DEPARTMENT OF ZOOLOGY

CENTRAL UNIVERSITY OF KERALA

Ph. D. Zoology
Syllabus

Programme Outcome:

1. Students will be acquainted with the research methodologies in biological sciences.
2. They will be equipped to apply these methods to address the research problem with critical thinking and adequate skills.
3. Adequate awareness will be obtained to follow the research ethics.
4. The overall knowledge gained will be helpful to the students to generate a core value of the subject and help them for proper dissemination to the academic and social community.

Programme Specific Outcome:

Two courses in the PhD programmes deal with diverse topics based on the research areas and research proposal of the PhD programme. The major research areas include Taxonomy, Evolution, Ecology, Biodiversity, Animal Behaviour, Genetics, Toxicology, Neurobiology, Physiology, Endocrinology, Developmental Biology, Cell and Molecular Biology, and Aquaculture and Diseases. The scholars will be equipped to pursue innovative research in the area as mentioned earlier and enable them to conduct original research addressing the regional/ National/global challenges on climatic, ecological, toxicological issues and the issues related to Aquaculture and develop a sustainable solution

ANS 601 -RESEARCH METHODOLOGY

Module I- Introduction to Scientific Thinking

Science as a tool for curiosity-driven search for seeking knowledge, Science and Non-science/Pseudo-science,Scientific attitude, Scientific method: Key steps of scientific method, Inductive and Deductive methods,Description, Causality, Prediction, and Explanation.

Unit II- Fundamentals of Research

Hypothesis: Qualities of a good hypothesis, null hypothesis & alternative hypothesis; Testing of hypothesis: Logic & importance;Types of errors - critical region, significance levels; Concept of theory and law, Empiricism,Understanding the language of research concept, construct, definition, variable, research process.Literature review-Primary and secondary sources reviews.

Unit III- Research Design

Experimental design: concept of independent & dependent variables,Significance of verification (proving), corroboration and falsification (disproving), peer reviews; Importance of models, simulations and virtual testing; experimentation in science: design of an experiment, observation, data collection – primary and secondary; parameter and variable - independent and dependent variables, importance of pilot study; necessity of units and dimensions; repeatability, replication and randomization; controls – negative and positive controls.

Unit IV- Data Collection and analysis

Population and sample: sampling - sample size, sampling errors. analysis of data: measures of central tendency – mean, median and mode; measures of dispersion – range, mean deviation and standard deviation; correlation and regression, T-test, Analysis of Variance, Chi-square; introduction and hands-on training in statistical packages Statistica/ SPSS/ EstimateS/ R; measuring biological diversity.

Unit V- Research Ethics, Research Integrity and Research Misconduct

Ethics in science, ethics of research on humans, responsible conduct of research with animals, intellectual property and data ownership, conflict of interest, mentoring, data management&plagiarism.

Unit VI- Laboratory Techniques

Biochemical techniques: pH and buffers, centrifugation, colorimetry and spectrophotometry, estimation of protein, amino acid, nucleic acid, RNA, separation and analytical techniques: electrophoresis and type of electrophoresis, western blotting, chromatography and types of chromatography; PCR, Real-Time PCR, DNA sequencing techniques; museology techniques in tissuing, fixing, preserving and curating invertebrate and vertebrate specimens.

Unit VII- Productivity and data management tools in research

Data documentation, management and processing tools-standalone and online; practical knowledge for the efficient use of Microsoft Office/Adobe Photoshop/Latex; online backup and sharing tools like Dropbox/OneDrive/Google Drive; image processing software ImajeJ (NIH, USA), Fiji (version of ImajeJ) etc.; mapping tool QGIS, Google Earth etc.; reference managers Mendley, Zotero etc.; getting familiar with maps; use of Post-it notes; proper organisation of lab and field data and research materials; knowledge of health and safety rules.

References

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2. Chalmers, A., 2012. *What is this thing called science? New and extended IV th edition.*
3. Chalmers, A.F., 1999. *What is this thing called science? 3rd edition*,
4. Cohen, R.S. et al., 1969. *Kuhn's Structure of Scientific Revolutions—50Years on*.
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6. Dawson. C, 2008. *Pratical research methods: A user-friendly guide to mastering research.*
7. Dunn, W.R. et al., 2003. *Research Methodology; The aims, practices and ethics of science*.
8. Fowler, J., Cohen, L & Jarvis, P., 1998. *Practical statistics for field biology 2nd edition*.
9. Friedland, A. J. & Folt, C. L., 2009. *Writing successful science proposals 2nd edition.*
10. Gauch Jr., H.G., 2003. *ScientificMethod in Practice*.
11. Kosso, P., 2011. *A summary of scientific method*.
12. Kuo, L.C., 2011. *Methods in Enzymology*.
13. Laake, P., Olsen, B.R. & Benestad H. B., 2007. *Research Methodology in the Medical and Biological Sciences*.
14. Singh, Y., K., 2006. *Fundamental of Research Methodology and Statistics*.
15. William, B. and Wade, N., 1982. *Betrayers of the Truth: Fraud and Deceit in Science*.
16. Wilson K and Walker J 2010. Principles and Techniques of Biochemistry and Molecular Biology (Cambridge University Press)
17. https://fiji.sc
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19. http://www.qgis.org
20. https://www.latex-project.org
21. https://www.dropbox.com

ANS 601 – AMPHIBIAN BIOLOGY

Module I- Phylogenetic position

The origin of amphibians and their phylogenetic position among the tetrapods. The major morphological and anatomical modifications in the evolution of extinct and extant amphibian Orders. The evolutionary origin of defining amphibian characters.

Module II-Diversification of amphibians

Theories on the origin of Lissamphibia. Species diversity, biogeography and phylogeography of extant amphibians. Gondwanan origin of South Asian and South East Asian amphibians. Out-of- India hypothesis.

Module III- Order: Anura

General morphology and anatomy. Reproduction and reproductive modes. Physiological ecology- Water balance, Gas exchange, Thermoregulation. Behavioral ecology- vocal communication, social behaviour, defense, foraging and diet.Fossorial anurans and their adaptations.

Module IV- Order: Urodela

General morphology and anatomy. Reproduction and reproductive modes, general physiology and behaviour, habitat.Fossorial and limbless salamanders and their adaptations.

Module V- Oder: Gymnophiona

General morphology and anatomy.Comparison of extant species with fossil species. Overview of organ systems and their evolutionary significance. Reproduction and reproductive modes. Life style and adaptations across families. Behavioral ecology, feeding and parental care.

References

Akiyoshi, H. & Inoue, A.M., 2012. Comparative histological study of hepatic architecture in the three orders amphibian livers. *Comparative Hepatology*, 11, p.1.

Anderson, J.S., 2008. Focal review: The origin(s) of modern amphibians. *Evolutionary Biology 35*, pp. 231-247.

Banavar, J.R. et al., Form, function, and evolution of living organisms. PNAS 111(9), pp. 3332-3337.

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Burggren, W. W. & Warburton, S. J., 1994. Patterns of form and function in developing hearts: contributions from non-mammalian vertebrates. Cardioscience 5(3), pp. 183-191.

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Dodd, C. K. 2009 Amphibian Ecology and Conservation-A Handbook of Techniques.

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Iordansky, N.N., 1990. Evolution of cranial kinesis in lower tetrapods. *Netherlands Journal of Zoology* 40 (1-2), pp. 32-54.

Kühnel, S., Reinhard, S. &Kupfer, A., 2010. Evolutionary reproductive morphology of amphibians: an overview. Bonn zoological Bulletin 57(2).

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Wake, M.H., 2003. Reproductive modes, ontogenies, and the evolution of body form. *Animal Biology*, 53(3), pp.209–223.

Wilkinson, M.,Sherratt, E., Starace, F. & Gower, D. J., 2013. A New Species of Skin-Feeding Caecilian and the First Report of Reproductive Mode in Microcaecilia (Amphibia: Gymnophiona: Siphonopidae). *PLoS ONE8(3)*, pp. 1-11.

ANS 602 – AMPHIBIAN ECOLOGY AND BIOGEOGRAPHY

Module I- Relationship with the environment

Water relations, temperature relations, movements and orientation, burrowing mode of life in limbless amphibians, caecilian habitat diversity, adaptations in cave salamanders.

Module II- Food and feeding

Feeding mechanisms in amphibians, spin feeding in caecilians, food webs in soil ecosystem, invertebrate and vertebrate prey base across habitats, Soil Ecosystem Engineers, prey-predator relationships, circadian rhythm in relation to feeding in amphibians in general and caecilians in particular.

Module III Community Ecology

Species richness and abundance, evolutionary and ecological time, climatic stability and predictability, spatial heterogeneity, historical and recent ecological studies, ecology of amphibian communities

Module IV- Population Ecology

Sympatry, parapatry, allopatry, character displacement, niche modelling, communication and social behavior of amphibians

Module V- Biogeography and phylogeography

General aspects of biogeography, distinguishing between ecological and historical biogeography, ecological determinants of species distribution, biomes and bio geographical realms, historical determinants of species distribution, phylogenetic approach to biogeography, historical biogeography of amphibians , biogeography in the recent past.

References:

1. Duellmn,W. E., & Treub, L. (1994). Biology of amphibians. McGraw-Hill Publishing Company , pp:197-284
2. Levin, S. A. (2009). Princeton guide to ecology. Princeton University Press.
3. Vitt, L. J., & Caldwell, J. P. (2014). Herpetology- An Introductory Biology of Amphibians and Reptiles (4th Ed.). Academic Press publications (Elsevier)
4. Wells, K. D. (2007). The Ecology and behavior of amphibians. The University of Chicago Press.
5. Boitani, L., & Fuller, T. K. (1893). Research Techniques in Animal Ecology. Columbia University Press.
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9. Renema, W. (2007). Biogeography, Time and Place distribution, Barriers & Islands. Springer.
10. Cox, C. B., Moore, P. D., & ladle, J. (2016). Biogeography An Ecological and Evolutionary Approach (9th Ed.). Wiley Blackwell.

ANS 720- CRUSTACEAN BIOLOGY AND AQUACULTURE

Unit I – Introduction

Crustacea classification, comparative morphology, crustacean appendages, larval forms, evolution and paleontology. Biology of Crustacea: General organization of decapod crustaceans, with special emphasis on crabs, prawns and lobsters. Morphology and anatomy of crabs, prawns and lobsters. Feeding and breeding biology of shrimps. Larval development in crabs, prawns and lobsters.

Unit II – Molt physiology of Crustacean

Molting in crustaceans- stages of molting- endocrine systems in crustaceans –Their role- Endocrine control of molting and metamorphosis.

Unit III –Hematopoiesis in Crustacean

Structure of Circulatory system- Crustacean Hemocytes. Crustacean Hematopoietic Tissue (HPT) –cell types in HPT. Crustacean hematopoiesis Molecular regulation of hemocyte synthesis, differentiation and release.

Unit IV –Crustacean immunology

Crustacean immune mechanism overview- Cellular and non-cellular immune components- antimicrobial peptides- (Phagocytosis-Encapsulation-Nodule formation- Cell mediated toxicity-Clotting Factors and wound healing- proPO system- Peroxinectin- etc). Host-Virus interaction

Unit V –Aquaculture and Crustacean fisheries

Introduction to aquaculture- Objectives and scope of aquaculture. Comparative efficiency of aquaculture as a means of protein. Aquaculture systems: Extensive, semi-intensive and intensive culture of fish, Pen and cage culture in lentic and lotic water bodies, polyculture, composite fish culture. Need for aquaculture development Aquaculture – Global Scenario. Status of aquaculture in India.
Crustacean fishery and aquaculture of India: Penaeid and non-penaeid shrimp fisheries. Stock assessment and management options. Lobster fishery. Crab fishery.

ZGY 603 BEHAVIOURAL BIOLOGY OF AMPHIBIANS

Unit 1. Water and Temperature Relations

Structure and function of Amphibian Skin; Evaporative Water Loss; Ecological Correlates of Water Loss; Behavioural Modification of Water Balance; Water Uptake and Storage; Osmoregulation in Aquatic, Acidic and Saline Environments; Kidney Function and Nitrogen Excretion; Effects of Temperature on Physiology and Behavior; Ecological Effects of Temperature; Behavioral Thermoregulation; Thermal Acclimation (Source: Wells, 2007).

Unit 2. Respiration, Metabolism and Energetics

Gas exchange in Embryonic, Larval, and Adult amphibians; Gas Exchange in Air and Water; Accessory Respiratory Structures; Metabolism of Amphibians at Rest; Temporal Changes in Resting Metabolism; Metabolism during Dormancy; Metabolism of Active Amphibians; Energetics of Reproductive Behaviour in Urodeles and Calling Anurans (Source: Wells, 2007).

Unit 3. Movements, Orientation and Vocal Communication

Types of Movements in Amphibians; Local Movements and Home Range; Migrations of Adult Amphibians; Movements of Juveniles; New Habitat Colonisation; Homing Behaviour in Amphibians; Orientation and Navigation; Vocal Communication in Anurans (Source: Wells, 2007). Contest behaviour: weapons, vocal and nonvocal contests in Anurans; territorial contests in salamanders (Source: Dyson et al., 2013)

Unit 4 Mating Systems in Anurans and Parental Care

Mating Behaviour and Modes of Fertilisation; Infraspecific Variation in Egg and Clutch Size; Patterns of parental Care; Parental Care in Anurans, Urodeles and Caecilians; Cost of Parental Care; Ecology and Evolution of Parental Care (Source: Wells, 2007).

Unit 5. Behaviour of Amphibian Larvae and Ecology of Amphibian Communities

Evolution of Amphibian Larvae; Morphology, Development, and Ecology of Anuran, Urodele and Caecilian Larvae; Social Behaviour of Amphibian Larvae; Kin Recognition in Tadpoles; Kin Recognition, Cannibalism, and Aggression in Salamander Larvae; Competition and Predation in Larval Salamander Communities ; The behavioral neuroscience of anuran social signal processing (Source: Wells, 2007).

Unit 6. Amphibians and their Predators

The Predators of Amphibians; Predation by Invertebrates, Amphibians, Reptiles, Birds, and Mammals; Evolutionary Responses to Predation (Source: Wells, 2007).

Source:

1. Andrew R. Blaustein, Bruce Waldman (1992), Kin recognition in anuran amphibians, AnimalBehaviour, Volume 44, Part 2, Pages 207-221, ISSN 0003-3472, https://doi.org/ 10.1016/0003-3472(92)90027-7

2. Bayard H. Brattstrom (1979), Amphibian Temperature Regulation Studies in the Field and Laboratory, *American Zoologist*, Volume 19, Issue 1, Pages 345–356, https://doi.org/10.1093/icb/19.1.345

3. Chivers, D.P., Kiesecker, J.M., Marco, A., DeVito, J., Anderson, M.T., and Blaustein, A.R. (2001), Predator-induced life history changes in amphibians: egg predation induces hatching. Oikos, 92(1):135–142. doi:10.1034/j.1600-0706.2001.920116.x.

4. Christopher R. Tracy, Keith A. Christian, Gregory Betts, C. Richard Tracy, Body temperature and resistance to evaporative water loss in tropical Australian frogs (2006), Comparative Biochemistryand Physiology Part A: Molecular & Integrative Physiology, Volume 150, Issue 2, Pages 102-108, ISSN 1095-6433, https://doi.org/10.1016/j.cbpa.2006.04.031

5. Christopher W. Beck, Mode of fertilization and parental care in anurans (1998), Animal Behaviour,Volume 55, Issue 2, Pages 439-449, ISSN 0003-3472, https://doi.org/10.1006/anbe.1997.0619.

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8. Robert W. Putnam, Albert F. Bennett, Thermal dependence of behavioural performance of anuranamphibians (1981), Animal Behaviour, Volume 29, Issue 2, Pages 502-509, ISSN 0003-3472, https://doi.org/10.1016/S0003-3472(81)80111-X

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10. Theodore L. Taigen, Activity Metabolism of Anuran Amphibians: Implications for the Origin of Endothermy (1983), The American Naturalist 121, no. 1: 94-109. https://doi.org/10.1086/284041

11. U. Sinsch, Movement ecology of amphibians: from individual migratory behaviour to spatiallystructured populations in heterogeneous landscapes (2014),*Canadian Journal of Zoology*, 92:491-502, https://doi.org/10.1139/cjz-2013-0028

12. Vitt, L. J. and Caldwell, J. P. (2014). *Herpetology an introductory biology of*

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13. Wells, K.D.(2007). *The Ecology and Behaviour of Amphibians.* The University of Chicago Press,London.

ZGY 724-Aquaculture diseases

UNIT I

Animal associations- symbiosis, commensalism, phoresis, mutualism, parasitism, intraspecific parasites, parasitoids; parasitism- advantages and limitations

UNIT II

Fish health management- Introduction, Common fish diseases, Epidemiological significance of infectious diseases in Aquaculture

UNIT III

Crustaceans- Classification, comparative morphology, crustacean appendages, larval forms; Parasitic crustaceans in fishes- copepods, branchiura and isopods; life cycle, pathogenesis and clinical signs

UNIT IV

Pathophysiology of fish diseases- General Adaptation Syndrome (GAS), Factors or parameters causing stress, Inflammation in vertebrates, Exudates, Necrosis

UNIT V

Laboratory Techniques
Biochemical Techniques:- pH and buffers; centrifugation; colorimetry and spectrophotometry; estimation of protein, amino acid, nucleic acid
Separation and Analytical Techniques:- Electrophoresis, types of electrophoresis; application of electrophoresis; western blotting; chromatography, types of chromatography.
Cell Culture Techniques:- Cell/Tissue: Basic Concepts; preparation of medium; preparation of serum; primary cell culture; culturing and sub- culturing of animal cells; vital staining and viable counting. Enzymatic Reactions:- PCR; Real- Time PCR; DNA sequencing Techniques.
Mircroscopic mounts-theory of fixation and fixatives, processing of tissues for paraffin sections-theoretical aspects, theory of staining and biological stains; principles of histochemistry

BZY0703- NEUROBIOLOGY AND NEURAL DISEASES

Unit I -The Nervous System

Introduction to the structure and function of the nervous system- Anatomy of Central nervous system- Anatomy of peripheral nervous system- Comparative Neuroanatomy of humans and Drosophila

Unit II -Cellular and molecular biology of the neuron

Neuron- structure and types of neurons- Synthesis and trafficking of neuronal proteins- Ion channels- Membrane potential

Unit III- Signaling in the Nervous system

Local signaling- Passive electrical properties of the neuron- Propagated signaling- The action potential- Synapse- Neurotransmitters- Modulation of synaptic transmission – Synaptic Plasticity- Synaptic plasticity as a cellular model of learning and memory

Unit IV- Developmental Neurobiology

Basic principles of developmental neurobiology- Neural induction, regional specification- Neural stem cell biology- Differentiation- Neurogenesis, gliogenesis- Neural migration, axon growth and guidance- Synaptogenesis and plasticity.

Unit V- Neurological disorders-

Physiological features and causes of Autism, Fragile X- Syndrome, Rett Syndrome, Schizophrenia, Alzheimer's Disease and Parkinson's Disease.

References

1. Cantile, C., & Youssef, S. (2016). Nervous System. Jubb, Kennedy & Palmer's Pathology of Domestic Animals: Volume 1, 250–406. https://doi.org/10.1016/B978-0-7020-5317-7.00004-7
2. Fundamental neuroscience fourth edition, edited by Larry R. Squire VA Medical Center San Diego, California, University of California, San Diego, La Jolla, California Darwin Berg University of California, San Diego, La Jolla, California Floyd E. Bloom The Scripps Research Institute, La Jolla, California Sascha du Lac The Salk Institute, La Jolla, California Anirvan Ghosh University of California, San Diego, La Jolla, California Nicholas C. Spitzer University of California, San Diego, La Jolla, California.
3. Molecular biology of the Neuron (molecular and cellular neurobiology)second edition, edited by R W Davies and B J Morris.
4. Developmental biology by Scott F Gillbert and Michael J F Barresi ,eleventh edition.
5. Neurological disorders public health challenges report by world health organization.

6. Diseases of the brain and nervous system , A Health education guide by Dr. Sudhir V Shah.