blackburn Press.

**ZOO 920**

**VENOMOUS REPTILES OF THE WORLD**

**3 (3+0)**

#### **Objectives**

1. The course will enable graduates to know about the kinds and species of venomous reptiles
2. Students will get acquainted with the biology and habits of venomous reptiles
3. Representative species of great economic importance will be focused and learnt about
4. Will get knowledge about the distribution of venomous reptiles

### Course outline

**The big fours:** *Daboia russelii*: characters and morphology, habits and habitat, food and feeding, skull structure and characteristics, venom characteristics; *Naja naja*: characters and morphology, habits and habitat, food and feeding, skull structure and characteristics, venom characteristics; *Banagarus caeruleus*: characters and morphology, habits and habitat, food and feeding, skull structure and characteristics, venom characteristics; *Echis carinatus*: characters and morphology, habits and habitat, food and feeding, skull structure and characteristics, venom characteristics

**The African venomous snakes:** black mamba, spitting cobra, boomslang, puff adder, gaboon viper;

**The Australian Venomous snakes:** Eastern brown snake, Western brown snake, Mainland tiger snake, Inland taipan, Coastal taipan, Mulga snake, Lowlands copperhead; **American Venomous snakes:** cottonmouth, copperhead, timber rattle snake, monocle cobra, coral snake; **European venomous snakes:** common European viper; the gila monster, varanid toxins.

### Literature Recommended

1. Minton Jr, S.A. and Minton, M.R. (1971). Venomous reptiles. London. George Allen and Unwin ltd.
2. O'Shea, M. (2005). Venomous snakes of the world. New Holland.
3. Fry, B. (2015). Venomous Reptiles and Their Toxins: Evolution, Pathophysiology and Biodiscovery. Oxford University Press
4. Ernst, G.H. and Ernst, E.M. (2011). JHU Press. enomous Reptiles of the United States, Canada, and Northern Mexico: *Crotalus* [\*Volume 2 of Venomous Reptiles of the United States, Canada, and Northern Mexico\*](#), Evelyn M. Ernst [\*Venomous Reptiles of the United States, Canada, and Northern Mexico: Heloderma, Micruroides, Micrurus, Pelamis, Agkistrodon, Sistrurus\*](#)
5. Fry, B.G. (2015). Venom Doc: The edgiest, darkest and strangest natural history memoir ever. Hachette Australia

ZOO 921

ECONOMIC HERPETOLOGY

3 (3+0)

### OBJECTIVES

1. Enable graduates to know the potential applications of amphibians and reptiles
2. Use amphibians and reptiles as source of economy generation
3. Know the venom use and preparation of antivenin
4. Use amphibians and reptiles as biocontrol agents

### COURSE OUTLINE

**Amphibian husbandry:** frog culture and food business, General amphibian husbandry, assisted reproductive technologies for amphibians, hygiene and disease management, amphibian quarantine

**Amphibians:** model animals for laboratory studies: history and future

**Antimicrobials:** antibiotics from amphibian skins, alkaloid toxins from frog skin: chemical nature and biological role

**Lizards:** potential food sources

**Booids serpentaria:** rearing and management of booid snakes, breeding and reproductive strategies and management, boid pet business.

**Venom Production:** Collection, Handling and rearing of big fours, collection of venom; apparatus and techniques; venom characteristics; venom in pharmaceuticals; antimicrobials from venom; antivenin production; immunology, apparatus and techniques.

### LITERATURE RECOMMENDED

1. Poole, V.A. (2012). Amphibian husbandry. National Aquarium, Baltimore, Shelley Grow, Association of Zoos and Aquariums.

2. Helfrich, L.A., Neves, R.J. and Parkhurst, J. (2009). Commercial frog farming. Virginia Tech., Virginia State University.
3. Klemens, M.W. and Thorbjarnarson, J.B. (1995). Reptiles as food source. *Biodiversity conservation*, 4: 281-298.
4. Sianto, L., Teixeira-Santos, I., and Araujo, A. (2012). Eating lizards: a millenary habit evidenced by palaeoparasitology. *BMC Research Notes*, 5: 586.
5. Reynold, R.G. and Henderson, R.W. (2018). Boas of the world (superfamily Booidae): a checklist with systematic, taxonomic and conservation assessments. *Bulltin of the Museum of Comparative Zoology*. 162 (1): 1-58.
6. WHO. (2016). WHO Guidelines for the production, control and regulation of snake antivenom immunoglobulins.

**ZOO 922**

**VETERINARY VACCINOLOGY**

**3 (3+0)**

The course aims to provide in-depth knowledge of the diseases, its occurrence, significance, etiology, pathogenesis, the available vaccines, the vaccination procedure and its efficacy. The course also aims to highlight the effect the vaccines have on the control and eradication and side effects / short comings of the vaccine if any. The course aims to make the student scholar an advocate of Veterinary Vaccines and their use for farm animals this in turn may result in the better health of the farm animals which in turn will boost the economic benefits of the farmers.

DIVA vaccine; Aujeszky disease. Intranasal vaccines; Infectious bovine rhinotracheitis in cattle, Bovine viral diarrhoea, Foot and mouth disease virus West Nile virus, Blue tongue, Brucellosis, contagious bovine pleuropneumonia, rabies virus in dogs and cats, *Clostridium difficile* and *C. Perfringens* infections in animals, botulism in animals, tetanus in animals, haemorrhagic septicemia in animals, Black quarter, anti-tick vaccine,

#### **REFERENCES AND FURTHER READING**

1. Concise Review of Veterinary Microbiology 2015 Second edition. By P. J. Quinn, B. K. Markey, F. C. Leonard, E. S. Fitzpatrick, S. Fanning Wiley Blackwell.
2. Veterinary Medicine: A Textbook of the Diseases of Cattle, Horses, Sheep, Pigs, and Goats Peter D. Constable, Kenneth W. Hinchcliff, Stanley H. Done, Walter Gruenberg 2016.
3. Veterinary Pharmacology and Therapeutics edited by Jim E. Riviere, Mark G. Papich Wiley Blackwell 2018.
4. Review of medical microbiology and immunology Warren, E. Levinson Peter Chin-Hong, Elizabeth Joyce, Jesse Nussbaum, Brian Schwartz 15<sup>th</sup> Edition 2018. Mc-Graw Hill Education.
5. Pharmacotherapeutics for Veterinary Dispensing edited by Katrina L. Mealey 2019 Willey Blackwell
6. **Journals:** Vaccines, Journal of Vaccine and Vaccination, Journal of Veterinary medical education, Veterinary clinical pathology, Veterinary Immunology and immunopathology, Veterinary science and technology

**AIMS**

The course aims to provide in-depth knowledge of the diseases, its occurrence, significance, etiology, pathogenesis, the available vaccines, the vaccination procedure and its efficacy. The course also aims to highlight the effect the vaccines have on the control and eradication and side effects / shortcomings of the vaccine if any. The course aims to make the student scholar an advocate of poultry Vaccines and their use which in turn may result in the better health and production of poultry.

**COURSE OUTLINE**

**Poultry** Avian coccidiosis, avian infectious bronchitis, avian infectious bursal disease, avian reovirus, chicken anaemia virus, duck virus enteritis, egg drop syndrome, erysipelas, infectious laryngotracheitis, Marek's disease, Newcastle disease, pasteurellosis, post-natal colibacillosis, salmonellosis, swollen head syndrome, turkey haemorrhagic enteritis, ornithobacterium rhinotracheitis, Infectious avian encephalomyelitis, fowl pox

**REFERENCES AND FURTHER READING**

1. Infectious diseases of poultry: Tlr based adjuvants in Vaccines 2014. Shishir Kumar and Sohini deya Gupta Satish serial publishing house.
2. Backyard poultry medicine and surgery second edition 2018. Edited by Cheryl B. Geener, Teresa Y. Morishita published by Wiley Blackwell.
3. Poultry diseases 6<sup>th</sup> Edition 2007. Edited by Mark Pattison, Paul McMullin, Janet Bradbury, Dennis Alexander. Elsevier.
4. Diseases of Poultry 2<sup>nd</sup> edition 1969. P. Seneviratna published by Elsevier.
5. Review of medical microbiology and immunology Warren, E. Levinson Peter Chin-Hong, Elizabeth Joyce, Jesse Nussbaum, Brian Schwartz 15<sup>th</sup> Edition 2018. Mc-Graw Hill Education.

**COURSE OUTLINE**

Fish Vaccines; bacterial vaccines, viral vaccines, vaccination against pancreatic necrosis, vaccination against vibriosis; *Vibrio anguillarum*, *Vibrio salmonicida* and *Vibrio viscosus* or *Moraxella viscosus*. Frunculosis, Photobacteriosis, Enteric septicemia of catfish against diseases caused by flavobacteriaceae species, *Pasteurella* vaccine, Warmwater *Vibrio* spp vaccine, *Aeromonas hydrophila* vaccine, Carp erythrodermatitis / ulcer disease vaccine, ISA virus vaccine, *Streptococcus agalactiae* vaccine, Enteric redmouth (ERM) Vaccine.

**REFERENCES AND FURTHER READING**

1. Fish Vaccinology by Midtlyng, P.J. Brown, F. Gudding, R. Lillehaug, A. published by Karger 1997.
2. Progress in Fish vaccinology by Midtlyng, P.J. Brown published by Karger 2005.
3. Fish Vaccines by Alexandra Adams published by Elsevier 2016.
4. Fish vaccination Roar Gudding, Atle Lillehaug, Oystein Evensen Wiley Blackwell 2014.
5. Fish Vaccination by Vikas Mishra by Delve Publishing LLC 2017.

**Aims, Objectives and Outcome:**

This course is aimed to give the idea about the role of various insect groups in the criminal investigation of various murder cases or suicide cases. A dead body lying in the deserted area, jungle or in an unattended place will give idea about its time of death and time period passed till it is attended. Various groups of insects come over the carcasses and start their life cycle over the decomposing dead body. Hence time estimation can be done for a dead body. So this course would be very useful to students employed in Investigative agencies and Forensic Department.

**COURSE CONTENTS:****Theory:**

Introduction to forensic entomology: entomology and the law: scope and status of FE, stored product entomology cases studies, urban entomology case studies: Insects of forensic importance: the flies (Diptera), the beetles (Coleoptera) Insect applications to medico-legal entomology: human decomposition and insect succession, factors that influence decomposition and succession; Case studies involving: insect succession, measuring insect development, calculating and estimating time of death, factors that influence insect development and PMI estimates; Molecular advances in forensic entomology: Use of DNA in forensic entomology, Research studies involving: COI, COII, CYTB, ITS, Micro-satellites > maggot gut content analyses.

**BOOKS RECOMMENDED:**

1. Charles Semple and Mike Steel (2003), *Phylogenetics*, Oxford University Press, ISBN 9780198509424
  2. Felsenstein J. (2004). *Inferring Phylogenies*. Sinauer Associates: Sunderland, MA. ISBN 0-87893-177-5.
  3. Freeman, Scott (1998). *Evolutionary Analysis*. Prentice Hall. p. 380. ISBN 0135680239.
  4. Mount DM. (2004). *Bioinformatics: Sequence and Genome Analysis* 2nd ed. Cold Spring Harbor Laboratory Press: Cold Spring Harbor, NY.
  5. Schub, R.T. and A. V. Z. Brower. 2009. *Biological Systematics: principles and applications (2nd edn.)* ISBN 978-0-8014-4799-0
- Sneath, P. H. A. & R. R. Sokal. 1973. *Numerical taxonomy - The principles and practice*