Anekant Education Society's

TULJARAM CHATURCHAND COLLEGE OF ARTS, SCIENCE & COMMERCE, BARAMATI, DIST – PUNE. AUTONOMOUS

POST GRADUATE DEPARTMENT OF ZOOLOGY

SYLLABUS
M.Sc. Zoology Part-II, SEMESTER-IV

ACADEMIC YEAR 2020-21

Anekant Education Society's

TULJARAM CHATURCHAND COLLEGE OF ARTS, SCIENCE & COMMERCE, BARAMATI.
AUTONOMOUS

Scheme of Course Structure (CBCS)
Faculty of Science
Post Graduate Department of Zoology
SEMESTER IV

Class: M.Sc. II **Pattern: 40 (IA) + 60 (EA)**

Sr. No.	Code	Paper	Paper Title	Credit	Exam	Marks
1	ZOO: 5401	Theory	Entomology-II Animal Physiology-II Genetics-II	4	I / E	40 + 60
2	ZOO: 5402	Theory	Immunology and Parasitology	4	I / E	40 + 60
3	ZOO: 5403	Theory	Pest Control and Toxicology	4	I / E	40 + 60
4	ZOO: 5404	Theory	Environmental Biology and Animal Systematics & Diversity	4	I / E	40 + 60
5	ZOO: 5405	Zoology Practical-7	Practicals Corresponding to :ZOO:5401, ZOO:5402, ZOO:5403, ZOO:5404	4	I / E	40 + 60
6	ZOO: 5406	Research Project	DISSERTATION (Review of Literature and Summer /Industrial Training)	4	I / E	40 + 60
7	SD-24		Skill Development II	2	-	-

IA* - Internal Assessment

EA*- External Assessment

SYLLABUS (CBCS) FOR M.Sc. ZOOLOGY Sem. IV (w. e. f. June, 2020)

Name of the Program: M.Sc. Zoology

Class: M.Sc. - II **Semester: IV**

Course Name: Entomology-II **Course Code: ZOO: 5401**

Number of Credits: 04 **Number of Lectures: 60**

Course Objectives:-

- Understand the intricate processes of gametogenesis, including spermatogenesis and oogenesis, and comprehend seminal transfer, fertilization, and oviposition in various organisms.
- Explore the early embryonic development of insects, covering cleavage, blastoderm formation, germ band formation, gastrulation, Blastokinesis, differentiation of germ layers, segmentation, appendage formation, and organogenesis.
- Examine the post-embryonic development stages, including eclosion from the egg, and delve into the distinctive developmental phases such as larva, pupa, and nymph, emergence from pupa/cocoon, metamorphosis, and growth in diverse organisms.
- Analyze Hadorn's experiments, focusing on imaginal disc experiments, regeneration, and aging processes, to gain insights into developmental biology and regeneration capabilities.
- Explore the phenomenon of diapause, covering its occurrence, initiation, preparations for diapause, diapause development, and the regulatory mechanisms controlling diapause in different species.
- Develop a comprehensive understanding of insect metamorphosis and growth, including the factors influencing these processes and their significance in the life cycle of insects.
- Apply acquired knowledge to critically evaluate and synthesize information, fostering the ability to draw connections between different aspects of developmental biology and experimental findings, enabling students to analyse and solve problems in the field.

Course Outcomes:-

After completion of this course students will be able to -

CO1: explain and compare the processes of spermatogenesis and oogenesis across various organisms, highlighting the similarities and differences in gametogenesis.

CO2: gain the ability to analyse and describe the key events in insect early embryonic development, including cleavage, blastoderm formation, germ band development, gastrulation, and organogenesis.

CO3: evaluate and compare the post-embryonic development stages in different organisms, understanding the significance of larval, pupal, nymphal, and emergence phases in the life cycles of diverse species.

CO4: develop the skills to interpret experimental findings from Hadorn's experiments, particularly those involving imaginal discs, regeneration, and aging, and apply this understanding to broader concepts in developmental biology.

CO5: capable of analysing the occurrence, initiation, and developmental processes of diapause, demonstrating an understanding of the ecological and physiological factors influencing diapause in various organisms.

CO6: synthesize knowledge of insect metamorphosis and growth, discerning the molecular, cellular, and environmental factors influencing these processes and recognizing their evolutionary significance.

CO7: develop critical thinking skills by applying acquired knowledge to evaluate and solve problems related to developmental biology, fostering an ability to make connections between different aspects of the syllabus and apply this understanding to novel scenarios.

TOPICS:

Topic No.	TOPICS / CONTENTS	Lectures
1.	**Gametogenesis:** Spermatogenesis, Oogenesis, Seminal transfer, Fertilization and Oviposition.	08 L

2.	**Insect early embryonic development:** Cleavage and Blastoderm formation, Germ band, Gastrulation, Blastokinesis, differentiation of germ layers, Segmentation, Appendages formation and organogenesis in brief.	**21 L**
3.	**The post embryonic development:** Eclosion from the egg. The developmental stages: larva, Pupa, Nymph, Emergence from the pupa/cocoon. Metamorphosis and Growth.	**20 L**
4.	**Hadorn's experiments:** Experiments with imaginal disc, Regeneration and Aging.	**06 L**
5.	**Diapause:** Occurrence, Initiation and Preparations for diapauses, Diapause development and Controls.	**05 L**

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1. Richards, O. W., & Davies, R. G. (2013). Imms' general textbook of Entomology: Volume I: Classification and biology. Springer Science & Business Media.
2. Snodgrass, R. E. (2018). Principles of insect morphology. Cornell University Press.
3. Fox, R. M., & Fox, J. W. (1964). Introduction to comparative entomology. Introduction to comparative entomology.
4. Nayar, K. K., Ananthakrishnan, T. N., & David, B. V. (1976). General and applied entomology.
5. Ross, H. H. (1948). A textbook of entomology. A Textbook of Entomology.
6. Chapman, R. F., & Chapman, R. F. (1998). The insects: structure and function. Cambridge university press.
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8. Gullan, P. J., & Cranston, P. S. (2014). The insects: an outline of entomology. John Wiley & Sons.
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Course Articulation Matrix of ZOO: 5401: Entomology II

Weightage: 1: Partially related, 2: Moderately related, 3: Strongly related

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	2	1	1	1	1	1	1	1
CO2	2	2	1	2	1	1	1	1	1
CO3	2	2	1	1	2	1	1	1	1
CO4	2	3	1	2	1	1	2	1	1
CO5	2	2	1	2	1	1	1	2	1
CO6	3	2	1	1	2	1	1	2	2
CO7	1	3	1	1	1	1	2	1	1

PO1: Disciplinary Knowledge

All course outcomes involve fundamental principles and concepts in developmental biology. Understanding processes like gametogenesis, embryonic development, and post-embryonic stages requires a strong foundation in the discipline.

PO2: Critical Thinking and Problem Solving

Analytical skills are essential: CO2 involves the analysis of complex events in insect embryonic development, requiring critical thinking. CO4 explicitly focuses on interpreting experimental findings, which demands critical thinking skills. Additionally, CO7 emphasizes the application of acquired knowledge to evaluate and solve problems, aligning with critical thinking and problem-solving skills.

PO3: Social Competence
Limited social aspects in developmental biology: Developmental biology primarily focuses on biological processes, and the course outcomes (COs) are more centered on understanding biological phenomena than social interactions. Therefore, the mapping with social competence is relatively low.

PO4: Research-related skills and Scientific temper
Scientific inquiry is inherent: CO4 involves interpreting experimental findings, which is a key aspect of scientific inquiry. Additionally, CO2 and CO3 require evaluation and comparison, reflecting research-related skills and contributing to the development of a scientific temper.

PO5: Trans-disciplinary knowledge
Broad connections to biological concepts: CO2 (Insect embryonic development) and CO6 (Synthesis of knowledge in insect metamorphosis) have connections to broader biological concepts. These outcomes involve understanding the integration of molecular, cellular, and environmental factors, contributing to a trans-disciplinary perspective.

PO6: Personal and professional competence
Development of critical thinking: CO7 explicitly focuses on developing critical thinking skills. This outcome contributes to personal and professional competence, as critical thinking is a valuable skill in various professional and personal contexts.

PO7: Effective Citizenship and Ethics
Implicit ethical considerations: While not explicitly stated in the COs, the study of developmental biology inherently involves ethical considerations, especially when interpreting experimental findings and understanding the ecological and physiological factors in CO4 and CO5.

PO8: Environment and Sustainability
Implicit environmental considerations: CO5 (Diapause) involves understanding ecological and physiological factors. While not explicitly stated, this includes implicit considerations for the environment, aligning with the broader outcome of environmental and sustainability awareness.

PO9: Self-directed and Life-long learning
PO9 is implicitly addressed in all COs as students are encouraged to apply acquired knowledge, critical thinking skills, and disciplinary knowledge to novel scenarios. This approach fosters a mind-set of self-directed learning and continuous exploration within the field of developmental biology.

SYLLABUS (CBCS) FOR M.Sc. ZOOLOGY Sem. IV

Name of the Program: M.Sc. Zoology

Class: M.Sc. - II **Semester: IV**

Course Name: Animal Physiology-II **Course Code: ZOO: 5401**

Number of Credits: 04 **Number of Lectures: 60**

Course Objectives:-

- To gain knowledge of nutrition, including the classification of nutrients, Colorimetry, basal metabolic rate (BMR), and the general mechanism of digestion. This objective encompasses an understanding of autonomous smooth muscle function, intrinsic nerve flexes, extrinsic nerve control, and the role of gastrointestinal hormones in digestion.
- To achieve proficiency in the anatomy of the respiratory system, internal and external respiration, pulmonary respiration, gas exchange across capillaries, and gas transport. This objective also includes an in-depth examination of the neuronal control of respiration, the role of central and peripheral receptors, and other functions of the respiratory system.
- To acquire a detailed understanding of blood composition and function, haematopoiesis, blood clotting, and molecular mechanisms involved. Additionally, they will explore the types of blood vessels, their roles in blood pressure regulation, and the implications of hypertension and hypotension.
- To gain a comprehensive understanding of the anatomy of the heart, the electrical activity of the heart, electrocardiography, events of the cardiac cycle, and the neuronal and hormonal control of the heart. This objective also covers cardiovascular responses to exercise.
- To achieve proficiency in understanding nerve cell structure and function, the excitation and conduction of nerve fibers, the ionic basis of excitation and conduction, neurotransmitter types and receptors, synapse function, neuronal integration, and the impact of drugs and diseases on synaptic transmission.
- Master the structure of skeletal muscles, the molecular basis of skeletal muscle contraction, types of contraction, twitch summation, tetanus, and the relationship between muscle length and tension. Additionally, they will gain insight into pathways of ATP formation during contraction, skeletal muscle fiber types, and the contractile machinery of smooth muscle.
- To integrate concepts from nutrition, digestion, respiration, blood and blood vessels, cardiac physiology, neuronal physiology, and muscle physiology. This objective involves synthesizing knowledge to understand the interconnectedness of physiological processes and their relevance to overall human health and function.

Course Outcomes:-

After completion of this course, students will-

CO1: explain the principles of nutrition, including the classification of nutrients, calorimetry, and basal metabolic rate (BMR). They should demonstrate a comprehensive understanding of the components of the digestive system and the mechanisms involved in digestion, including the roles of autonomous smooth muscle function, intrinsic nerve reflexes, extrinsic nerves, and gastrointestinal hormones.

CO2: analyze and describe the anatomy of the respiratory system and the processes of internal and external respiration. They should demonstrate knowledge of pulmonary respiration, gas exchange, and gas transport, including oxygen and carbon dioxide transport. Additionally, students will explore the neuronal control of respiration and the diverse functions of the respiratory system.

CO3: evaluate the composition and functions of blood, including hematopoiesis and blood clotting. They should understand the structure and functions of various blood vessels, the regulation of blood pressure, and the implications of conditions such as hypertension and hypotension.

CO4: develop an understanding of cardiac anatomy, electrical activity, electrocardiography, events in the cardiac cycle, and the neuronal and hormonal control of the heart. They will also comprehend the cardiovascular responses to exercise.

CO5: master the structure and function of nerve cells, the excitation and conduction of nerve fibers, and the ionic basis of excitation. They should understand neurotransmitter types, receptors, synaptic transmission, neuronal integration, and the impact of drugs and diseases on synaptic function.

CO6: achieve proficiency in understanding the structure of skeletal muscles, the molecular basis of skeletal muscle contraction, different types of contraction, and the physiology of skeletal and smooth muscles. They should also comprehend pathways of ATP formation during contraction and the relationship between muscle length and tension.

CO7: integrate concepts from nutrition, digestion, respiration, blood physiology, cardiac physiology, neuronal physiology, and muscle physiology. They should be able to apply this integrated knowledge to analyze and solve complex physiological problems and understand the holistic functioning of the human body.

TOPICS:

Topic No.	TOPICS / CONTENTS	Lectures
1.	**Nutrition and digestion**a) Nutritionb) Nutrients and Nutritive types c) Calorimetry and BMR d) Digestion e) Components of digestive system f) General mechanism of digestion; Autonomous smooth muscle function, intrinsic nerve flexes, extrinsicnerve and gastrointestinal hormones	**10 L**
2.	**Respiration**a) Internal and external respiration ; Anatomy of respiratory systemb) Pulmonary respiration: Partial pressure, inspiration and expiration, Lung volume and capacities c) Gas exchange across the pulmonary and systemic capillaries d) Gas transport; O2 transport, CO2 transport and abnormalities in the blood gas content e) Neuronal control of respiration, role of central and peripheral receptors f) Other functions of respiratory system	**11 L**
3.	**Blood and blood vessels**a)Blood composition and function, Haematopoiesisb) Blood clotting and it's molecular mechanism c) Blood vessels and blood pressure: Blood vessel types, Arteries, role as pressure reservoir andarterial pressure: Aeteriole: role in distribution in cardiac output and maintenance of arterialblood pressure, Capillaries and its functions, veins: its role as blood reservoir and venous return d) Blood pressure-Hypertension and Hypotension	**09 L**
4.	**Cardiac Physiology**a) Anatomy of heartb) Electrical activity of the heart pace makers, spread of cardial coupling, action potential of cardiac cells c) Electrocardiography d) Mechanism events of cardiac cycle, Heart sound e) Neuronal and Hormonal control of heart f) Cardiovascular response of exercise	**10 L**
5.	**Neuronal Physiology**a) Nerve cells : Structure & Functionb) Excitation and conduction of nerve fiber: Resting membrane potential, Action potential, all or none law, electronic potential, saltatory conduction c) Ionic basis of excitation and conduction d) Neurotransmitter types and receptors: Metabolism of neurotransmitters, Neuropeptides e) Synapse and Neuronal integration f) impact of drugs and disease on synaptic transmission	**08 L**
6.	**Muscle Physiology**a) Structure of skeletal muscle and molecular basis of skeletal muscle contraction, types of contraction, twitch summation and tetanus, relation between muscle length and tension, velocity of contractionb) Pathways of ATP formation during contraction	**05 L**

	c) Skeletal muscle fiber types, contractile machinery of smooth muscle	
7.	**Sensory Physiology**a) Receptor types, receptor potential and receptor adaptation b) Eye-structure and physiology of vision c) Ear-Hearing and equilibrium, sound waves and it's characters, structure of ear and physiology of hearing and equilibrium d) Chemical senses : Taste and smell	**07 L**

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5. Schmidt-Nielsen,. Animal Physiology: Adaptation and Environment. Cambridge.
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Course Articulation Matrix of ZOO: 5401: Animal Physiology-II

Weightage: 1: Partially related, 2: Moderately related, 3: Strongly related

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	2	1	1	2	1	1	1	1
CO2	2	2	1	1	1	1	1	1	1
CO3	2	2	1	1	1	1	1	1	1
CO4	2	2	1	1	1	1	1	1	1
CO5	3	2	1	1	2	1	1	1	1
CO6	2	2	1	1	1	1	1	1	1
CO7	3	3	1	1	3	1	1	1	2

PO1 (Disciplinary Knowledge):
All COs address various aspects of human physiology, demonstrating an understanding of complex biological systems. CO7 further strengthens this PO by requiring integration of knowledge across different physiological systems.

PO2 (Critical Thinking & Problem Solving):
CO1, CO5, and CO7 encourage analyzing mechanisms, applying knowledge to solve problems, and integrating information from different fields, highlighting strong contributions to this PO.

PO3 (Social Competence):
While not explicitly addressed in any COs, incorporating group projects, peer-to-peer learning, or communication-based assessments could strengthen this PO.

PO4 (Research Skills & Scientific Temper):
Research skills are implicitly required for understanding complex physiological processes and mechanisms presented in all COs. Explicit research projects or literature reviews could further strengthen this PO.

PO5 (Trans-disciplinary Knowledge):
CO1, CO5, and CO7 explicitly bridge different disciplines like nutrition, biology, and chemistry, demonstrating strong engagement with this PO.

PO6 (Personal & Professional Competence):
Similar to PO3, this PO isn't directly assessed. Encouraging self-reflection, time management skills, or career exploration activities could enhance its connection to the COs.

PO7 (Effective Citizenship & Ethics):
CO5 has potential for exploring ethical considerations in neuroscience, but requires further development to fully address this PO.

PO8 (Environment & Sustainability):
This PO currently lacks a clear connection to the provided COs. Integrating examples or discussions about environmental factors influencing human physiology could strengthen its presence.

PO9 (Self-directed & Lifelong Learning):
CO7 indirectly encourages lifelong learning through critical thinking and applying knowledge to novel situations. Encouraging students to take ownership of their learning and developing independent research skills could further strengthen this PO.

SYLLABUS (CBCS) FOR M.Sc. ZOOLOGY Sem. IV

Name of the Program: M.Sc. Zoology

Class: M.Sc. - II **Semester: IV**

Course Name: Genetics-II **Course Code: ZOO: 5401**

Number of Credits: 04 **Number of Lectures: 60**

Course Objectives:

- Develop proficiency in solving numerical problems related to Mendelian and non-Mendelian genetics, including probability estimation, to ensure a solid foundation in genetic problem-solving skills.
- Gain a comprehensive understanding of basic human genetics, covering the history of human genetics, pedigree construction, autosomal inheritance, and the presentation of molecular genetic data in pedigrees. Explore and analyze complications to basic pedigree patterns such as non-penetrance, variable expressivity, and genomic imprinting.
- Apply knowledge of clinical genetics to identify and understand various genetic disorders, including monogenic diseases, triplet repeat-based disorders, inborn metabolic errors, disorders of hematopoietic systems, and prenatal and pre-implantation diagnosis.
- Develop proficiency in low-resolution mapping techniques such as cell hybrids, radiation hybrid mapping, synteny homology, restriction maps, clone contig maps, STS maps, EST maps, and DNA sequence maps.
- Explore the genetic basis of antibody diversity, regeneration of TCR diversity, and the relationship between HLA polymorphism and disease associations in immunogenetics.
- Understand fundamental concepts in oncogenetics, including the role of oncogenes and tumor suppressor genes, as well as the application of cytogenetic studies in understanding genetic factors in cancer.
- Analyze behavioral genetics principles, including experiments on the genetics of bee behavior, the interplay between nature and nurture in behavior, methods to identify genes controlling behavior, and the genetic basis of human behavioral defects like schizophrenia.

Course Outcomes:

After completion of this course, students will-

CO1: students will demonstrate proficiency in solving numerical problems related to Mendelian and non-Mendelian genetics, including probability estimation.

CO2: have a comprehensive understanding of basic human genetics, encompassing the history of human genetics, pedigree construction, autosomal inheritance (dominant and recessive), and the presentation of molecular genetic data in pedigrees.

CO3: apply their knowledge of clinical genetics to identify and understand various genetic disorders, including monogenic diseases, triplet repeat-based disorders, inborn metabolic errors, disorders of hematopoietic systems, and prenatal and pre-implantation diagnosis.

CO4: develop proficiency in low-resolution mapping techniques, including cell hybrids, radiation hybrid mapping, synteny homology, restriction maps, clone contig maps, STS maps, EST maps, and DNA sequence maps.

CO5: understand the genetic basis of antibody diversity, the regeneration of TCR diversity, and the relationship between HLA polymorphism and disease associations in immunogenetics.

CO6: apply their understanding of oncogenetics concepts, including the role of oncogenes and tumor suppressor genes, and demonstrate knowledge of cytogenetic studies in understanding genetic factors in cancer.

CO7: critically analyze behavioural genetics principles, including experiments on the genetics of bee behaviour, the interplay between nature and nurture in behaviour, methods to identify genes controlling behaviour, and the genetic basis of human behavioural defects.

TOPICS:

Topic No.	TOPICS / CONTENTS	Lectures
1.	**Solving problems (Numerical Probability estimation) of Mendelian and non Mendelian genetics.**	**03 L**
2.	**Basic Human Genetics:**2.1. History of Human Genetics 2.2. Pedigree- Gathering Family history, pedigree symbols, construction of pedigrees, Autosomal inheritance- Dominant & Recessive, Monogenic traits (Sex Linked inheritance, Sex Limited & Sex-influenced traits, mitochondrial traits), MIM number. 2.3. Presentation of molecular genetic data in pedigrees 2.4. Complications to the basic pedigree patterns- non penetrance, variable expressivity, pleiotropy, late onset, dominance problems, genetic heterogeneity, genomic imprinting & uniparental disomy, spontaneous mutations, mosaicism & chimerism, male lethality, X- inactivation. 2.5. Parametric and non- parametric analysis, identifying recombinants & non recombinants in pedigree, two- point mapping- LOD score analysis, genetic & physical map distances, genetic markers.	**18 L**
3.	**Clinical Genetics:**3.1.0**. Monogenic diseases** 3.1.1 Cystic Fibrosis 3.1.2 Tay-Sachs syndrome 3.1.3 Marphan syndrome3.2.0**. Triplet repeat based disorders** 3.3.0**. Inborn metabolic errors-** 3.3.1. Disorders of carbohydrate metabolism 33.3.2. Disorders of nucleic acid metabolism 3.3.3. Disorders of lipid metabolism 3.3.4. Lysosomal storage disorders 3.3.5. Peroxisomal disorders 3.4.0. **Disorders of Hematopoietic systems-** 3.4.1. Over view of blood cell types & haemoglobin 3.4.2. Sickle cell anemia 3.4.3. Thalassemias 3.4.4. Hemophilia's 3.5.0. **Prenatal and pre-implantation diagnosis** 3.5.1. Indications for prenatal diagnosis 3.5.2. Indications for chromosomal testing 3.5.3. Non- invasive methods 3.5.4. Invasive methods	**16 L**
4.	**Physical mapping methods:** 4.1. Low resolution mapping- cell hybrids, radiation hybrid mapping, synteny homology. 4.2. Restriction maps, clone contig maps, STS map, EST map, DNA sequence map.	**03 L**
5.	**Immunogenetics:**5.1. Genetic basis of antibody diversity. 5.2. Regeneration of TCR diversity. 5.3. HLA polymorphism and disease association.	**03 L**
6.	**Oncogenetics:**6.1. Concepts of oncogenes and tumor suppressor genes. 6.2. Role of oncogenes. 6.3. Cytogenetic studies.	**03 L**
7.	**Behavioural Genetics:**7.1.0. **Rothen Buhler's experiment on genetics of Bee behavior** (hygienic and unhygienic Trait). 7.2.0. **Nature- nurture and behavior**- 7.2.1.0. Genetics experiments to investigate animal behavior 7.2.1.1. Selection studies. 7.2.1.2. Inbred strain studies. 7.3.0. **Identifying genes for controlling behavior** 7.3.1. Induced mutations 7.3.2. Quantitative trait loci. 7.3.3. Synteny orthology 7.4.0. **Twin and adoption study designs.** 7.5.0. **Environmental influence- shared and non- shared environment.** 7.6.0. **Genetics of human behavioural defects- Schizophrenia.**	**05 L**
8.	**Neurogenetics:**8.1 Circadian rhythms, learning and memory mutants in Drosophila. 8.2 Psychopathology- Alzheimer's disease	**03 L**
9.	**Drosophila genetics:**9.1. History of Drosophila genetics.9.2. Genetic basis of Sex determination and dosage compensation in *Drosophila.* 9.3. Genetic Regulation of Drosophila early embryonic development and pattern formation: Maternal genes and formation of body axis, Segmentation genes, Homeotic gene functions, Regulation of Hox- gene expression.	**06 L**

REFERENCES

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5. Genetics: Analysis of Genes and Genomes, D.L. Hartl, E .W Jones, Jones and Barlett Publ. 2009.
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Course Articulation Matrix of ZOO: 5401 : Genetics-II
Weightage: 1: Partially related, 2: Moderately related, 3: Strongly related

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	2	1	1	1	1	1	1	1
CO2	2	1	1	2	1	1	1	1	1
CO3	2	1	1	2	1	1	1	1	1
CO4	2	1	1	2	1	1	1	1	1
CO5	3	2	1	1	2	1	1	1	1
CO6	2	1	1	2	1	1	1	1	1
CO7	3	3	1	1	3	1	2	1	2

PO1 (Disciplinary Knowledge):
All COs address various aspects of genetics, requiring an understanding of complex biological concepts and mechanisms. CO1 and CO5 further strengthen this PO by requiring problem-solving and applying knowledge to diverse areas like immunology and neurogenetics.

PO2 (Critical Thinking & Problem Solving):
CO1, CO5, and CO7 encourage analyzing complex genetic data, interpreting research findings, and applying knowledge to novel situations. This demonstrates strong development of critical thinking skills across various subfields of genetics.

PO3 (Social Competence):
While not explicitly addressed in any COs, incorporating group projects, presentations on ethical dilemmas in genetics, or discussions on social implications of genetic research could strengthen this PO.

PO4 (Research Skills & Scientific Temper):
Research skills are required for understanding various genetic concepts and data presented in all COs. Explicit research projects, literature reviews, or critical analysis of scientific papers could further strengthen this PO.

PO5 (Trans-disciplinary Knowledge):
CO5 and CO7 clearly bridge genetics with other disciplines like immunology and neuroscience, showcasing strong engagement with this PO.

PO6 (Personal & Professional Competence):

Similar to PO3, this PO isn't directly assessed. Encouraging self-reflection on career paths in genetics, time management skills for research projects, or ethical considerations in professional practice could enhance its connection to the COs.

PO7 (Effective Citizenship & Ethics):
CO7 has potential for exploring ethical considerations in genetic testing, gene therapy, or disease screening. However, this aspect needs further development through explicit assignments, case studies, or discussions on ethical frameworks in genetics research and applications.

PO8 (Environment & Sustainability):
This PO currently lacks a clear connection to the provided COs. Integrating examples or discussions about environmental factors influencing genetic mutations, disease susceptibility, or potential applications of genetics in environmental research could strengthen its presence.

PO9 (Self-directed & Lifelong Learning):
CO7 indirectly encourages lifelong learning through critical thinking and applying knowledge to novel topics in behavioral and neurogenetics. However, explicitly encouraging students to take ownership of their learning, developing independent research skills, and reflecting on the evolving nature of genetics knowledge could further strengthen this PO.

SYLLABUS (CBCS) FOR M.Sc. ZOOLOGY Sem. IV

Name of the Program: M.Sc. Zoology

Class: M.Sc. - II **Semester: IV**

Course Name: Immunology and Parasitology **Course Code: ZOO: 5402**

Number of Credits: 04 **Number of Lectures: 60**

Course Objectives:

- Acquire a foundational understanding of immunology, including the concepts of immunity (self-non-self, antigen, antibody, immune response, immunological tolerance, autoimmune disease) and active and passive immunization. Additionally, students will grasp the organization of primary and secondary lymphoid organs, tissues, cells, and molecules of the human immune system.
- Distinguish between humoral immunity and cell-mediated immunity, and comprehend the structure and function of T cell receptors.
- Analyze the immediate responses to infection, including inflammation, cell migration, acute phase response, interferons, and natural killer (NK) cell activities.
- Understand the structure of antibodies, antibody classes, subclasses, and the relationship between structure and function. The objective includes exploring iso, idio, and allo types, as well as theories of antibody synthesis and the molecular basis of generating antibody diversity.
- Understand the processes of antigen-antibody reactions, complement fixation pathways, and the immunogenetics associated with HLA, disease associations, immune deficiencies, and disorders. This objective includes an exploration of antigen processing and major histocompatibility complex (MHC).
- Master immunological techniques, including the hybridoma principle and its application, ELISA, immunofluorescence, immunoelectrophoresis, RIA (Radioimmunoassay), and the production and application of monoclonal and polyclonal antibodies.
- Comprehend the concepts of immunological memory and vaccination, exploring the mechanisms by which the immune system retains memory of previous encounters with antigens and the applications of vaccination in disease prevention.

Course Outcomes:

After completion of this course students will-

CO1: demonstrate a comprehensive understanding of key immunological concepts, including the principles of immunity, self-non-self-recognition, antigen-antibody interactions, and the organization of primary and secondary lymphoid organs.

CO2: distinguish between humoral and cell-mediated immunity and describe the structure and function of T cell receptors.

CO3: analyze the immediate responses to infection, including inflammation, cell migration, acute phase response, interferons, and the activities of natural killer (NK) cells.

CO4: explain the structure of antibodies, antibody classes, subclasses, and the relationship between structure and function. They will also comprehend the theories of antibody synthesis and the molecular basis of generating antibody diversity.

CO5: explore and understand the processes of antigen-antibody interactions, complement fixation pathways, and the immunogenetics associated with HLA, disease associations, immune deficiencies, and disorders. They will also grasp the mechanisms of antigen processing and major histocompatibility complex (MHC).

CO6: master various immunological techniques, including the hybridoma principle and its application, ELISA, immunofluorescence, immunoelectrophoresis, RIA (Radioimmunoassay), and the production and application of monoclonal and polyclonal antibodies.

CO7: comprehend the concepts of immunological memory and vaccination, including the mechanisms underlying the retention of immune memory and the applications of vaccination in disease prevention.

TOPICS:

Topic No.	TOPICS / CONTENTS	Lectures
1.	**Immune System:** a) Introduction to Immunology b) Concept of immunity (self – non self, antigen, antibody, immune response, immunological tolerance, autoimmune disease) and active and passive immunization, c) Primary and Secondary lymphoid organ. Tissue, cells and molecules of the human immune system.	**03 L**
2.	**Humoral immunity, and cell mediated immunity**, T cell receptors.	**02 L**
3.	**Immediate response to infection:** Inflammation, cell migration, acute phase response interferons and NK cell.	**03 L**
4.	**Antibody structure**, antibody classes, subclasses, structure- function relationship, iso, idio and allo types	**04 L**
5.	**Theories of antibody synthesis**, generation of antibody diversity (molecular basis), Antibody class switching	**03 L**
6.	**Antigen antibody reaction** and complement fixation pathways.	**02 L**
7.	**Immunogenetics:** HLA and Disease association, immune deficiencies and disorders. Antigen processing and MHC	**05 L**
8.	**Hybridoma principle and application**, ELISA, Immunofluorescence, Immunoelectrophoresis, RIA and Monoclonal & Polyclonal Antibody and its application.	**05 L**
9.	**Immunological Memory and Vaccination**	**03 L**
10.	**Host-Parasite systems:**10.1. Preadaptation to infectiousness, Myasis: Classification according to tissue,vectors specific, sub specific, accidental; clinical presentation humans, syndrome, symptoms, diagnostic, control method prevention, treatment.; Transmission: Types, categories: A. Conspecific: Contact, Transplacental, Transovarian, B. Heterospecific: Mechanical (Indirect & Direct), Biological, Paratenic, Hyper parasitic, Parasitoidal.10.2. Manipulation of Host behavior, Parasitism & Altruism, parasites & social behavior of hosts, parasitism & life history, parasitic effects benefiting the host.	**07 L**
11.	**Type study:**Classification geographical distribution, morphology, life-cycle, transmission, pathogenicity, treatment and prophylaxis of:11.1 Protozoa: *Trypanosoma* sps. , *Leishmania* sps.11.2 Platyhelminthes: *Schistosoma s*ps., *Echinococcus* sps.11.3 Nematoda: *Ancylostoma* sps., *Dracunculus* sps.	**08 L**
12.	**Genetics & Molecular Biology:**12.1 Trypanosoma: Diploid & Sexual stage, Molecular characteristics of surface coat, Variable surfaceglycoprotein (VSG) and VSG gene expression.12.2 Plasmodium: Diploid & haploid stages, Chromosome polymorphism, gene encoding circumsporozoiteprotein & merozoites S- antigens, surface antigen diversity. Resistance of Malaria to drugs, itsmechanism & assessment.12.3 Platyhelminthes: Inseminative behaviour, parthenogenesis and polyspermy, sex determination, sexlinked inheritance in Schistosomes.12.4 Nematoda: chromosome germ line limited DNA & chromatin diminution in Ascaris.	**07 L**
13.	**Serology & immunodiagnostic methods:**13.1 Serology & antibody synthesis, preparation & demonstration of specific antigens of *Entamoeba,Plasmodium, Trypanosoma* & *Leishmania*13.2 Immunodiagnostic assays, Immunodiffusion, Indirect Haemagglutination test, indirect fluorescentantibody test, Radio immuno assay, ELISA, complement fixation test, Latex agglutination test	**06 L**
14.	**Prophylaxis & control:**Biologic, Genetic, Chemical, Physical & Other methods chemical, Physical & Other methods	**02 L**

REFERENCES

1. Essential immunology, Ivon Roitt, Blackwell scientific publications, London.
2. Immunology,I.V. Roitt, Butterworth publishers, USA
3. Kuby Immunology: Kindt T.J., Goldsby R.A., Osborne B.A., Kuby J. : Freeman WH Publ.
4. Comparative protozoology, Ecology, Physiology, Life history, Anderson, O.R. , Springer verlag, Berlin.
5. General Parasitology, Cheng T. C., Academic Press.
6. Modem Parasitology, Cox F.E.G., Eds.Parasitology in focus, facts & trends, Melhorn h., Eds., Spriger Verlag, Beriin.
7. Medical Parasitology, Piakarsky G. L., Springer Verlag, Berlin.
8. Modern Parasitology, Cellular immunological & immunological aspects, Wyler D. J., Eds.,W. H. Freeman, NY.

Course Articulation Matrix of ZOO: 5402: Immunology and Parasitology
Weightage: 1: Partially related, 2: Moderately related, 3: Strongly related

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	2	1	1	2	1	1	1	1	1
CO2	2	2	1	1	1	1	1	1	1
CO3	2	2	1	1	1	1	1	1	1
CO4	3	2	1	2	1	1	1	1	1
CO5	3	3	1	2	2	1	2	1	1
CO6	2	1	1	2	1	1	1	1	1
CO7	2	2	1	1	2	1	2	1	1

PO1 (Disciplinary Knowledge):
All COs address various aspects of immunology, requiring an understanding of complex biological concepts and mechanisms. CO4 and CO5 delve deeper into complex antibody structure and interactions, strengthening this PO.

PO2 (Critical Thinking & Problem Solving):
COs like 2, 3, and 5 encourage analyzing diverse immunological processes, interpreting research findings, and applying knowledge to novel situations. This demonstrates strong development of critical thinking skills.

PO3 (Social Competence):
This PO is not explicitly addressed in any COs. Incorporating group projects, debates on ethical implications of immunology research, or discussions on social impacts of vaccination could strengthen this PO.

PO4 (Research Skills & Scientific Temper):
Research skills are implicit in understanding and analyzing complex immunological concepts presented in all COs. Explicit research projects, literature reviews, or analyzing scientific papers could further strengthen this PO.

PO5 (Trans-disciplinary Knowledge):
CO5, with its exploration of antigen-antibody interactions and immunogenetics, connects immunology to other fields like genetics and public health, showcasing strong engagement with this PO.

PO6 (Personal & Professional Competence):
Similar to PO3, this PO lacks direct assessment. Encouraging self-reflection on career paths in immunology research, time management skills for projects, or ethical considerations in professional practice could enhance its connection to the COs.

PO7 (Effective Citizenship & Ethics):
While CO5 has potential for exploring ethical considerations in vaccine development or genetic testing, this aspect needs further development through case studies, discussions on ethical frameworks, or exploring social issues related to vaccinations.

PO8 (Environment & Sustainability):
This PO currently lacks a clear connection to the provided COs. Integrating examples or discussions about environmental factors influencing immune responses, emerging infectious diseases, or environmentally-friendly approaches in immunology research could strengthen its presence.

PO9 (Self-directed & Lifelong Learning):
Some COs indirectly encourage lifelong learning by fostering critical thinking and applying knowledge to novel topics. However, explicitly encouraging students to take ownership of their learning, developing independent research skills, and reflecting on the evolving nature of immunology knowledge could further strengthen this PO.

SYLLABUS (CBCS) FOR M.Sc. ZOOLOGY Sem. IV

Name of the Program: M.Sc. Zoology

Class: M.Sc. - II **Semester: IV**

Course Name: Pest Control and Toxicology **Course Code: ZOO: 5403**

Number of Credits: 04 **Number of Lectures: 60**

Course Objectives

- Understand fundamental concepts of pest control, including the identification and importance of different types of pests and the damage they cause.
- Explore the medical and veterinary entomology, focusing on measures to control vectors. They will understand control measures for household and stored grain pests.
- Gain proficiency in the principles and methods of pest control, covering cultural, physical, mechanical, and chemical control measures. They will understand insecticidal formulations, dilutions, and the advantages and drawbacks of biological control.
- Comprehend autocidal control, chemosterilants, Knipling's model, and Pheromonal and hormonal control. They will also grasp the concept of Integrated Pest Management (IPM).
- Identify and apply control measures for non-insect pests, including rats, bandicoots, crabs, snails, slugs, birds, and squirrels.
- Master the use of pesticide appliances, such as sprayers and dusters, and understand the hazards associated with pesticides along with their antidotes.
- Gain an introduction to basic toxicology concepts, including the history, definitions of toxicology, poison, toxicity, and the classification of toxicants.

Course Outcomes

After completion of this course, students will-

CO1: demonstrate the ability to identify different types of pests, understand their importance, and assess the damage caused by pests in various settings.

CO2: apply measures in medical and veterinary entomology, specifically focusing on controlling vectors and implementing strategies for managing household and stored grain pests.

CO3: master the principles and methods of pest control, including cultural, physical, mechanical, and chemical control measures. They will also be proficient in understanding insecticidal formulations, dilutions, and the advantages and drawbacks of biological control.

CO4: implement autocidal control measures, chemosterilants, and concepts like Knipling's model, pheromonal, and hormonal control. They will also apply the integrated pest management (IPM) approach.

CO5: effectively manage non-insect pests, including rats, bandicoots, crabs, snails, slugs, birds, and squirrels, employing appropriate control measures.

CO6: apply pesticide application techniques using sprayers and dusters, and effectively mitigate hazards associated with pesticides, including the understanding and implementation of antidotes.

CO7: comprehend basic toxicology concepts, such as the history, definitions of toxicology, poison, and toxicity. They will apply this knowledge to understand the classification of toxicants and their implications in pest control and environmental health.

TOPICS:

Topic No.	TOPICS / CONTENTS	Lectures
1.	**Introduction of the pest control**, types of pests and their importance, Damage caused by pests.	02 L
2.	Brief outline of medical and veterinary entomology with reference to important measures to control the vectors. House hold and stored grain pest and their control measures.	06 L
3.	**Principles and methods of pest control:** Cultural control measures,	12 L

	Physical control measures, Mechanical Control measures, Chemical control measures. Types and mode of action. Insecticidal formulations and dilutions. Drawbacks of chemical control. Biological control measures: Biological agents, Advantages and Drawbacks of Biological control, Biological, Control Management.	
4.	**Autocidal control**, Chemosterilents, Kniplings model, Pheromonal and hormonal control. Concept of Integrated pest management	**06 L**
5.	**Non- insect pest and their control:** Rat, Bandicoots, Crabs, Snails, Slugs, Birds and Squirrels	**02 L**
6.	**Pesticide- Appliances:** Sprayers and Dusters, Hazards of Pesticides and Antidotes.	**02 L**
7.	**Basic Concept of Toxicology:** Introduction of toxicology, history of toxicology, definition of toxicology, definition of poison, definition of toxicity and classification of toxicants.	**02 L**
8.	**Toxic agent and their mode of action:** Introduction, Toxic agent and mode of action of toxic agents.	**03 L**
9.	**Xenobiotics:** Introduction, Important of Xenobiotics concerned to Human health, Adverse effects of Xenobiotics through Biological Magnification and Biotransformation, mechanism of Xenobiotics Translocation, Membrane permeability and mechanism of chemical transfer, absorption of Xenobiotics, distribution of Xenobiotics, accumulation of Xenobiotics, elimination, biotransformation and excretion.	**08 L**
10.	**Pesticides and Heavy Metal Toxicity: Pesticides and their toxicological effects:** Classification of Pesticides, Insecticides, Mode of action of Insecticide	**04 L**
11.	**Heavy Metal Toxicity:** Introduction, dispersion, general principal of metal toxicity, sources, toxic metals and their toxicity. Arsenic, Aluminium, Cadmium (Itai-Itai disaster), Chromium Lead, Mercury, Manganese, Zinc and Nickel.	**06 L**
12.	**Evaluation of toxicity.** Acute sub Acute and chronic assays LD50, LC50,NOEL	**03 L**
13.	Maintenance and general handling of animals for toxicological laboratory.	**02 L**
14.	**Ecotoxicology,** clinical toxicology, occupational and nanotoxicology.	**02 L**

REFERENCES

1. Principles of Toxicology: Environmental and Industrial Applications – Eds.: Phillip L. Williams, Robert C. James, Stephen M. Roberts; JOHNWILEY & SONS, INC.
2. Casarett and Doull's Toxicology The basic science of poisons – Ed: Curtis Klaassen; McGraw-Hill
3. Fundamental Toxicology – Eds: John Duffs & Howard Worth; RSC Publishing.
4. "Pest control- A Survey" By A. Woods. (McGraw-Hill, London, 1974).
5. Pest control" – By W. W. Kilgore and R. L. Doutt (Academic Press, New York, 1967).

Course Articulation Matrix of ZOO: 5403 : Pest Control and Toxicology

Weightage: 1: Partially related, 2: Moderately related, 3: Strongly related

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	**2**	**1**	**1**	**2**	**1**	**1**	**1**	**1**	**1**
CO2	**2**	**2**	**1**	**2**	**2**	**1**	**1**	**1**	**1**
CO3	**2**	**2**	**1**	**2**	**1**	**1**	**1**	**1**	**1**
CO4	**3**	**3**	**1**	**2**	**1**	**1**	**2**	**2**	**1**
CO5	**2**	**2**	**1**	**2**	**1**	**1**	**1**	**1**	**1**
CO6	**2**	**1**	**2**	**1**	**1**	**2**	**1**	**2**	**1**
CO7	**2**	**1**	**1**	**2**	**2**	**1**	**1**	**2**	**1**

PO1 (Disciplinary Knowledge):
All COs address various aspects of pest control and toxicology, requiring an understanding of complex biological concepts, pest types, control methods, and their impacts. Some COs like CO4 delve deeper into advanced control measures and pest identification, solidifying PO1.

PO2 (Critical Thinking & Problem Solving):
COs like 2, 3, and 5 encourage analyzing diverse control methods, choosing appropriate strategies based on context, and applying knowledge to new pest scenarios. This demonstrates strong development of critical thinking skills.

PO3 (Social Competence):
CO6 directly addresses social awareness by emphasizing safety protocols and potential societal impacts of pesticide use. However, other COs could be enhanced by incorporating group projects, discussions on ethical considerations in pest control, or community outreach projects.

PO4 (Research Skills & Scientific Temper):
Research skills are implicit in understanding and analyzing complex pest control concepts presented in all COs. Explicit research projects, literature reviews, or analyzing scientific papers could further strengthen this PO.

PO5 (Trans-disciplinary Knowledge):
Some COs, particularly CO2 and CO7, connect pest control to other fields like medicine, veterinary science, and toxicology, showcasing engagement with trans-disciplinary knowledge.

PO6 (Personal & Professional Competence):
Similar to PO3, CO6 shows merit in developing personal responsibility regarding safe pesticide application. Other COs could be strengthened by encouraging time management skills for research projects, career exploration in pest control, or ethical considerations in professional practice.

PO7 (Effective Citizenship & Ethics):
While not explicitly addressed in most COs, some potential exists for discussing ethical considerations in pest control, environmental implications, and responsible pesticide use. Further development in this area through case studies, ethical frameworks discussions, or social impact analysis could strengthen PO7.

PO8 (Environment & Sustainability):
CO7 introduces basic toxicology concepts and environmental concerns indirectly. Integrating examples or discussions about environmentally friendly pest control methods, pesticide impacts on ecosystems, or sustainable development approaches could strengthen PO8.

PO9 (Self-directed & Lifelong Learning):
Courses often indirectly encourage lifelong learning through critical thinking, research, and the evolving nature of pest control. However, explicitly encouraging students to take ownership of their learning and explore new pest control advancements through independent research projects or self-directed learning activities could further strengthen PO9.

SYLLABUS (CBCS) FOR M.Sc. ZOOLOGY Sem. IV

Name of the Program: M.Sc. Zoology

Class: M.Sc. - II **Semester: IV**

Course Name: Environmental Biology, Animal Systematics and Diversity

Course Code: ZOO: 5404

Number of Credits: 04 **Number of Lectures: 60**

Course Objectives:-

- Comprehensively understand the fundamental principles of ecology, including energy flow, biogeochemical cycles, ecosystem stability, and human impacts on the environment.
- Analyze the diverse biomes and habitats of India, identifying their key biotic elements and the threats they face due to human activities.
- Critically evaluate the importance of biodiversity in India, exploring its historical context, current status, and the significance of conservation efforts.
- Master the practical skills and theoretical foundations of wildlife management, including population analysis, habitat assessment, and protected area networks in India.
- Gain competence in the principles and methodologies of biological classification, applying taxonomic characters and understanding species concepts.
- Effectively utilize various taxonomic techniques, including morphology-based, numerical, cyto-, and molecular approaches, for species identification and evaluation of diversity.
- Develop practical abilities in taxonomic procedures, such as specimen collection, preservation, and identification techniques, following established protocols and nomenclature rules.

Course Outcomes:-

After completion of this course, students will be able to-

CO1: explain and analyze the fundamental concepts of ecology, including energy flow, biogeochemical cycles, ecosystem stability, and the impact of human activities on natural environments.

CO2: differentiate and characterize the major biomes and habitat types of India, outlining their ecological significance and biodiversity.

CO3: critically evaluate the current state of Indian biodiversity, analyzing threats to different biomes and species and proposing effective conservation strategies.

CO4: apply the principles and methodologies of biological classification to accurately identify and classify organisms belonging to various taxonomic groups.

CO5: utilize different taxonomic techniques, including morphology, numerical analysis, cytotaxonomy, and molecular tools, for effective species identification and assessment of diversity within populations.

CO6: demonstrate competency in practical taxonomic procedures like specimen collection, preservation, and identification techniques, adhering to established protocols and nomenclature rules.

CO7: analyze and interpret evolutionary relationships between species using molecular phylogenetics and phylogeographic approaches.

TOPICS:

Topic No.	TOPICS / CONTENTS	Lectures
1.	**Introduction:** Fundamentals of Ecology, Ecosystems: Definition and, concept of ecosystems, energy flow in ecosystems, Nutritional Flux. Development and evolution of the ecosystems. Biogeochemical cycles, Foodchains, ecotone, edge effects, ecological niche, and ecosystem stability	**06 L**
2.	**Environmental Microbiology:** Microbes - classification and their applications in the environmental sciences. Cultivation and growth of	**02 L**

	microorganisms. Microorganisms and their association with man, animals and plants. Microbes as anti-microbial agents.	
3.	**Biomes and Habitat Diversity:** Classification of biomes, major biotic elements of each biome and their characteristics. Human impact on the natural environment.	**02 L**
4.	**Biological diversity of lndia:** Definition and nature, India's biogeographically history, physiography, climate and its impact on biodiversity. Indian forest and vegetation types and diversity of flora and fauna.	**04 L**
5.	Population and Community Ecology.	**02 L**
6.	**Wetlands Forests and Semi-arid Habitats of India:** Definition and types of wetlands, important wetlands of India and their conservation issues. Forests and semi-arid habitats of lndia: their distribution in India, ecological status of forests and arid lands, and their conservation.	**04 L**
7.	**Endangered, Endemic and Extinct Species of India:** Threatened species categories of IUCN, threatened species of plants and animals in India and their reasons, Red data books.	**03 L**
8.	**Wildlife management and conservation. Protected Areas Network in India:** Goals of management, Strategies for planning. Factors influencing wildlife management such as habitats, population, behavior, food-habits, health, etc., tools for data collection and analysis. Human land-use and wildlife management units, important projects for the conservation of wildlife in India, Role of local communities in wildlife management.	**07 L**
9.	**Fundamental of Systematics:** Biological classification, Hierarchy of categories and higher taxa, Taxonomic characters – procedures and keys, Species concepts: varieties, subspecies, sibling species, race etc.	**07 L**
10.	**Kingdoms of Life :** General outline of kingdoms including Monera& Protista; Broad outline & Diversity in kingdom Animalia	**03 L**
11.	**Methodologies in Systematics:** Morphology based taxonomy, Numerical taxonomy, Cyto-taxonomy and chemotaxonomy, Molecular Systematics, DNA fingerprinting & Molecular markers for detection/evaluation of polymorphism,RFLP, RAPD etc.	**08 L**
12.	**Taxonomic keys:** Types of taxonomic keys, their merits and demerits International code of Zoological nomenclature. Its operative principles, interpretation and application of important rules, zoological nomenclature, formation of names and various taxa	**06 L**
13.	**Taxonomic procedures:** taxonomic collection preservation, curetting process and identification.	**03 L**
14.	**Molecular phylogenetics and phylogeography.**	**03 L**

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1. Fundamentals of Ecology: E. P. Odum
2. Modern concepts in Ecology: H: D. Kumar
3. Microbes, Man and Animals: The Natural History of Microbial Interactions: Linton, A. H. and Burns, R.G. John Wiley and Sons.
4. Elements of Microbiology: Pelszar, M.J. and Chan ECS, McGraw Hill.
5. General Microbiology: Steiner, R.Y., Adelberg, EA and Ingraham, J.L. Macmillan Press.
6. Microbial Methods for Environmental Biotechnology: Grainer, J.M. and Lynch, J.M. .Academic Press.
7. Microbiological Methods for Environmental Scientists and Engineers: Gaudy, A.F. and Gaudy, E.T. McGraw Hill.

8. Kato., The biology of biodiversity, Springer.
9. Avise J.C., Molecular markers, Natural history and evolution, Chapman and Hill, NY.
10. Wilson A.O., biodiversity, Academic Press, Washington.
11. Principals of systematic Zoology by Ernst Mayr.

Course Articulation Matrix of ZOO: 5404: Environmental Biology, Animal Systematics and Diversity

Weightage: 1: Partially related, 2: Moderately related, 3: Strongly related

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	2	1	2	1	1	1	2	1
CO2	2	1	1	1	2	1	1	2	1
CO3	2	3	1	2	1	1	2	2	1
CO4	2	2	1	1	1	1	1	1	1
CO5	2	2	1	2	1	1	1	1	1
CO6	2	1	1	1	1	2	1	1	1
CO7	3	2	1	2	1	1	1	1	1

PO1 (Disciplinary Knowledge):
All COs address various ecological and taxonomic concepts, requiring understanding of complex processes, classification systems, and biodiversity. CO1-3 delve deeper into ecosystem dynamics, CO4-7 focus on taxonomic principles and techniques, and CO7 specifically touches on advanced concepts like phylogenetics.

PO2 (Critical Thinking & Problem Solving):
COs like 1, 3, 5, and 7 encourage analyzing environmental impacts, evaluating conservation strategies, interpreting taxonomic data, and applying critical thinking for species identification. This demonstrates strong development of problem-solving skills.

PO3 (Social Competence):
While not explicitly addressed in most COs, some potential exists for discussing social aspects of conservation and ethical considerations in taxonomic practices. Further development in this area through case studies, group projects, or discussions on ethical frameworks could strengthen PO3.

PO4 (Research Skills & Scientific Temper):
Research skills are implicit in understanding and analyzing complex ecological and taxonomic concepts presented in all COs. Explicit research projects, literature reviews, or data analysis exercises could further strengthen this PO.

PO5 (Trans-disciplinary Knowledge):
Some COs, particularly CO2 and CO7, connect ecology and systematics to other fields like geography, climate science, and molecular biology, showcasing engagement with trans-disciplinary knowledge.

PO6 (Personal & Professional Competence):
CO6 addresses personal responsibility through practical taxonomic procedures, but other COs could be enhanced by encouraging time management skills for research projects, career exploration in ecology or systematics, or ethical considerations in professional practice.

PO7 (Effective Citizenship & Ethics):
While not explicitly addressed in most COs, some potential exists for discussing ethical considerations in conservation practices, environmental sustainability, and responsible use of taxonomic techniques. Further development in this area through case studies, ethical frameworks discussions, or social impact analysis could strengthen PO7.

PO8 (Environment & Sustainability):
CO1-3 discuss environmental concerns related to ecosystems and biodiversity, but integrating examples or discussions about sustainable approaches in ecology and conservation could strengthen PO8.

PO9 (Self-directed & Lifelong Learning):
Courses often indirectly encourage lifelong learning through research skills, critical thinking, and the evolving nature of ecology and systematics. However, explicitly encouraging students to take ownership of their learning and explore new research or taxonomic advancements through independent projects or self-directed learning tasks could further strengthen PO9.

SYLLABUS (CBCS) FOR M. Sc. ZOOLOGY Sem. IV (w. e. f. June, 2020)

Name of the Program: M.Sc. Zoology

Class: M. Sc. II **Semester: IV**

Course Name: Zoology Practical-7 (Based on Courses: ZOO: 5401, ZOO: 5402, ZOO: 5403, ZOO: 5404)

Course Code: ZOO: 5405

Number of Credits: 04 **Number of Practicals: Any 10**

Course Objectives:-

- Master the essential knowledge of insect morphology, development, and reproductive systems through practical dissections and histological studies.
- Develop skills in identifying and classifying beneficial and harmful insects based on taxonomic characteristics, ecological roles, and economic significance.
- Gain practical experience in applying various insect pest control methods, including insecticides, repellents, and attractants.
- Explore and analyze terrestrial ecosystems using vegetation study methods, soil analysis, and microbial isolation, understanding their ecological significance.
- Gain a foundational understanding of various animal phyla and their key characteristics, utilizing museum specimens and identification keys to classify invertebrates and chordates.
- Develop practical skills in culturing and identifying parasites like Entamoeba and Plasmodium from different environments.
- Investigate aquatic ecosystems through plankton identification and water quality analysis, applying field collection and laboratory techniques.

Course Outcomes:-

After completion of this course, students will be able to-

CO1: demonstrate a comprehensive understanding of insect morphology, including external and internal structures, their functions, and adaptations to diverse environments.

CO2: apply taxonomic principles to accurately identify major insect orders and families based on morphological characteristics and diagnostic features.

CO3: explain the structure and function of insect reproductive systems, including male and female organs, and describe the process of spermatogenesis and oogenesis.

CO4: develop comprehensive strategies for the control and prevention of parasitic diseases transmitted by vectors and protozoa like ticks, mosquitoes, Trypanosoma, and Leishmania.

CO5: classify and identify major helminth parasites based on their morphology, life cycles, and host interactions, understanding their potential health impact.

CO6: analyze the ecological interactions within aquatic and terrestrial ecosystems, applying field and laboratory techniques to assess water quality, plankton diversity, and soil characteristics.

CO7: employ taxonomic keys and museum specimens to accurately identify and classify animals belonging to various invertebrate and chordate phyla, recognizing their roles in ecosystem functions.

Section I: ***Practical based on*: *ZOO: 5401 – Entomology II***

Practical No.	Title of Practical	Practicals No. of
1.	Study of different types of insect Eggs.	**1 P**
2.	Early embryology of insect: egg, cleavage, blastula, germ band, gastrula, embryo- 1day old, 2 day old and 3 day old in suitable insect.	**1 P**
3.	Study of post embryonic development of insects: Collection and study of types of larvae, pupae, Nymph (Aquatic and Terrestrial).	**2 P**

4.	Histological studies of male reproductive system (Testes, Vasa deference, Ejaculatory duct, Accessory gland and spermatogenesis).	**1 P**
5.	Histological studies of female reproductive system (Ovariole, oviduct, common oviduct, Accessory glands and bursa copulatris, spermatheca).	**1 P**
6.	Dissection of House fly: The digestive system, Nervous system, Male and Female Reproductive System, Temporary mountings of antenna, halters, legs and ovipositor.	**3 P**
7.	Dissection of butterfly: The digestive system, Nervous system, Male and Female Reproductive System, Temporary mountings of antenna, scales and ovipositor.	**3 P**
8.	Study of Beneficial Insects: Any 5 insects to be studied inclusive of their Systematics, Habit and Habitat, Diagnostic features, Economics and Ecological significance, Threats and Conservation measures.	**1 P**
9.	Study of Harmful Insects: Any 5 insect Pests, Predators, Parasites and Vectors of diseases to be studied inclusive of their Systematics, Habit and Habitat, Diagnostic features, Nature of damage and control measures.	**1 P**
10.	Morphological and taxonomic study of insect pest of agricultural importance. (any 10).	**1 P**
11.	Study of insect pests and veterinary and public health importance. Nonconventional pests.	**1 P**
12.	Study of efforts of contact poison on pests: a) Chlorinated hydrocarbons, b) Organophosphatesc) Carbamate.Calculation of LD50 and effects on behavior.	**1 P**
13.	Study of respiratory poisons (fumigants)-Carbon tetrachloride, ethylene dichoride, Nicotine.	**1 P**
14.	Study of insect repellants (any two).	**1 P**
15.	Study of insect attractants (any two).	**1 P**

Section I: *Practical based on*: *ZOO: 5401– Animal Physiology II*

Practical No.	**Title of Practical**	**Practicals No. of**
1.	Effect of exercise on breathing rate, pulse rate and blood lactate of man	**1 P**
2.	Determination of bleeding time and clotting time in man	**1 P**
3.	Study of invertebrate (earthworm and crab) heart	**1 P**
4.	Ionic effects on perfused heart of frog	**1 P**
5.	Effect of vagoctomy on frog heart	**1 P**
6.	Effect of adrenalin and acetylcholine on perfused heart of frog	**1 P**
7.	Capillary circulation in frog and cockroach/Fish.	**1 P**
8.	Study of glycerinated muscles fibers	**1 P**
9.	LDH isoenzymes isolation and detection using agarose gel electro phoresis in heart / skeletal muscle of rat	**2 P**
10.	Phosphagen kinase in mouse and crab muscle phosphagen	**1 P**
11.	Effect of load on muscles contraction in frog	**1 P**
12.	Cobalt back filling of cockroach ventral nerve cord	**1 P**
13.	Detection and measuring of heart beats(Manually) in Drosophila larva/Daphnia	**1 P**
14.	Estimation of Respiratory Quotient by Warburg's Respirometer	**1 P**
15.	Mapping of taste areas on human tongue.	**1 P**
16.	Study of Types of heart (Myogenic and Neurogenic)	**1 P**
17.	Effect of pH, temperature and incubation on human salivary amylase activity.	**1 P**

18.	Determination of protein, glucose in Urine	**1 P**
19.	Determination of protein, glucose in Urine from diabetic patient	**1 P**
20	Qualitative Analysis:1) Preparation and study of Urine crystals.2) Estimation of serum urea.	**1 P**

Section I: *Practical based on*: *ZOO: 5401 – Genetics II*

Practical No.	Title of Practical	Practicals No. of
1.	Methodology for constructing Human Pedigree	**1 P**
2.	Analysis and construction of typical pedigrees for autosomal dominant and recessive genes, sex linked dominant and recessive genes.	**1 P**
3.	Preparation of metaphase chromosomal spreads of one vertebrate.	**2 P**
4.	Enzyme polymorphism in natural population.	**2 P**
5.	Visit to a medical genetics laboratory for cytogenetic, biochemical and other studies.	**1 P**
6.	G- banding on mouse metaphase spread	**1 P**
7.	In-silico design of PCR primers for a gene of interest.	**1 P**
8.	C banding on mouse metaphase chromosomes.	**2 P**
9.	Study of courtship behavior in wild type and mutant Drosophila.	**1 P**
10.	Study of maternal effect mutants for genes- Bicoid and Nanos.	**1 P**
11.	Preparation of metaphase chromosomal spread of 3'd instar larva of Drosophila (from brain Ganglion)	**2 P**
12.	Measurement of olfaction activity in Drosophila larvae and Adult Fly.	**1 P**
13.	Measurement of locomotory activity in Drosophila larvae and Adult Fly.	**1 P**
14.	Larval mechanosensation assay in Drosophila.	**1 P**
15.	Chromatography of Drosophila eye colour pigment.	**1 P**
16.	To Study effect of mitogen induction on lymphocytes.	**2 P**
17.	Concept of genetic disorder databases and demonstration of use of OMIM.	**1 P**
18.	Genetic monitoring (using immuno genetic marker) in laboratory animals.[by skin grafting]	**2 P**
19.	Open field Activity test and Elevated plus maze test for anxiety levels in laboratory mice.	**1 P**

Section I: *Practical based on*: *ZOO: 5402 – Immunology*

Practical No.	Title of Practical	Practicals No. of
1.	Ouchterlony technique of agar gel diffusion	**2 P**
2.	Immunoelectrophoresis	**2 P**
3.	Haemagglutination inhibition test	**2 P**
4.	Histology of Lymphoid organ- Skin, Spleen, Thymus, Ilium, Lymph node, Bone marrow2p	**2 P**
5.	Blood smear preparation to study various blood cells	**2 P**
6.	Blood group analysis with reference to cross matching	**2 P**
7.	To estimate the antigen concentration using rocket electrophoresis	**2 P**
8.	Dot immunobinding assay to detect antibodies in the serum	**2 P**
9.	To perform ELISA	**2 P**

Section II: *Practical based on*: *ZOO: 5402– Parasitology*

Practical No.	Title of Practical	Practicals No. of
1.	Study of life cycle, role as vector & control measures of: Ticks(*Argas, Boophilus*)Mosquito - anyone from- *Anopheles/ Aedes/ Culex* Any two flies: *Tabanus/ Phlebotomus/ Sarcophaga.Cyclops*	**2 P**

2.	Ectoparasites & Endoparasites of wild rat, cattle, dog, chick & human including stages in excreta	**2 P**
3.	Study of life cycle of parasitic protozoa: *Trypanosoma, Leishmania*	**1 P**
4.	Study of life cycle of helminth parasites: *Schistosoma.Echinococcus, Ancylostoma, Dracunculus*.	**2 P**
5.	Culturing of *Entamoeba* & *Plasmodium*	**2 P**
6.	Study of Parasites from digestive tract of Cockroach /gut parasites of hen	**1 P**

Section II: *Practical based on*: *ZOO: 5404– Environmental Biology*

Practical No.	**Title of Practical**	**Practicals No. of**
1.	A visit to aquatic ecosystem and methods for water and plankton collection	**2 P**
2.	Plankton identification and quantification from river / lake water samples.	**2 P**
3.	Vegetation studies by line, quadrates and belt transect methods and their analysis.	**2 P**
4.	Preparation of media for microbial culture, Isolation and culturing of microbes from soil/water samples.	**2 P**
5.	Water analysis for physico-chemical characteristics.	**1 P**
6.	Physico-chemical analysis of soil.	**1 P**
7.	Minor phyla-specimen Study	**1 P**
8.	Study of museum specimens and slides(invertebrates,1-2 examples from each phyla)	**1 P**
9.	Study of museum specimens(protochordates and chordates,1-2 examples from each phyla)	**1 P**
10.	Identification of animals with the help of keys-House fly, Honey bee etc.	**1 P**
11.	Identification of animals with the help of keys- Cockroach, Earthworm.	**1 P**
12.	Method of collection, Preservation, and Curetting of any insect Specimen	**2 P**
13.	Visits to Scientific Institute like Zoological Survey of India and Report writing	**1 P**

Section II: *Practical based on*: *ZOO: 5404– Animal Systematics & Diversity*

Practical No.	**Title of Practical**	**Practicals No. of**
1.	Minor phyla-specimen Study 1p	**1 P**
2.	Study of museum specimens and slides(invertebrates,1-2 examples from each phyla)	**2 P**
3.	Study of museum specimens(protochordates and chordates,1-2 examples from each phyla)	**2 P**
4.	Identification of animals with the help of keys-House fly, Honey bee etc.	**1 P**
5.	Identification of animals with the help of keys- Cockroach, Earthworm.	**1 P**
6.	Method of collection, Preservation, and Curetting of any insect Specimen	**2 P**
7.	Visits to Scientific Institute like Zoological Survey of India and Report writing	**1 P**

Course Articulation Matrix of ZOO: 5405: Zoology Practical-7

Weightage: 1: Partially related, 2: Moderately related, 3: Strongly related

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	2	1	2	1	1	1	2	1
CO2	3	2	1	1	1	1	1	1	1
CO3	3	2	1	1	1	1	1	1	1
CO4	2	3	1	2	1	1	1	1	1
CO5	3	2	1	1	1	1	1	1	1
CO6	2	2	2	1	2	1	2	1	1
CO7	2	2	1	1	1	1	1	1	1

PO1 (Disciplinary Knowledge):
All COs directly address insect biology, covering morphology, taxonomy, reproduction, behavior, and ecology. Students gain in-depth knowledge specific to this field.

PO2 (Critical Thinking & Problem Solving):
COs like 4 and 5 explicitly involve designing experiments, analyzing data, and solving problems during insect identification and pest control strategies.

PO3 (Social Competence):
CO6 explores the economic and environmental significance of insects, leading to potential connections with the social impact of pest management practices. However, explicit discussions on ethical considerations are needed for stronger mapping.

PO4 (Research Skills & Scientific Temper):
Though not explicitly addressed, data collection, analysis, and scientific principles used in entomology contribute to developing these skills in most COs.

PO5 (Trans-disciplinary Knowledge):
Some COs have potential for connections beyond entomology. CO4 could link to neurobiology, CO5 to genetics in other organisms, and CO6 to ecological economics or agriculture. Further integration or project work could strengthen this.

PO6 (Personal & Professional Competence):
While project-based activities or research tasks could indirectly contribute to time management and independent learning, COs don't directly address this PO.

PO7 (Effective Citizenship & Ethics):
Similar to PO3, CO6 has potential to connect to environmental ethics of pest control, but dedicated discussions and activities are needed for strong mapping.

PO8 (Environment & Sustainability):
CO6 explicitly addresses environmental considerations of beneficial and harmful insects. Integrating sustainability aspects into pest control discussions could further strengthen this PO.

PO9 (Self-directed & Lifelong Learning):
While COs indirectly encourage lifelong learning through research skills, critical thinking, and the dynamic nature of entomology, explicit encouragement of independent research, literature reviews, or further exploration of topics could strengthen this PO.

SYLLABUS (CBCS) FOR M. Sc. ZOOLOGY Sem. IV (w. e. f. June, 2020)

Name of the Program: M.Sc. Zoology

Class: M. Sc. II **Semester: IV**

Course Name: Research Project **Course Code: ZOO: 5406**

Number of Credits: 04 **Number of Hours: 60**

RESEARCH PROJECT

The project course would involve:

1. Training to students in:

a) Literature survey,

b) Planning and execution of experimental work,

c) Analysis of data and its presentation.

Studies would utilize few of the practicals from their course more intensively for this course. **Project should start at fourth** semester and **will be assessed at the end of fourth semester**.

The experimentation work during the project should be equivalent to minimum 20 practicals in the semester.

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Examination:

[A] Pattern of Examination: Evaluation of Students:

1. The In-semester and End-Semester examinations will be of 60 marks each.
2. There shall be revaluation of answer script of end semester examination, but not of internal assessment papers.

In-semester Examination: Internal assessment for each course would be continuous and dates for each Tutorials/practical tests etc. will be pre-notified in the time table for teaching or placed separately as a part of time table. Department / College Internal Assessment Committee will coordinate this activity.

a) Theory Courses: Students should be encouraged to participate in various academic activities.

A teacher must select a variety of the procedures for conducting internal assessment suggested as follows:

a) Multiple choice questions
b) Combination of objective and subjective questions.
c) Open book test (concerned teacher will decide the allowed books)
d) Tutorial
e) Surprise test specified topics in a given notified period
f) Oral
g) Assignments
h) Review of research paper
i) Seminar presentation
j) Journal/Lecture/Library notes

Student has to preserve the documentation of the internal assessment except midterm test answer script. It is the Responsibility of the student to preserve the documents.

b) Practical Courses: It is a continuous evaluation process. Practical courses will be evaluated on the basis of the following:

1. Performance assessment of each experiment on the basis of attendance, punctuality, journal completion, practical skills, results, oral and analysis.
2. Assessment on practical course be conducted before the end-semester examination.
3. Assessment of each experiment shall be done for each practical weekly

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