Central University of Himachal Pradesh
Shahpur Parisar
Department of Animal Science

Program Specific Outcomes

Program Outcomes

Course Outcomes & Course Contents

of

Master of Science in Zoology (M. Sc. Zoology)

School of Life Sciences

Programme Specific Outcomes of Master of Science in Zoology

PSO[1]- To ensure indepth domain knowledge.

PSO[2]- To enhance students' dissertation knowledge and research paper writing skills.

PSO[3]- To foster a culture of performance based evaluation.

Programme Outcomes of Master of Science in Zoology

PO[1]- To develop the critical analysis aptitude in the students.

PO[2]- To enhance scientific aptitude in the students.

PO[3]- To augment the analytical and interpretative abilities of the students

PO[4]- To make them empathetic and responsible individuals with scientific sensibility.

CENTRAL UNIVERSITY OF HIMACHAL PRADESH

[Established under the Central Universities Act 2009]

PO Box: 21, Dharamshala, District Kangra - 176215 (HP)

www.cuhimachal.ac.in

Course Code: ZOO 415
Course Name: Animal Physiology
Course Instructor: Dr. Ranjit Kumar
Credits: 2

Credits Equivalent: (One credit is equivalent to 10 hours of lectures / organized classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objectives:

- To enable the students to know about all the physiological processes going on in animal/human body.
- To make the students understand the functions of hormones and their mode of action at molecular level.
- To allow the students to understand difference between healthy body and an abnormal physiology.

Course Outcomes: Upon completion of the course, students should be able to:
CO^1 Identify the interaction and communication between various biological systems.
CO^2 Understand the normal and abnormal physiological/hormonal values.
CO^3 Recognize and explain how all physiological systems work in unison to maintain homeostasis in the body; and use of feedback loops to control the same.
CO^4 Learn an integrative approach to understand the interactions of various organ systems resulting in the complex overall functioning of the body.

Attendance Requirements:
Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.

Evaluation Criteria:

1. Mid Term Examination: 20
2. End Term Examination: 60
3. Continuous Internal Assessment: 20

Course Contents:

UNIT – I: DIGESTION AND RESPIRATION (3 hours)
Digestion: Mechanism of digestion & absorption of Carbohydrates, Proteins, Lipids and Nucleic acids. Composition of bile, Saliva, Pancreatic, gastric and intestinal juices. Respiration: Exchange of gases, Transport of O_2 and CO_2, Oxygen dissociation curve, Chloride shift.

UNIT –II: CIRCULATION AND CARDIAC SYSTEM (4 hours)
Composition of blood, Plasma proteins and their role, blood cells, Haemopoiesis, Mechanism of coagulation of blood. Mechanism of working of heart: Cardiac output, Cardiac cycle, origin and conduction of heart beat.

UNIT – III: EXCRETION AND MUSCLE CONTRACTION (5 hours)

Excretion: modes of excretion, Ornithine cycle, Mechanism of urine formation. Structure of Cardiac, Smooth & Skeletal muscles, threshold stimulus, All or None rule, single muscle twitch, muscle tone, isotonic and isometric contraction, Physical, chemical & electrical events of mechanism of muscle contraction.

UNIT-IV: NERVOUS SYSTEM AND NEUROTRANSMITTER (5 hours)

Neurons, action potential, gross neuroanatomy of the brain and spinal cord, central and peripheral nervous system, neural control of muscle tone and posture. Mechanism of generation and propagation of nerve impulse, structure of synapse, synaptic conduction, saltatory conduction, Neurotransmitters.

UNIT-V: ENDOCRINOLOGY AND REPRODUCTION (3 hours)

Mechanism of hormone action (insulin and steroids) Different Endocrine glands- Hypothalamus, Pituitary, pineal, thymus, thyroid, parathyroid and adrenals, hypo & hyper-secretions. Male and female reproductive system, spermatogenesis and oogenesis.

SUGGESTED BOOKS:

1. Ruegg, J.C., Calcium in muscle activation, Springer Verlag Berlin Heidelberg, New York. 25
2. Hoar, W.S. General and comparative physiology, Prentice, Hall Inc./England Wood cliffs, New Jersey.
3. Guyton, A.C. and Hall, J.E.; Text book of medical physiology, 10th Ed, Saunders, Harcourt, India.
4. Heilmeyer, L.M.G. Cellular regulation of protein phosphorylation, springer-verlag, Berlian Heidelberg, New York.
5. Prosser, C.L. and Brown, F.A. comparative Animal Physiology 2nd Ed. W.B. Sunders, Philadelplina.
6. Karpati, G., Jones, D.H. and Griggs. R.C. Disorders of Voluntary Muscle, 7th Edn, Cambridge University Press.
7. Turner, C.D. General Endocrinology, 4th Ed. W.B. Saunders, Philadelphia London.
8. Prosser, C.L., Comparative Animal Physiology, W.B. Saunders, Toppen Publication.

Course Articulation Matrix of ZOO 415- Animal Physiology

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	3	3	3	2		3	1	2
CO2	3	3	3	1		3	1	3
CO3	3	2	3	1		3	1	1
CO4	2	3	3	1		2	1	2

1. Partially Related
2. Moderately Related
3. Highly Related

Course Code: **ZOO 416**
Course Name: **Structure and Function of Invertebrate**
Course Instructor: **Dr. Rakesh Kumar**
Credits: **2**

Credits Equivalent: (One credit is equivalent to 10 hours of lectures / organized classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objectives:

- To enable the students to develop an appreciation for the biodiversity of invertebrate species.
- To impart knowledge about co-existence of different forms of living organisms ranging from unicellular to multicellular animals.

Course Outcomes: Upon completion of the course, students should be able to:
CO^{1} Learn about the importance of systematics, taxonomy and structural organization of animals.
CO^{2} Appreciate the diversity of non-chordates living in varied habit and habitats.
CO^{3} Critically analyse the organization, complexity and characteristic features of non-chordates making them familiarize with the morphology and anatomy of representatives of various animal phyla.
CO^{4} Explain and demonstrate the importance of the invertebrate in the ecological system.

Attendance Requirements:
Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.

Evaluation Criteria:
Mid Term Examination: 20
End Term Examination: 60
Continuous Internal Assessment: 20

Course Contents:

UNIT I: PROTOZOA AND PORIFERA (4 hours)
Protozoa: General organization of Protozoa with special reference to feeding, locomotory organelles and locomotion, reproduction.
Porifera: General organisation of phylum Porifera with special reference to canal system, skeleton and development.

UNIT II: PHYLUM COELENTERATA AND PLATYHELMINTHES (4 hours)
Coelenterata: General organisation of phylum Coelenterata with special reference to polymorphism, corals and coral reefs, development and alternation of generation.

Platyhelminthes: General organisation of phylum Platyhelminthes with special reference to body wall.Digestive system, excretory system and reproductive system. Development and life cycles of *Fasciola* and *Taenia*.

UNIT III: PHYLUM ASCHELMINTHES AND ANNELIDA (4 hours)

Aschelminthes: General organisation of phylum Aschelminthes. Life cycle of *Ascaris lumbricoides*.

Annelida: General organisation of phylum Annelida with special reference to segmentation, digestive, excretory and reproductive systems.

UNIT IV: PHYLUM ARTHROPODA (2 hours)

Arthropoda: General organisation of Arthropoda. Digestive, Respiratory and Reproductive systems.

UNIT-V: PHYLUM MOLLUSCA AND ECHINODERMATA (6 hours)

Mollusca: General organisation of Mollusca with special reference to feeding, respiration and shell diversity, podium or foot in Mollusca, torsion and detorsion in Gastropoda.

Echinodermata: General organisation of Echinodermata, Comparative account of water vascular system, haemal and perihaemal systems, Larval forms in Echinodermata.

SUGGESTED BOOKS:

1. Invertebrate Zoology: EL Jordan; P.S. Verma
2. A Text Book of Zoology Vol.I : P.S. Dhami; Jk.Dhami.
3. A Text Book of Invertbrate zoology : R.L.Kotpal.
4. Biology of Animals : Cleveland P. Hickman JR Larryds. Roberts.
5. Hyman, L.H. The invertebrates. Vol. I protozoa through Ctenophora, McGraw Hill Co., New York.
6. Barrington, E.J.W. Invertebrate structure and function. Thomoes Nelson and sons Ltd. London.
7. Jagerstein, G. Evolution of Metazoan life cycle, Academic Press, New York & London.
8. Hyman, L.H. The Invertebrates Vol. 8, McGraw Hall. Co., New York. & London.
9. Barnes, R.D. Invertebrate Zoology, III edition, W.b.Saunsders Co., Philadelphia
10. Russel Hunter, W.D.A biology of higher invertebrates, the Macmillan co. Ltd. London.

Course Articulation Matrix of ZOO 416- Structure and Function of Invertebrate

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	1	1	1	1		3	1	1
CO2	2	1	2	3		3	1	1
CO3	3	3	3	1		3	1	2
CO4	1	1	2	2		2	1	1

1. Partially Related
2. Moderately Related
3. Highly Related

Course Code: **ZOO 417**
Course Name: **Cell and Molecular Biology**
Course Instructor: **Dr. Ranjit Kumar**
Credits: **2**

Credits Equivalent: (One credit is equivalent to 10 hours of lectures / organized classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objectives:

- To learn and develop an understanding of a cell as a basic unit of life.
- To understand the functions of cellular organelles and how a cell carries out and regulates cellular functions

Course Outcomes: Upon completion of the course, students should be able to:
CO^1 Be able to understand how the cell functions as a unit of life.
CO^2 Be able to draw parallels between the physiological processes at the cellular and organism levels.
CO^3 Apply their knowledge to understand importance of DNA replication and associated abnormalities
CO^4 Able to perform simple molecular techniques such as SEM, TEM and PCR.

Attendance Requirements:
Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.

Evaluation Criteria:
Mid Term Examination: 20
End Term Examination: 100
Continuous Internal Assessment: 20

Course Contents:

UNIT- I: CELL STRUCTURE AND FUNCTIONS (4 hours)
Introduction to Cell biology, Basic properties of cells. Structural organization and function of intracellular organelles: Nucleus, Mitochondria, Endoplasmic reticulum, Golgi complex, Lysosomes, Persoxisomes.

UNIT- II: CELLULAR MEMBRANE AND CYTOSKELETON (4 hours)
An overview of membrane functions. Membrane models. Chemical composition of cell membrane. Structure and functions of membrane proteins: Integral protein, peripheral membrane proteins and lipid-anchored membrane proteins. Structure and organization of Microtubules, Intermediate filaments and Microfilaments and their role in cell motility.

UNIT- III CELL SIGNALLING AND CELL TRANSPORT (4 hours)
Different mechanism of cell signalling pathways, Movement of substances across cell membranes: Diffusion, active transport, uniport, symport and antiport.

UNIT- IV: FUNDAMENTAL PROCESSES IN MOLECULAR BIOLOGY (4 hours)

DNA and its organization in cell; structure; A, B, and Z forms. Replication, Transcription, translation, damage and repair. Regulation of gene expression in prokaryotes and eukaryotes

UNIT- V: BASIC TECHNIQUES (4 hours)

Microscopy application and types (TEM and SEM). Centrifugation and Polymerase chain reaction (PCR). Molecular Markers (RFLP, RAPD, SSR's and SNP's), Blotting techniques.

SUGGESTED BOOKS:

1. Lewin, B. 2000. Genes VIII Oxford University, Press, New York
2. Alberts, B. Bray, D., Lewis, J. Raff, M., Roberts, K. and Watson, J.D. 1999, Molecular biology of the cell. Garland Publishing, Inc. New York.
3. Wolfe, S.L. 1993, Gruissem, W. and Jones, R.L. 2000, Biochemistry and molecular biology of plants, American society of plant physiologists, Maryland, USA
4. Frifelder, D. Molecular Biology. John and Bartlett Publishers, inc., Boston, USA

Course Articulation Matrix of ZOO 417- Cell and Molecular Biology

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	2	2	3	1		3	1	1
CO2	3	2	3	1		3	1	1
CO3	1	2	2	1		3	1	1
CO4	1	1	3	1		3	1	1

1. Partially Related
2. Moderately Related
3. Highly Related

Course Code: **ZOO 418**
Course Name: **Cell and Molecular Biology & Animal Physiology Lab**
Course Instructor: **Dr. Ranjit Kumar**
Credits: **2**

Credits Equivalent: (One credit is equivalent to 10 hours of lectures / organized classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objectives:

- To enable the students to know about all the physiological processes going on in animal/human body.
- Provide knowledge about the complex organization in the eukaryotic cell and the molecular mechanisms of the cellular processes that exist in all cell types.

Course Outcomes: Upon completion of the course, students should be able to:
CO[1] Learn an integrative approach to understand the interactions of various organ systems resulting in the complex overall functioning of the body.
CO[2] Gain knowledge about the techniques and experiments that contributed to the understanding of molecular mechanisms of the cellular processes.
CO[3] Hands on knowledge of various haematological techniques.
CO[4] Ability to differentiate between healthy and abnormal tissue histology.

Attendance Requirements:
Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.

Evaluation Criteria:
End Term Examination: 50
Continuous Internal Assessment: 50

Course Contents:

1. Study of permanent histological slides of testis and ovaries of insects/ mice/rat.
2. Basis of reaction and demonstration of the sites of proteins, nucleic acids, lipids & carbohydrates in ovaries of insects/rat/mice through slides and photographs.
3. Study of stages of mitosis and meiosis from permanent slides from animal and plant materials through slides/charts/photographs.
4. To demonstrate that the optimum activity of salivary amylase is pH dependent.
5. Demonstration of estimation of Haemoglobin.
6. Demonstration of determination of TLC, DLC, RBC &Count.
7. Demonstration of determination of bleeding and clotting time.
8. Demonstration of determination of blood groups.
9. Demonstration of measurement of blood pressure.
10. Demonstration of estimation of ESR.
11. To study the effect of exercise on cardiovascular and respiratory systems.
12. Demonstration of estimation of the glucose level in blood of mammal, Haematocrit

SUGGESTED BOOKS:

1. Lewin, B. 2000. Genes VIII Oxford University, Press, New York
2. Alberts, B. Bray, D., Lewis, J. Raff, M., Roberts, K. and Watson, J.D. 1999, Molecular biology of the cell. Garland Publishing, Inc. New York.
3. Wolfe, S.L. 1993, Gruissem, W. and Jones, R.L. 2000, Biochemistry and molecular biology of plants, American society of plant physiologists, Maryland, USA
4. Frifelder, D. Molecular Biology. John and Bartlett Publishers, inc., Boston, USA

5. Prosser, C.L. and Brown, F.A. comparative Animal Physiology 2nd Ed. W.B. Sunders, Philadelplina.

6. Karpati, G., Jones, D.H. and Griggs. R.C. Disorders of Voluntary Muscle, 7th Edn, Cambridge University Press.

7. Turner, C.D. General Endocrinology, 4th Ed. W.B. Saunders, Philadelphia London.

8. Prosser, C.L., Comparative Animal Physiology, W.B. Saunders, Toppen Publication.

Course Articulation Matrix of ZOO 418- Cell and Molecular Biology & Animal Physiology Lab

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	2	2	3	1		1	3	3
CO2	2	2	3	2		2	2	1
CO3	1	1	1	2		1	2	2
CO4	1	1	1	1		1	3	1

Course Code: **ZOO 419**
Course Name: **Structure and Function of Invertebrates Lab**
Course Instructor: **Dr. Rakesh Kumar**
Credits: **2**

Credits Equivalent: (One credit is equivalent to 10 hours of lectures / organized classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objectives:

- To make the students know about the habitat, habits, morphology and economic importance of various types of invertebrates.
- To make students differentiate between various invertebrates class.

Course Outcomes: Upon completion of the course, students should be able to:
CO[1] Identify the invertebrates belonging to different class.
CO[2] Understand the importance of these in the ecological system.
CO[3] Apply their knowledge to understand morphology of the invertebrates.
CO[4] Comprehend the economic importance of non-chordates, their interaction with the environment and role in the ecosystem.

Attendance Requirements:
Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.

Evaluation Criteria:
End Term Examination: 50
Continuous Internal Assessment: 50

Course Contents:

1. PORIFERA

a) Specimens: *Scypha, Grantia, Spongilla, Euplectella, Hyalonema, Euspongia.*
b) Prepared slides: Spicules, gemmules, *Sycon* (T.S and L.S) gemmules and spicules.

3. COELENTERATA

a) **Specimens:***Porpita, Physalia, Aurelia, Metridium, Alcyonium, Tubipora, Madrepora, Fungia, Gorgonia* and *Pennatula.*
b) Prepared slides: Hydra (W.M.), T.S. through regions of testis and ovary, *Obelia* (colony, medusa and polyp), *Sertularia*, *Plumularia*, *TubulariaBougainvillea*, *Aurelia*,*Obelia, Sertularia* and *Plumularia*
c) Preparation of permanent slides.

4. PLATYHELMINTHES

a) Specimens: *Planaria, Dugesia, Fasciola, Taenia*, and *Echinococcus*.
b) Slides: *Fasciola* (miracidium, sporocyst, redia and cercaria), scolex and proglottids of *Taenia* (Mature and gravid L.S. & T.S.).
c) Stained preparation of: Amphistome, proglottid of a cestode.

5. ASCHELMINTHES

a) Specimens: *Ascaris* (Male and female)

b) Slides: *Ascaris* (T.S. of male and female gravid**).**

6. ANNELIDA

a) Demonstration of dissection of Earthworm (digestive, nervous and reproductive systems) through video clippings/models/charts.

b) Specimens: *Nereis, Heteronereis, Polynoe, Tubifex, Eunice, Aphrodite, Chaetopterus, Arenicola, Pontobdella, Amphitrite* and *Hirudinaria.*

7. ARTHROPODA

a) Specimens: *Peripatus, Lepisma*, Cockroach, Grasshopper, Praying mantis, Earwig, Dragonfly, Termite (queen and other castes), Ant, Butterfly, Moth, Beetles, Wasp, Honeybee, Crab, Prawn, *Lepas, Balanus, Apus, Limulus*, Scorpion, Spider, *Millepede* and *Centipede.*

8. MOLLUSCA

a) Demonstration of dissection of *Anodonta* (digestive and nervous systems) through video clippings/models/charts.

b) Specimens: *Anodonta, Mytilus, Pholas, Pecten, Haliotis, Aplysia, Doris, Limax, Pila, Sepia, Octopus, Nautilus, Chiton* and *Dentalium.*

c) Prepared Slides: Glochidium larva, radula of *Pila*, gill lamina of *Anodonta***.**

9. Echinodermata

a) Specimens: *Asterias, Echinus, Cucumaria, Antedon, Ophiothrix*.

SUGGESTED BOOKS:

1. Invertebrate Zoology ------- EL Jordan; P.S. Verma
2. A Text Book of Zoology Vol.I ------ P.S. Dhami; Jk.Dhami.
3. A Text Book of Invertbrate zoology ----- R.L.Kotpal.
4. Biology of Animals --- Cleveland P. Hickman JR Larryds. Roberts.
5. Hyman, L.H. The ivertebrates. Vol. I protozoa through Ctenophora, McGraw Hill Co.,New York.
6. Barrington, E.J.W. Invertebrate structure and function. Thomoes Nelson and sons Ltd.London.
7. Jagerstein, G. Evolution of Metazoan life cycle, Academic Press, New York & London.
8. Russel Hunter, W.D.A biology of higher invertebrates, the Macmillan co. Ltd. London.

Course Articulation Matrix of ZOO 419- Structure and Function of Invertebrates Lab

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	2	2	3	1		3	1	2
CO2	1	3	1	1		1	2	3
CO3	1	2	1	3		3	3	2
CO4	2	1	2	3		2	1	3

Course Code: ZOO 420
Course Name: Entomology
Course Instructor: Dr. Sunil Kumar
Credits: 2

Credits Equivalent: (One credit is equivalent to 10 hours of lectures / organized classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objectives:

- To make the students aware of various pests of food crops and food products and various insect control methods.
- To educate the students about economic importance and techniques of Apiculture and sericulture
- To introduce students to the various orders and some of the most important families of insects so that they can distinguish between harmful and beneficial insects, which form the basis of entomology.

Course Outcomes: Upon completion of the course, students should be able to:
CO^1 Identify the organism belonging to the class insecta and Understand the economic importance of insects.
CO^2 Get a glimpse of the highly organized social life of insects.
CO^3 Appreciate the diversity of insects
CO^4 Understand the physiology of Insects which has made them the most successful animals in terms of numbers and variety of species.

Attendance Requirements:
Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.

Evaluation Criteria:
Mid Term Examination: 20
End Term Examination: 60
Continuous Internal Assessment: 20

Course Contents:

UNIT- I: INTRODUCTION TO CLASS INSECTA (4 hours)
General Introduction of Class Insecta: Characteristic and adaptive features for diversity, Basis of classification and classification up to orders.

General Anatomical description of Insect body: Segmentation and Tagmosis; Integument-structure and function of cuticle, Moulting, Sclerotization and Colouration; Head-Structure of head, Appendages and Antennae, types of antennae; Thorax- Generalized thoracic structure, Appendages of thorax, Types of legs, Development of wings,Types of wing, Flight mechanism, Abdomen- Structure, Appendages; External genitalia.

UNIT-II: DIGESTION, RESPIRATION AND CIRCULATION IN INSECTS (4 hours)

Digestive system: Mouth parts, types and feeding mechanism, Structure of alimentary tract and accessary glands, mechanism of digestion and absorption; Respiratory system: Aerial respiration- spiracles, trachea and tracheoles;Aquatic respiration, mechanism of gas exchange; Circulatory system: organs and mechanism of circulation, haemolymph and haemocytes.

UNIT-III: **EXCRETION, REPRODUCTION AND NERVOUS SYSTEM OF INSECTS (4 hours)**

Excretory system: Organs and physiology of excretion, Osmoregulation; Reproductive system: Female & Male reproductive systems; Modes of reproduction; Nervous system-vision (Structure of compound eye, Formation of image)and acoustics (Sound production organs, structure and Mechanism of sound production).

UNIT-IV: SOCIAL, BENEFICIAL AND HARMFUL INSECTS (4 hours)

Social Insects: Evolution of Sociality, Life cycle and Social organization of termites, honeybees and ants.

Beneficial and Harmful Insects: Pollinator and Edible insects, Insect pests of agricultural and medical importance.

UNIT-V: INSECT DEVELOPMENT AND COMMUNICATION (4 hours)

Chemical Communication in Insects: Pheromones and allomones-chemistry and functions; Bioluminescence: Structure of organs and mechanism of light production; Endocrine system: Insect hormones, Metamorphosis; Insect development: Types of larvae and pupae.

SUGGESTED BOOKS:

1. Imms , A. D., A general text book of entomology, Chapman & Hall, UK
2. Borror, D. J., Triplehorn, C. A., and Johnson, Introduction to the study of insects, N. F.,M Saunders College Publication, USA
3. Gullan, P. J., and Cranston, P. S.,The Insects, An outline of Entomology, Wiley Blackwell, UK
4. Snodgrass, R. E., Principles of Insect Morphology, Cornell Univ. Press, USA
5. Chapman, R. F., The Insects: Structure and function, Cambridge University Press, UK
6. Wilson, E. O., The Insect Societies, Harvard Univ. Press, UK .
7. Wigglesworth, Vincent B, The Principles of Insect Physiology, Chapman & Hall Ltd. USA.
8. Klowden, M. J., Physiological system in Insects, Academic Press, USA

Course Articulation Matrix of ZOO 420- Entomology

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1								
CO2								
CO3								
CO4								

1. Partially Related; 2. Moderately Related; 3. Highly Related

Course Code: **ZOO 421**
Course Name: **Ecology, Environment and Biodiversity**
Course Instructor: **Dr. Amit Kumar**
Credits: **2**

Credits Equivalent: (One credit is equivalent to 10 hours of lectures / organized classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objectives:

- To acquaint the students with the habitat and interactions of diverse animal groups with their environment.
- To educate the students about the basic environmental phenomena like ecosystem, energy flow through the ecosystem and biogeochemical cycles.
- To enable the students to develop an appreciation for the biodiversity of invertebrate and vertebrates.

Course Outcomes: Upon completion of the course, students should be able to:
CO^1 Students will be exposed to the fundamental aspects of ecology.
CO^2 Student will get idea about the impact of anthropogenic activities on the environment.
CO^3 Students will get idea about the natural resources and their conservation.
CO^4 Apply the basic principles of ecology in wildlife conservation and management.

Attendance Requirements:
Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.

Evaluation Criteria:

Mid Term Examination: 20
End Term Examination: 60
Continuous Internal Assessment: 20

Course Contents:

UNIT-I: CONCEPT AND STRUCTURE OF ECOSYSTEM
Physical environment; biotic and abiotic factors,Ecosystem and its types, Ecosystem structure, function productivity and energy flow. Habitat, ecological niche, fundamental and realized niche; resource partitioning; character displacement.Ecological succession and its types

UNIT-II: POPULATION ECOLOGY
Characteristics of a population; population growth curves; population regulation; life history strategies (r and K selection), Species Interactions and its types

UNIT-III: BIODIVERSITY AND ITS CONSERVATION
Biological diversity: concepts and levels, role of biodiversity in ecosystem functions and stability, Categories of threat, Terrestrial biodiversity hot spots.Conservation of biodiversity: *In-situ* and *Ex-situ* conservation of biodiversity.

UNIT-IV:BIODIVERSITY MANAGEMENT
Sustainable development, natural resource management in changing environment. Molecular ecology, genetic analysis of single and multiple population, phylogeography, molecular approach to behavioural ecology, conservation genetics.

UNIT-V: ENVIRONMENTAL POLLUTION
Air pollution, Water pollution, Soil pollution, Noise pollution, Ozone and climate change.

SUGGESTED BOOKS:

1. Charls J. Kreb. 1972. Ecology: The Experimental Analysis of Distribution and Abundance
2. Phi**l**ipson,J.1966.EcologicalEneregetic,EdwardArnoldLtd.London.
3. Odum,E.P.1970:Ecology,AmerindPubl.Co.NewDelhi.
4. Kormondy,E.T.1971.ConceptofEcology.PrenticeHa**l**ofIndia,NewDelhi.
5. Ricklefs,R.E.1973.Ecology.ThomesNelsonandsonsltd.
6. Colinbaux,P.A.1985Introductiontoecology.JohnWiley&Sons.
7. Wiegert,R.G.1976.EcologicalEnergeticDowden,Hutchinson&Ross.Inc.Pennsylvania.
8. Scuthwick,C.H.1976.Ecologyandthequalityofourenvironment.D.VanNestrand
9. Fahey,J.J,andKnapp,A.K.2007.Principles and Standards for measuring primary production.
10. OxfordUniv.Press.UK.
11. Grant,W.E.andSwanmack,T.M.2008.EcologicalModeling.Blackwe**l**Publ.Hou
12. 1. Evolution, Barton, N. H., Briggs, D. E.G., Eisen, J. A., Goldstein, A. E., Patel, N. H., Cold Spring Harbor Laboratory Press, New York, USA
13. 2. Evolution, Hall, B. K. and Hallgrimsson, B., Jones and Bartlett Publisher, Sudbury, USA
14. 3. Evolution, Futuyma, D. J., Sinauer Associates, Inc., Sunderland, USA
15. 4. What Evolution Is, Mayr, E., (2001), Basic Books, New York, USA

Course Articulation Matrix of ZOO 421- Ecology, Environment and Biodiversity

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	1	1	1	1		3	1	1
CO2	2	1	1	2		3	1	1
CO3	1	2	3	1		1	2	3
CO4	2	2	1	3		2	1	1

1. Partially Related; 2. Moderately Related; 3. Highly Related

Course Code: **ZOO 422**
Course Name: **Immunology**
Course Instructor: **Dr. Rakesh Kumar**
Credits: **2**

Credits Equivalent: (One credit is equivalent to 10 hours of lectures / organized classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objectives:

- To enable understanding the molecular and cellular basis of the development and function of the immune system and identification of its biological, clinical and therapeutic implications.
- To make the student understand the role of immunity in controlling the pathogenic infection.
- To acquaint the students with the defense mechanisms of animals/bodies.

Course Outcomes: Upon completion of the course, students should be able to:

CO^1 Define the cellular/molecular pathways of humoral/cell-mediated adaptive responses including the role of Major Histocompatibility Complex

CO^2 Integrate knowledge of each subsystem to see their contribution to the functioning of higher-level systems in health and disease.

CO^3 Discuss various types of hypersensitivity.

CO^4 Understand vaccination, autoimmunity, immunodeficiency, hypersensitivity and tolerance.

Attendance Requirements:
Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.

Evaluation Criteria:
Mid Term Examination: 20
End Term Examination: 60
Continuous Internal Assessment: 20

Course Contents:

UNIT –I: OVERVIEW OF IMMUNE SYSTEM
Components of the immune system, principles of innate and adaptive immunity, antigen and immunogenicity, clonal selection theory; Evolution of immune system.

UNIT –II: PATTERN RECOGNITION AND BCR
Antigen recognition by immune cells:Innate Immunity- Pattern recognition in the innate immune system, TLRs and their role in innate immune response; Adaptive immunity- Antibody structure, antigen recognition by B lymphocytes; molecular mechanism behind BCR formation; B lymphocyte development and survival. Structure and function of MHC

complex: antigen processing cells, antigen processing and presentation to T lymphocytes, MHC restriction.

UNIT –III: TCR- STRUCTURE AND FUNCTION

TCR structure and function: T-cell receptor gene rearrangement; T lymphocyte development and survival; Antigen recognition by T-cells, signaling through TCR and T-cell activation, co- receptors and their role in T –cell functioning; co-stimulation.

UNIT –IV: EFFECTOR MECHANISM OF IMMUNE SYSTEM

Effector mechanisms and regulation of immune responses: Induced innate response to infection, Innate memory, Complement system, NK and NKT cell functions,Humoral immune response, Production of effector T- cells, cytotoxic T- cell effector mechanisms.

UNIT –V: REGULATION OF IMMUNE SYSTEM

Regulation of immune response:Leukocyte activation and migration, Cytokines, innate regulation of the immune response, T-cell mediated immune response, Immunological tolerance. Mucosal immunity. Immunity in health and disease: Allergy and hypersensitivity, Autoimmunity, Immunodeficiency diseases

SUGGESTED BOOKS:

1. Kuby Immunology, Richard, Thomas, Barbara, Janis , W. H. Freeman and Company [Latest edition].
2. Immuno Biology- The immune system in health and disease, Janeway, Travers, Walport and Shlomchik, Garland Science Publishing [Latest edition].
3. Essentials of Immunology, David, Brostoff and Roitt, Mosby & Elsevier Publishing[Latest edition].
4. Fundamentals of Immunology by William E. Paul, Lippincott Williams & Wilkins Publishing[Latest edition].
5. Cellular and Molecular Immunology by Abul K. Abbas, Andrew H. Lichtman, Shiv Pillai, Elsevier Publishing [Latest edition].

Course Articulation Matrix of ZOO 422 - Immunology

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	2	2	3	2		3	1	3
CO2	1	2	1	1		2	1	1
CO3	2	1	3	1		3	1	2
CO4	3	1	2	1		2	1	2

1. Partially Related
2. Moderately Related
3. Highly Related

Course Code: **ZOO 423**
Course Name: **Advanced Techniques in Biology**
Course Instructor: **Dr. Amit Kumar**
Credits: **2**

Credits Equivalent: (One credit is equivalent to 10 hours of lectures / organized classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other wolrkload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objectives:
To acquaint the students with various instruments and methodological techniques enable them to peruse scientific research in future

Course Outcomes: Upon completion of the course, students should be able to:

CO[1] To demonstrate proper and safe laboratory practice

CO[2] Student will be able to demonstrate the equipment and principle of working.

CO[3] Apply their knowledge to use basic techniques in several areas and advanced techniques.

CO[4] Hands on knowledge of the PCR, EM, ELISA.

Attendance Requirements:
Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.

Evaluation Criteria:

4. Mid Term Examination: 20
5. End Term Examination: 60
6. Continuous Internal Assessment: 20

Course Contents:

UNIT –I: MICROSCOPY AND IMAGE ANALYSIS
Significance of microscopy, stereoscopic zoom microscope, compound microscope, Bright field microscope; fluorescence microscope; confocal microscope,

UNIT –II: ELECTRON MICROSCOPY
Scanning Electron Microscope (SEM) and Transmission Electron Microscope (TEM). Image acquisition and data analysis.

UNIT –III: ANALYTICAL TECHNIQUES AND INSTRUMENTATION
Colorimetry; Spectrophotometry, Atomic Absorption Spectrophotometry (AAS), Basic Lab Instruments Skills using Laminar Air Flow, Incubator, Oven, Autoclave etc. Cell Staining Techniques, Cell Culture of Prokaryote and Eukaryote. Basic Sterilization Techniques in Laboratory. Reagent Preparation in Lab.

UNIT –IV: CHROMATOGRAPHY

Chromatographic Techniques, Thin Layer Chromatography, Paper Chromatography, High Performance Liquid Chromatography, Gas Chromatography, GC Mass Spectroscopy.

UNIT –V: ELECTROPHORESIS AND PCR

Electrophoresis and PCR, Immmunological techniques like ELISA and RIA, Chromatography – HPLC/GCMS, ICPMS.

SUGGESTED BOOKS:

1. Principles and Techniques in biochemistry and molecular biology Wilson &Walkes
2. Culture of animal cells Freshuay
3. Sharma V.K.(1991), Techniques in microscopy and cell Viology, Tata-Mc Craw Hil.
4. Robert Braun Introduction to instrumental analysis Mc.Crew.Hil
5. Bisen&Mathw. Tools and Techniques in Life Sciences, CBS Publishers & distributors.
6. Principles of animal cell culture, Basant Kumar &Rinesh Kumar, Int.Bork 2008, XXII edn.

Course Articulation Matrix of ZOO 423- Advanced Techniques in Biology

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	1	1	3	2		1	3	2
CO2	1	3	1	1		1	1	3
CO3	1	2	1	3		3	3	2
CO4	2	1	2	3		2	1	3

1. Partially Related
2. Moderately Related
3. Highly Related

Course Code: **ZOO 424**
Course Name: **Basics of Wild Life Study**
Course Instructor: **Dr. Rakesh Kumar/Dr. Sunil Kumar**
Credits: **2**

Credits Equivalent: (One credit is equivalent to 10 hours of lectures / organized classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objectives:

- To educate the students about the basic environmental phenomena like pollution, ecosystem, biogeochemical cycles, etc.
- To educate the students about the importance of wild life conservation.

Course Outcomes: Upon completion of the course, students should be able to:
CO^1 Identify the problems in wildlife and conservation biology
CO^2 Know the principles of wildlife and conservation biology and how they are used to manage wildlife and solve environmental problems
CO^3 Apply their knowledge for conservation of wildlife.
CO^4 Discuss the importance of the wildlife among community.

Attendance Requirements:
Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.

Evaluation Criteria:
Mid Term Examination: 20
End Term Examination: 60
Continuous Internal Assessment: 20

Course Contents:

UNIT - I: BASIC CONCEPT OF WILDLIFE BIOLOGY
Definition and importance of wildlife and biodiversity; Values of wildlife- positive and negative.
Threatened wildlife and IUCN status - Concept of Extinct, Critically Endangered, Endangered, Vulnerable and rare species; Red data book.
Conservation ethics; Importance of conservation; Causes of depletion; World conservation strategies: WCS, CBD, Agenda 21

UNIT – II: WILDLIFE SAMPLING
Random sampling, systematic sampling, stratified sampling, cluster sampling (Basics).
Habitat analysis: a) Physical parameters: Topography, Geology, Soil and water; b) Biological Parameters: food, cover, forage, browse and cover estimation; Faecal analysis of ungulates and carnivores: Faecal samples, slide preparation, and Hair identification; Pug marks and Census methods, Standard evaluation procedures: remote sensing and GIS.

UNIT – III: WILDLIFE CONSERVATION STRATEGIES AND POLICIES

Estimation of carrying capacity; Human-wildlife conflict; Eco tourism / wild life tourism in forests; Climax communities: characteristics and theories; Ecology of purterbance.

*In situ*and *Ex situ* conservation- problems and prospects; Sanctuaries, National parks, Community Reserves and Conservation Reserves; Biosphere Reserve, Concept of corridor. Environmental Laws- Environment Protection Act, Air act, Water act, Wildlife protection act, Forest conservation act.

UNIT – IV: WILDLIFE CONSERVATION IN INDIAN PERSPECTIVE

Aims & Objectives of wildlife conservation. Wildlife wealth of India; causes for depletion of Indian wildlife; wildlife conservation in India- through age, post-independence initiatives. Different approaches for conservation – *in situ* and *ex situ*.

UNIT – V: MANAGEMENT OF IMPORTANT WILD ANIMALS

Conservation status, habit & habitat, behavioural biology, threats and conservation management of the animals-Himalayan salamander/Olive ridley turtles/Great Indian bustard/Himalayan musk deer/Ganges river dolphin.

- Project tiger
- Project elephant
- Project crocodile

SUGGESTED BOOKS:

1. Saha, G.K. and Mazumdar, S. (2017). Wildlife Biology: An Indian Perspective. PHIlearningPvt. Ltd. ISBN: 8120353137, 978-812035313
2. Sinclair, A.R.E., Fryxell, J.M. and Caughley,G. (2006). Wildlife Ecology, Conservationand Management. Wiley-Blackwell, Oxford, UK.
3. Singh, S.K. (2005). Text Book of Wildlife Management. IBDC, Lucknow.
4. Singh, I.K. and Maurya A.K. (2016) Basics of Environmental Studies, Book Age Publications, ISBN: 9789383281411

Course Articulation Matrix of ZOO 424- Basics of Wild Life Study

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	3	1	3	2		3	1	2
CO2	3	3	1	1		3	1	3
CO3	3	2	1	3		3	2	2
CO4	2	1	2	3		2	1	3

1. Partially Related
2. Moderately Related
3. Highly Related

Course Code: **ZOO 425**
Course Name: **Medical Microbiology**
Course Instructor: **Dr. Amit Kumar/Dr. Ranjit Kumar**
Credits: **2**

Credits Equivalent: (One credit is equivalent to 10 hours of lectures / organized classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objectives:

- The main objective of this course is to provide basic knowledge to students on various microbiological practices in the laboratory.
- To elaborate their knowledge in basic microbiology techniques and performing experiments to identify unknown bacteria by biochemical tests, fungal cultivation and staining, special media.

Course Outcomes: Upon completion of the course, students should be able to:
CO[1] Understand the methods of cultivation of microorganisms
CO[2] To understand and perform various biochemical tests to identify unknown microorganisms, practical exposure to fungus cultivation and staining.
CO[3] To understand the use of differential, selective and special media.
CO[4] Understand and explain the medically important insects.

Attendance Requirements:
Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.

Evaluation Criteria:
Mid Term Examination: 20
End Term Examination: 60
Continuous Internal Assessment: 20

Course Contents:

UNIT I: INTRODUCTION TO MEDICAL MICROBIOLOGY
Principles of classification of microbes; morphological, metabolic and molecular criteria for the classification, A brief introduction to major group of bacteria. Ultra structure of bacteria. Microbial Cultivation, Growth curve and factors influencing growth. Nutritional types requirements of bacteria.

UNIT II: STERILIZATION AND STAINING
Disinfection and sterilization: Staining characteristics and techniques. Serological characteristics, Bacterial respiration, Microbial Diversity.

UNIT III: FOOD MICROBIOLOGY

Food Microbiology: Microbiology of dairy industry and beverage fermentation. Role of microorganisms in beverages tea and coffee fermentations. Vinegar Fermentation, microbiology of wine industry. Genetically modified foods. Biosensors in food.

UNIT IV: ANTIBIOTICS AND THEIR MECHANISM OF ACTION

Antibiotics and their Mechanism of action. Molecular principles of drug targeting. Bacterial resistance to antibiotics. New vaccine technology, DNA vaccines, synthetic peptide vaccines, multivalent subunit vaccines. Vaccine clinical trials.

UNIT V: MEDICAL MICROBIOLOGY

Diseases caused by Gram positive bacteria, Diseases caused by Gram
negative bacteria, Disease caused by toxigenic bacteria, Diseases caused by Gram negative bacteria of family Enterobacteriaceae, sexually transmitted diseases, Overview of medical mycology, Overview of medical parasitology.

SUGGESTED BOOKS:

1. Mackie & McCartney Practical Medical Microbiology 14th edition: Eds: J.G.Colle, A.G. Fraser, B.P. Marmion, A.Simmons- Reprint 2008 Elsevier, New Delhi
2. Jawetz, Melnick &Adelberg's, Medical Microbiology 24th edition: Eds: Brooks and others, McGraw Hill, New York.
3. Koneman'sColorAltas and Text book of Diagnostic Microbiology 6th edn: Eds: Washington winn and others. 2006 Lippincott Williams and Wilkins, Baltimore, USA
4. Ananthanarayan and Paniker's Text book of Microbiology 8th edn. 2009 Universities Press, Hyderabad.
5. Ananthanarayan&Paniker's Textbook of Microbiology, 8th Ed., Orient Longsman, India; 2009.

Course Articulation Matrix of ZOO 425- Medical Microbiology

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	3	1	3	2		3	3	2
CO2	3	3	1	1		3	1	3
CO3	1	2	1	3		3	3	2
CO4	2	1	2	3		2	1	3

1. Partially Related
2. Moderately Related
3. Highly Related

Course Code: **IKS**
Course Name: **Bhartiya Knowledge System**
Course Instructor: **Dr. Sunil Kumar**
Credits: **2**

Credits Equivalent: (One credit is equivalent to 10 hours of lectures / organized classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objectives:

- This course aims at introducing students with various treatises on physical as well as ancient sciences and their contribution to modern branches of sciences and also making a student to ponder over the ancient knowledge systems of India.
- The Course is designed in order to associate the young Indian minds to their ancient knowledge systems, wisdom, culture and patterns of growth of personality in order to understand the environment around them.

Course Outcomes: Upon completion of the course, students should be able to:
CO^1 Channelizing their mind in positive, valued and ethically rational activities.
CO^2 Understand the significance of ancient Indian wisdom and knowledge.
CO^3 Ability to understand, connect up and explain basics of Indian Traditional knowledge to modern scientific perspective.
CO^4 Understand the Holistic life style of Yogic-science and wisdom capsules in Sanskrit literature are also important in modern society with rapid technological advancements and societal disruptions.

Attendance Requirements:
Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.

Evaluation Criteria:
Mid Term Examination: 20
End Term Examination: 60
Continuous Internal Assessment: 20

Course Contents:

UNIT -I: BHÂRATÏYA CIVILIZATION AND DEVELOPMENT OF KNOWLEDGE SYSTEM (4 hours)

Antiquity of civilization, Discovery oí the Saraswati River, the Saraswatï-Sindhu Civilization, Traditional Knowledge System, The Vedas, School of Philosophy (6+3), Ancient Education System, the Takṣaśilã University, the Nãlandã University

UNIT-II: ARTS, LITERATURE, AND SCHOLARS IN ANCIENT BHARAT (4 hours)
Art, Music, and Dance, Natarãja- A Masterpiece of Bhãratïya Art, Literature, Life and works of Agastya, Lopãmudrã, Ghoṣã, Vãlmiki, Patañjali, Vedavyäsa, Yãjñavalkya, Gârgi, Caraka, Suśruta, Ka?ãda, Kauṭilya, Pãqini, Thiruvalluvar, Ãryabhaṭa, Bhãskarãcãrya, Mãdhavãcãrya.

UNIT-III: ANCIENT BHARTIYA CONTRIBUTION TOWARDS SCIENCE & MATHEMATICS (4 hours)
Sage Agastya's Model of Battery, Vedic Cosmology and Modern Concepts, Concept of Zero and Pi, Number System, Phythagoras Theroem, and Vedic Mathematics; Kerala School for Mathematics and History of Culture of Astronomy, Astronomical of day, year and Yuga.

UNIT-IV: ANCIENT BHARTIYA ENGINEERING, TECHNOLOGY & ARCHITECTURE (4 hours)
Pre-Harappan and Sindhu Valley Civilization, Juices, Dyes, Paints and Cements, Glass and Pottery, Metallurgy, Iron Pillar of Delhi, Rakhigarhi, Mehrgarh, Sindhu Valley Civilization, Marine Technology, and Bet-Dwãrkã.

UNIT-V: ANCIENT BHARTIYA CONTRIBUTION IN ENVIRONMENT & HEALTH (4 hours)
Ethnic Studies, Life Science in Plants, Agriculture, Ecology and Environment, Ayurveda, Integrated Approach to Healthcare, Surgery, and Yoga, etc.

Course Articulation Matrix of IKS- Bhartiya Knowledge System

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	3	1	3	2		1	3	2
CO2	1	3	1	1		1	1	3
CO3	3	2	3	3		3	3	2
CO4	2	1	2	3		2	1	3

1. Partially Related
2. Moderately Related
3. Highly Related

SEMESTER II

Course Code: **ZOO 465**
Course Name: **Cytogenetics**
Course Instructor: **Dr. Ranjit Kumar**
Credits: **2**

Credits Equivalent: (One credit is equivalent to 10 hours of lectures / organized classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objectives:

- To provide an overview of genetics starting from the work of Mendel to the current understanding of various phenomena like recombination, transposition, sex determination and mutations
- To introduce the basic concepts of inheritance patterns, genetic and genomic basis of traits.
- To inculcate a holistic understanding about the genetic basis of a particular clinical disorder.

Course Outcomes: Upon completion of the course, students should be able to:
CO^1 Have a deeper understanding of the varied branches of the biological sciences like microbiology, evolutionary biology, genomics and metagenomics.
CO^2 Students will gain knowledge of the basic principles of inheritance.
CO^3 Analyse pedigree leading to development of analytical skills and critical thinking enabling the students to present the conclusion of their findings in a scientific manner
CO^4 Discuss and demonstrate the topic like cancer in the community.

Attendance Requirements:
Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.

Evaluation Criteria:
Mid Term Examination: 20
End Term Examination: 60
Continuous Internal Assessment: 20

Course Contents:

UNIT –I: CHROMOSOME ORGANISATION (4 hours)
Chromatin structure, Histones, DNA, nucleosome morphology and higher level organization. Functional states of chromatin. Metaphase chromosomes, centromere and kinetochore. Telomere and its maintenance. Holocentric chromosomes, heterochromatin and euchromatin. Giant chromosomes likePolytene and lampbrush chromosomes.

UNIT –II: CELL DIVISION (4 hours)
Overview of mitosis and meiosis, sister chromatid cohesion remodeling, regulation of exit from metaphase, chromosome movement at anaphase. Stages in cell cycle.

UNIT –III: CYTOPLASMIC INHERITANCE (4 hours)

Extra chromosomal inheritance**.** Inheritance of mitochondrial and chloroplast genes, maternal inheritance, Role of Mitochondrial inheritance in Evolution.

UNIT –IV: DISEASE DUE TO CHROMOSOMAL ABBERATIONS AND CANCER (4 hours)

Chromosomal anomalies. Structural and numerical alterations of chromosomes, Deletion, duplication, inversion, translocation, ploidy and their genetic implications and common disease due to chromosomal anomalies.

UNIT –V: CANCER GENETICS

Genetics and cancer: oncogenes- tumor inducing retroviruses and viral oncogenes; chromosome rearrangement and cancer; tumor suppressor genes- cellular roles of tumor suppressor genes, pRB, p53, pAPC, genetic pathways to cancer.

SUGGESTED BOOKS:

1. Gardner, E.J.; Simmon, M.J. and Snustad, D.P. Principles of Genetics, John wiley& Sons, inc. NY.
2. Weaver, R.F. and Hedrick, P.W. Genetics. Wm C. Brown Publishers.
3. Brown, T.a. Genetics- A Molecular, Approach, Chapman & Hall.
4. Mitra, S. Genetics-A Blueprint of life, Tata McGraw Hill
5. Dobzhansky, Th. Genetics and Origin of Species. Columbia University Press.
6. Dobzhansky, Th; Ayala, F.J.; Stebbins, G.L. and Valentine, J.M. Evolution, Surjeet Publihsers, Delhi.
7. Futuyama, D.J. Evolutinary Biology, Suinuaer Associations. INC Publishers. Dunderand.
8. King, M. Species, Evolution –The role of chromosomal change. The Cambridge University Press, Cambridge.
9. Merrel, D.J. Evolution and Genetics Holt. Rinchart and Winston, Inc.
10. Strikberger, M.W. Evolution Jones and Barlett Publishers. Boston London.

Course Articulation Matrix of ZOO 465- Cytogenetics

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	3	1	3	2		3	3	2
CO2	2	3	3	1		1	1	3
CO3	1	2	1	3		3	3	2
CO4	2	3	2	3		2	1	3

1. Partially Related
2. Moderately Related
3. Highly Related

Course Code: **ZOO 466**
Course Name: **Comparative Anatomy of Vertebrate**
Course Instructor: **Dr. Rakesh Kumar**
Credits: **2**

Credits Equivalent: (One credit is equivalent to 10 hours of lectures / organized classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objectives:

- To enable the students to develop an appreciation for the biodiversity of vertebrates.
- To draw a comparative account of anatomy of vertebrates and hence to understand the evolution of different systems in vertebrates.
- The course furnishes an understanding of evolutionary basis of morphological and anatomical differences as well as similarities that occur among vertebrates.

Course Outcomes: Upon completion of the course, students should be able to:
CO^1 Explain comparative account of the different vertebrate systems
CO^2 Learn the comparative account of integument, skeletal components, their functions and modifications in different vertebrates.
CO^3 Understand the evolution of heart, modification in aortic arches, structure of respiratory organs used in aquatic, terrestrial and aerial vertebrates.
CO^4 **Comp**are and contrast digestive system and its anatomical specializations with respect to different diets and feeding habits.

Attendance Requirements:
Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.

Evaluation Criteria:
Mid Term Examination: 20
End Term Examination: 60
Continuous Internal Assessment: 20

Course Contents:

UNIT I: INTRODUCTION AND INTEGUMENTARY SYSTEM
Introduction to chordates. Organisation and affinities of *Herdmania* and *Amphioxus*. Comparative account of following systems of the vertebrates with evolutionary trends from Pisces to Mammals. Integumentary system: Integument and its derivatives.

UNIT II: SKELETAL AND DIGESTIVE SYSTEM
Skeletal system: Chondrocranium, Splanchnocranium, Dermatocranium, Jaw suspension. Digestive system: Alimentary canal and associated glands. (Types of teeth,dental formulae and functions, Types of stomach, small and large intestines, Glands : Salivary, gastric, Pancreas and liver).

UNITIII: CIRCULATORY AND RESPIRATORY SYSTEM

Circulatory system: Evolution of heart & aortic arches in different classes of vertebrates. Respiratory system: Respiratory organs. Types of respiratory mechanisms (gills, lungs, skin and accessory respiratory organs).

UNITIV: URINOGENITAL SYSTEM

Urinogenital system: Succession of kidney (archinephros, pronephros, mesonephros, and metanephros), osmoregulation, evolution of gonads and urinogenital ducts.

UNITV: NERVOUS SYSTEM AND SENSE ORGANS

Nervous system: Comparative account and evolution of brain, spinal cord and cranial nerves.Sense organs: Chemoreceptors, photoreceptors and mechanoreceptors

SUGGESTED BOOKS:

1. A Text Book of Zoology, Vol.II Vertebrates by A.J. Marshall, MacMillan & Co. Ltd., New York (1972). 2. Anatomy of Chordates by C.K. Weichert, McGraw Hill Book Co. Inc. London (1958).
2. Biology of Vertebrates by H.E. Walter and L.P. Sayles, McMillan Co. New York (1949).
3. Comparative Anatomy of Vertebrates by G.C. Kent, TorpenCo.Ltd., Tokyo (1954).
4. Anatomy of Comparative Vertebrates. Hyman, L. H. Satish Serial Pub. House 2004.

Course Articulation Matrix of ZOO 466- Comparative Anatomy of Vertebrate

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	1	3	3	2		2	3	2
CO2	3	3	2	1		1	1	3
CO3	3	2	1	3		3	3	2
CO4	2	1	2	3		2	1	3

1. Partially Related
2. Moderately Related
3. Highly Related

Course Code: **ZOO 467**
Course Name: **Biosystematics and Evolution**
Course Instructor: **Dr. Amit Kumar/Dr. Rakesh Kumar**
Credits: **2**

Credits Equivalent: (One credit is equivalent to 10 hours of lectures / organized classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objectives:

- The study of evolutionary biology is essential for anyone who seeks to obtain an understanding of life and natural world. It is a unifying thread which joins all organisms from prokaryotes to highest of eukaryotes.
- This course emphasizes on the development of evolutionary thought by dealing in general with the process and pattern of biological evolution. On one hand, it offers a chance to students to learn about deciphering evidences ranging from fossil records to molecular data and arranges them to establish phylogenetic relationships of species, while, on the other, it provides a platform to understand various forces which bring about variations among populations of a species and cause them to diversify into new species.

Course Outcomes: Upon completion of the course, students should be able to:
CO^1 Acquire problem solving and high order analytical skills by attempting numerical problems as well as performing simulation studies of various evolutionary forces in action.
CO^2 Apply knowledge gained, on populations in real time, while studying speciation, behaviour and susceptibility to diseases.
CO^3 Gain knowledge about the relationship of the evolution of various species and the environment they live in.
CO^4 Discuss and recall the evolution of various vertebrates.

Attendance Requirements:
Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.

Evaluation Criteria:
Mid Term Examination: 20
End Term Examination: 60
Continuous Internal Assessment: 20

Course Contents:

UNIT – I: DEFINITION AND BASIC CONCEPTS OF BIOSYSTEMATICS
Definitions and perspectives of systematics, classification and taxonomy, goals and importance, Taxa, Taxonomic keys-different kinds, their merits and demerits Polytypic species, race, variety, cline, subspecies, semispecies, super species. Trends in Biosystematics-concepts of different conventional and newer aspects-chemotaxonomy, cytotaxonomy, molecular taxonomy

UNIT – II: TAXONOMIC PROCEDURES

Taxonomic collections, preservation, curetting, process of identification Taxonomic keys- different kinds, their merits and demerits, International code of zoological Nomenclature (ICZN)- its operative principles, interpretation and application of important rules, zoological nomenclature; formation of scientific names of various taxa

UNIT –III: INTRODUCTION TO EVOLUTION

Lamarckism; Darwinism, Evolutionary history, Adaptation, struggle, fitness and natural selection, Types of Natural selection, Stabilizing selection, Sexual Selection, Group Selection, Directional Selection, Disruptive Selection Concepts of Oparin and Haldane, Miller's experiment.

UNIT – IV: ORIGIN AND EVOLUTION OF SPECIES

Speciation, Species concepts - Typological species concept, nominalistic species concept, biological species concept, evolutionary species concept, Difficulties in applying biological species concept.

UNIT –V: EVOLUTION FROM FISH TO MAMMALS

Origin of Vertebrates: Fishes, Amphibians, Reptiles, Aves and Mammals, Evolutionary history of man.

SUGGESTED BOOKS:

1. M.Kato.The Biology of Biodiversity. Springer.
2. E.O. Wilson, biodiversity. Academic Press, Washington.
3. G.G. Simpson, Principle of animal taxonomy. Oxford IBH Publishing company.
4. E. Mayer. Eleements of Taxonomy. Oxford IBH Publishing company.
5. E.O. Wilson. The diversity of Life (The College edition W.W. Northem& Co.
6. B.K. Tikadar. Threatened Animal of India, ZSI publication Calcutta
7. V.C. Kapoor. Theory and Practice of Animal Taxonomy. Oxford & IBH Publishing Co.
8. J.C. Avise, Molecuular Markers, Natural History and Evolution, Chapman & Hall, New York.
9. Dobzhansky, Th. Genetics and Origin of Species. Columbia University Press.
10. Dobzhansky, Th; Ayala, F.J.; Stebbins, G.L. and Valentine, J.M. Evolution, Surjeet Publihsers, Delhi.
11. Futuyama, D.J. Evolutinary Biology, Suinuaer Associations. INC Publishers. Dunderand.
12. King, M. Species, Evolution –The role of chromosomal change. The Cambridge University Press, Cambridge.
13. Merrel, D.J. Evolution and Genetics Holt. Rinchart and Winston, Inc.
14. Strikberger, M.W. Evolution Jones and Barlett Publishers. Boston London.

Course Articulation Matrix of ZOO 467- Biosystematics and Evolution

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	1	1	3	2		3	3	2
CO2	3	3	1	1		1	1	3
CO3	1	2	1	3		3	3	2
CO4	2	1	2	3		2	1	3

1. Partially Related
2. Moderately Related
3. Highly Related

Course Code: **ZOO 468**
Course Name: **Developmental Biology**
Course Instructor: **Dr. Reshma Sinha/Dr. Amit Kumar**
Credits: **2**

Credits Equivalent: (One credit is equivalent to 10 hours of lectures / organized classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objectives:

- The course explains the basic principles and concepts underlying the developmental processes at the cellular and molecular level.
- The main objective of Developmental Biology course is to provide four-dimensional thinking of students to truly understand the patterns and process of embryonic development, body plan, fate map, induction, competence, regulative and mosaic development, molecular and genetic approach for the study of developing embryo which is not necessarily shared with any other disciplines in the biological sciences.

Course Outcomes: Upon completion of the course, students should be able to:
CO[1] Understand the events that lead to formation of a multicellular organism from a single fertilized egg, the zygote.
CO[2] Describe the general patterns and sequential developmental stages during embryogenesis; and understand how the developmental processes lead to establishment of body plan of multicellular organisms.
CO[3] Discuss the general mechanisms involved in morphogenesis and to explain how different cells and tissues interact in a coordinated way to form various tissues and organs.
CO[4] Relate and determine the stages of embryo development.

Attendance Requirements:
Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.

Evaluation Criteria:
Mid Term Examination: 20
End Term Examination: 60
Continuous Internal Assessment: 20

Course Contents:

Unit I: BASIC CONCEPTS OF DEVELOPMENT (4 hours)
Basic concepts of developmental biology- cell division, cell differentiation, signaling, patterning.
Model systems: vertebrates model organisms- *Xenopus laevis*, mammals, invertebrate model organism- *Drosophila melanogaster*,

Unit II: GAMETOGENESIS, CLEAVAGE AND GASTRULATION (4 hours)

Embryonic development in vertebrates and invertebrates: Structure of the gametes– the sperm, the egg; Molecular basis of spermatogenesis, Oogenesis. Fertilization, Cleavage types and significance, comparative account of gastrulation, axes and germ layers, Fate maps
Morphogenesis- movement and formation of germ layers;
Gastrulation in amphibian and birds

Unit III: EMBRYONIC DEVELOPMENT OF INVERTEBRATES AND VERTEBRATES (4 hours)

Early embryonic development- of vertebrates and invertebrates- Cleavage and formation of blastula, gastrulation, neural tube formation, cell migration;
General concept of potency, commitment, specification, induction, competence and determination. Late embryonic development- Vulva formation in Caenorhabditis, Formation of neural tube in vertebrates

Unit IV: ORGANOGENESIS (4 hours)

Concept of organogenesis- Development and patterning of vertebrate limb, homeobox genes in patterning, signaling in patterning of the limb. Postembryonic development: growth, cell proliferation, growth hormones; aging- genes and senescence
Hormonal regulation of metamorphosis in insects and amphibians; Regeneration- epimorphic and morphollaxis

Unit V: TERATOGENETICS (4 hours)

Medical implications of developmental biology-Teratogenesis: environmental assaults on development; teratogenic agents; teratological abnormalities.

SUGGESTED BOOKS:

1. Developmental Biology, Scott F Gilbert, 8thed 2006, Sinauers.
2. Essentials of Developmental Biology, JMW Slack 3rd ed, Wiley-Blackwell.
3. Principles of Development, Louis Wolpert, 3rd ed 2007, Oxford.
4. An introduction to Embryology, Balinsky, 5thed 1981, Saunders.
5. Analysis of Biological development, Kalthoff:, 1996, McGraw.

Course Articulation Matrix of ZOO 468- Developmental Biology

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	1	1	3	2		1	3	2
CO2	1	3	2	1		1	1	3
CO3	3	2	1	3		3	3	2
CO4	2	2	2	3		2	1	3

1. Partially Related
2. Moderately Related
3. Highly Related

Course Code: **ZOO 469**
Course Name: **Cytogenetics and Developmental Biology Lab**
Course Instructor: **Dr. Ranjit Kumar**
Credits: **2**

Credits Equivalent: (One credit is equivalent to 10 hours of lectures / organized classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objectives:

- The course explains the basic principles and concepts underlying the developmental processes at the cellular and molecular level.
- To introduce the basic concepts of inheritance patterns, genetic and genomic basis of traits.

Course Outcomes: Upon completion of the course, students should be able to:
CO^1 Understand the events that lead to formation of a multicellular organism from a single fertilized egg, the zygote.
CO^2 Acquire basic knowledge of the cellular processes of development and the molecular mechanisms underlying these.
CO^3 Gain knowledge of the basic principles of inheritance.
CO^4 Analyse pedigree leading to development of analytical skills and critical thinking enabling the students to present the conclusion of their findings in a scientific manner.

Attendance Requirements:
Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.

Evaluation Criteria:
7. End Term Examination: 50
8. Continuous Internal Assessment: 50

Course Contents:

1. Techniques in the study of chromosomes and their applications: Short term (lymphocyte) and long term (fibroblast) cultures, chromosome preparations, karyotyping, chromosome labeling, in situ hybridization, chromosome painting.
2. Study banding pattern of chromosome.
3. Giant chromosome polytene from Cheironomous/Drosophila larva.
4. Preparation of solutions for Molecular Biology experiments.
5. Isolation of chromosomal DNA from bacterial cells.
6. Isolation of Plasmid DNA by alkaline lysis method
7. Agarose gel electrophoresis of genomic DNA & plasmid DNA
8. Evolution study through collection of specimens.
9. Study of morphological characters of local Amphibians and Reptiles.
10. Study of Homologous and Analogous organs from suitable specimens.

11. Study of fossil evidences from plaster cast models and pictures.
12. Visit to Forest/National park/Wild life Sanctuary to study the behaviour of animals.
13. Developmental stages study of drosophila
14. Developmental stages study of amphibian embryo
15. Developmental stages study of Chick embryo
16. Developmental stages study of mammal embryo
17. Experiments of Spemann and Mangold.
18. Vital dyeing, extirpation, isolation, transplantation; Role of nucleus, cytoplasm and yolk;

Suggested Reading

1. Gardner, E.J.; Simmon, M.J. and Snustad, D.P. Principles of Genetics, John wiley& Sons, inc. NY
2. Weaver, R.F. and Hedrick, P.W. Genetics. Wm C. Brown Publishers.
3. Brown, T.a. Genetics- A Molecular, Approach, Chapman & Hall.
4. Mitra, S. Genetics-A Blueprint of life, Tata McGraw Hill
5. Developmental Biology, Scott F Gilbert, 8thed 2006, Sinauers.
6. Essentials of Developmental Biology, JMW Slack 3rd ed, Wiley-Blackwell.
7. Principles of Development, Louis Wolpert, 3rd ed 2007, Oxford.
8. An introduction to Embryology, Balinsky, 5thed 1981, Saunders.
9. Analysis of Biological development, Kalthoff:, 1996, McGraw.

Course Articulation Matrix of ZOO 469- Cytogenetics and Developmental Biology Lab

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	1	1	3	2		3	3	2
CO2	3	3	3	1		3	1	3
CO3	1	3	1	3		3	1	2
CO4	3	1	2	3		2	1	3

1. Partially Related
2. Moderately Related
3. Highly Related

Course Code: **ZOO 470**
Course Name: **Comparative anatomy of vertebrates and biosystematics Lab**
Course Instructor: **Dr. Rakesh Kumar/Dr. Amit Kumar**
Credits: **2**

Credits Equivalent: (One credit is equivalent to 10 hours of lectures / organized classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objectives:

- The course explains the basic principles and concepts underlying the developmental processes at the cellular and molecular level.
- The main objective of Developmental Biology course is to provide four-dimensional thinking of students to truly understand the patterns and process of embryonic development, body plan, fate map, induction, competence, regulative and mosaic development, molecular and genetic approach for the study of developing embryo which is not necessarily shared with any other disciplines in the biological sciences.

Course Outcomes: Upon completion of the course, students should be able to:
CO^1 Understand the events that lead to formation of a multicellular organism from a single fertilized egg, the zygote.
CO^2 Describe the general patterns and sequential developmental stages during embryogenesis; and understand how the developmental processes lead to establishment of body plan of multicellular organisms.
CO^3 Identify and characterise the morphological features of the vertebrates.
CO^4 Recognize and explain the taxonomic placement of the organisms.

Attendance Requirements:
Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.

Evaluation Criteria:
9. End Term Examination: 50
10. Continuous Internal Assessment: 50

<u>Course Contents</u>:

1. Classification upto orders, excepting Pisces and Aves, where classification upto subclasses is required, Habits, Habitats, external characters and economic importance (if any) of the following animals:
   Chondrichthyes: *Zygaena, Pristis, Trygon, Rhinobatus, Chimaera.*
   *Actinopterygii: Polypterus, Acipenser, Muraena, Catla. Hippocampus, Syngnathus, Exocoetus, Anabas, Tetradon, Echeneis*and*Solea*.
   Dipneusti (Dipnoi): *Protopterus*(Lung fish)

Amphibia: *Uraeotyphlus, Necturus, Ambystoma* and its *Axolotl* larva, *Salamandra, Hyla, Rhacophorus.*

2. **Reptilia**: *Hemidactylus, Calotes, Draco, Varanus, Phrynosoma, Chamaeleon. Typhlops, Python, Bungarus, Naja, Hydrus, Vipera, Crocodilus. Gavialis, Chelone* and *Testudo.*
3. Demonstration of dissection of *Labeo* through video clipping/models/charts: Digestive and reproductive systems, Circulatory system: heart, afferent and efferent branchial arteries, Nervous system: cranial nerves and internal ear.
4. Study of the skeleton of *Labeo, Rana* and *Varanus.*
5. Study of poison apparatus in snakes through charts.
6. **Aves**:*Anas, Milvus, Pavo, Eudynamis, Tyto* and*Alcedo.*
7. **Mammalia**: *Ornithorhynchus, Echidna, Didelphis, Macropus, Loris, Macaca,Manis, Hystrix, Funambulus, Panthera, Canis, Herpestes, Capra,Pteropus.*
8. Demonstration of dissection of Chick and White Rat through video clipping/models/charts. Chick: Digestive, arterial, venous and urinogenital systems. White Rat: Digestive, arterial, venous and urinogenital systems.

SUGGESTED BOOKS:

1. A Text Book of Zoology, Vol.II Vertebrates by A.J. Marshall, MacMillan & Co. Ltd., New York (1972). 2. Anatomy of Chordates by C.K. Weichert, McGraw Hill Book Co. Inc. London (1958).
2. Biology of Vertebrates by H.E. Walter and L.P. Sayles, McMillan Co. New York (1949).
3. Comparative Anatomy of Vertebrates by G.C. Kent, TorpenCo.Ltd., Tokyo (1954).
4. Anatomy of Comparative Vertebrates. Hyman, L. H. Satish Serial Pub. House 2004.

Course Articulation Matrix of ZOO 470- Comparative anatomy of vertebrates and biosystematics Lab

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	2	1	3	2		1	3	2
CO2	1	3	1	1		1	1	3
CO3	2	1	2	3		1	3	2
CO4	2	1	2	3		2	1	3

1. Partially Related
2. Moderately Related
3. Highly Related

Course Code: **ZOO 471**
Course Name: **Endocrinology and Neural Physiology**
Course Instructor: **Dr. Reshma Sinha/ Dr. Ranjit Kumar**
Credits: **2**

Credits Equivalent: (One credit is equivalent to 10 hours of lectures / organized classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objectives:

- To provide students with a basic understanding of human endocrine glands, neuro-endocrine glands and their structure, function and signalling pathways.
- To facilitate the understanding of the biosynthesis and biochemistry of hormones.
- To integrate the basic and clinical aspects of endocrinology to enhance the understanding of students about the consequences due to hyposecretion, hypersecretion and absence of hormones leading to various diseases and metabolic disorders.

Course Outcomes: Upon completion of the course, students should be able to:
CO^1 Understand endocrine system and the basic properties of hormones.
CO^2 Appreciate the importance of endocrine system and the crucial role it plays along with the nervous system in maintenance of homeostasis.
CO^3 Gain insight into the molecular mechanism of hormone action and its regulation.
CO^4 Identify principles /mechanism underlying various neurological disorders.

Attendance Requirements:
Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.

Evaluation Criteria:
Mid Term Examination: 20
End Term Examination: 60
Continuous Internal Assessment: 20

Course Contents:

UNIT –I: INTRODUCTION TO ENDOCRINOLOGY (4 hours)
Introduction to endocrine system and common endocrine organs. Chemical nature of hormones.Hormone Secretions (apocrine, holocrine, and merocrine) Hormone Delivery, Hormonal feedback in homeostasis

UNIT –II: MECHANISM OF HORMONE ACTION (4 hours)
Mechanism of hormone action. Protein Hormones, Membrane receptors, G-proteins and control of adenylate cyclase, Cyclic AMP cascade, Other signal Transduction systems (PLC and PLA pathways). Steroid hormones, Hypothalamo-hypophysial System, General organization, Neurohypophysial octapeptides (Oxytocin and Vasopressin). Hypophysiotropic

hormones: Chemistry localization and actions. Adenohypophysial hormones: Chemistry and physiological roles.

UNIT –III: NEURAL CONTROL OF HORMONES (4 hours)

Somatotropin and Prolacin, Glycoprotein hormones (FSH, LH and TSH), Pro-opiomelanocortin (ACTH, MSH, β-LPH & β-endorphin), Neural control of adenohypophysis. Thyroid Gland : Biosynthesis of thyroid hormones. Control of secretion and Physiological roles of thyroid hormones.

UNIT –IV: STEROID HORMONES (4 hours)

Steroid hormone biosynthesis and pathways: Testis - Physiological roles of androgens. Ovary -Physiological roles of Estrogen, Progesterone and Relaxin.

UNIT –V: ADRENAL HORMONES (4 hours)

Adrenal Cortex - Control of mineralocorticoid and glucocorticoid secretions. Physiological roles of glucocorticoid and mineralocorticoid, Neural control of endocrine system and sense organ. Adrenal Medulla: Catecholamine biosynthesis, release and its physiological roles of these hormones.

SUGGESTED BOOKS:

1. Hadley: Endocrinology, Prentice hall. International Edition. 2000
2. Norris: Vertebrate Endocrinology (2nd ed). Lea &Febriger. 1997
3. Brooks and Marshall: Essentials of Endocrinology, Blackwell Science. 1995
4. Turner and Bagnara: General Endocrinology, W. B. Saunders Company Philadelphia. 1984
5. Larson: Williams Text Book of Endocrinology, 10th edition. W. B. Saunders Company, Philadelphia. 2002.

Course Articulation Matrix of ZOO 471- Endocrinology and Neural Physiology

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	1	1	3	2		1	3	2
CO2	1	3	1	1		1	1	3
CO3	1	2	1	3		3	3	2
CO4	2	1	2	3		2	1	3

1. Partially Related
2. Moderately Related
3. Highly Related

Course Code: **ZOO 472**
Course Name: **Principles of Biochemistry**
Course Instructor: **Dr. Rakesh Kumar/ Dr. Amit Kumar**
Credits: **2**

Credits Equivalent: (One credit is equivalent to 10 hours of lectures / organized classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objectives:

- To comprehend the fundamental principles of chemistry that govern complex biological systems.
- To make the study relevant, interesting, encouraging to the students to join the industry or to prepare them for higher studies including research.

Course Outcomes: Upon completion of the course, students should be able to:
CO^1 Gain knowledge and skill in the fundamentals of biochemical sciences, interactions and interdependence of physiological and biochemical processes.
CO^2 Get exposed to various processes used in industries and gain skills in techniques of chromatography and spectroscopy.
CO^3 Demonstrate foundation knowledge in biochemistry; synthesis of proteins, lipids, nucleic acids, and carbohydrates; and their role in metabolic pathways along with their regulation.
CO^4 Recognize and explain various biochemical cycles in the body.

Attendance Requirements:
Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.

Evaluation Criteria:
Mid Term Examination: 20
End Term Examination: 60
Continuous Internal Assessment: 20

Course Contents:

UNIT- I: INTRODUCTION (4 hours)
Structure of atoms, molecules and chemical bonds, Stablizing interactions (Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction) Principles of biophysical chemistry (pH, buffer, reaction kinetics, thermodynamics, colligative properties)

UNIT- II:CARBOHYDRATES: STRUCTURE AND FUNCTION (4 hours)
General structure, classification and chemical properties of carbohydrates.
Isomerism in Glucose **(**Optical isomerism**,** Ring structure**,** Anomers & Epimers**,** Aldose & Ketose Isomerism)Bioenergetics - glycolysis, TCA cycle and oxidative phosphorylation

UNIT- III: AMINO ACIDS AND PROTEINS (4 hours)

Structure and classification of amino acids, Protein structure and function (Ramachandran plot, secondary structure, domains, motif and folds, Myoglobin, haemoglobin, etc)
Enzymes (Principles of catalysis, kinetic and regulation, isozymes), protein hormones and Conjugated proteins: Lipoproteins, glycoproteins, nucleo proteins.

UNIT- IV: LIPIDS: STRUCTURE & FUNCTION (4 hours)

Definition and Nomenclature of fatty acids Classification of fatty acids and lipids.
Saturated & Unsaturated fatty acids Simple lipids: Triacylglycerols, waxes
Complex Lipids: Phospholipids, Glycolipids Derived Lipids: Steroids, Lipoprotein, Prostaglandins, Oxidation of fatty acids; biosynthesis of saturated and unsaturated fatty acids.

UNIT- V: NUCLEOTIDES AND NUCLEIC ACIDS (4 hours)

Nucleotides; building blocks of nucleic Acid
Conformation of nucleic acids (DNA, RNA, helix (A, B, Z), t-RNA,)
Proteins-nucleic acid interaction and Post-transcriptional modification, Biosynthesis of purines and pyrimidines.

SUGGESTED BOOKS:

1. Zubay, G. 1988, biochemistry (2nd ed), Macmillan Publ. House N.Y.
2. Mahler, H.R. and codes F.H. 1971. Biological chemistry, Harper International.
3. Lehinger. A.L. 1978, Biochemistry Kalyani Publishers, Ludhiana
4. Goodwin T.W.adnMeriar L.E.I. 1989 Introductory plant Biochemistry pergamon Press VY.
5. Conn, E.E. and Shimpap, P.K. 1976. Outlines of Biochemistry Wiley Eastern
6. Styer, Biochemistry.
7. Freifelder Molecular Biochemistry.

Course Articulation Matrix of ZOO 472- Principles of Biochemistry

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	1	1	3	2		1	3	2
CO2	1	3	1	1		1	1	3
CO3	1	2	1	3		3	3	2
CO4	2	1	2	3		2	1	3

1. Partially Related
2. Moderately Related
3. Highly Related

Course Code: **ZOO 473**
Course Name: **Animal Behaviour**
Course Instructor: **Dr. Amit Kumar/Dr. Sunil Kumar**
Credits: **2**

Credits Equivalent: (One credit is equivalent to 10 hours of lectures / organized classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objectives:

- To understand the historical foundations of the field, as well as current theories and evidence for a broad range of behavioral topics.
- Behavioral ecology and the evolution of behaviors as adaptations will be recurring themes interwoven through all topics discussed. The purpose of the Animal Behavior Laboratory is for students to have hands-on experiences designing and implementing experiments that concern a variety of behavior.

Course Outcomes: Upon completion of the course, students should be able to:
CO^1 Exhibit critical and integrative thinking skills
CO^2 Demonstrate ability to communicate scientific information in both oral and written formats
CO^3 Demonstrate knowledge of key concepts in animal behavior
CO^4 Exhibit quantitative research skills (or demonstrate ability to perform all parts of the scientific method)

Attendance Requirements:
Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.

Evaluation Criteria:
Mid Term Examination: 20
End Term Examination: 60
Continuous Internal Assessment: 20

Course Contents:

UNIT- I: INTRODUCTION
Introduction -Definition, Ethology, History of the study of animal behavior and contribution of scientists; significance of Animal behaviour, objectives of behaviour; Approaches and methods in study of behaviour.

UNIT- II: PATTERNS OF BEHAVIOUR
Reflexes- reflex action, types of reflexes, reflex arch, characteristics of reflexes; Orientation and Navigation, Migration in fishes and birds; Individual behaviouralpatterns; Fixed action

pattern, Instinct and Learnt Behaviour; Associative learning, classical andoperant conditioning, Habituation, Imprinting; Learning and memory.

UNIT- III: ROLE OF BRAIN, HORMONES AND PHEREMONES

Hormones and pheromones in regulation of behaviour; Motivation; Mimicry, mimetic releaser and code breakers; Biological rhythms- Types and characteristics.

UNIT- IV: SOCIAL BEHAVIOR

An over view of Sociality in animal systems, Aggregations- Schooling in fishes, Flocking in birds, Herding in mammals, Social organization in honey bee, Various type of communications

Altruism: Reciprocal altruism, group selection, kin selection and inclusive fitness, cooperation, alarm call and Parental care.

UNIT- V: ECOLOGICAL ASPECTS OF BEHAVIOUR

Habitat selection, Homing, Territoriality, Dispersal, Foraging; Reproductive behaviour: Asymmetry and Sexual Dimorphism, Mate choice, Sexual selection and sexual conflicts.

SUGGESTED BOOKS:

1. Peter Marler and J. Hamilton, Mechanism of Animal Behaviour, John Wiley & Sons, USA
2. David McFarland,AnimalBehaviour, Pitman Publishing Limited, London, UK
3. John Alcock, Animal Behaviour, Sinauer Associate Inc., USA
4. Goodenough, McGuire and Wallace, Perspective on Animal Behaviour, John Wiley & Sons, USA
5. Sherman P. W. and John Alcock, Exploring Animal Behaviour, Sinauer Associate Inc.,Massachusetts, USA
6. Manning A. and DawkinsM.S., An Introduction to Animal Behaviour, Cambridge University Press, UK
7. Richard Dawkins, The Selfish Gene, Oxford University Press, 2016.

Course Articulation Matrix of ZOO 473- Animal Behaviour

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	1	1	3	2		3	3	1
CO2	1	2	1	1		1	1	3
CO3	1	2	1	3		3	3	1
CO4	1	1	2	3		2	1	3

1. Partially Related
2. Moderately Related
3. Highly Related

Course Code: **ZOO 474**
Course Name: **Applied Zoology**
Course Instructor: **Dr. Sunil Kumar/Dr. Reshma Sinha**
Credits: **2**

Credits Equivalent: (One credit is equivalent to 10 hours of lectures / organized classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objectives:

- To make the students aware of various pests of food crops and food products and various insect control methods.
- To educate the students about economic importance and techniques of Apiculture and sericulture

Course Outcomes: Upon completion of the course, students should be able to:
CO^1 Understand pests of food crops and food products and various insect control methods.
CO^2 Understand different honey bee species, bee products, silk worm species and sericulture.
CO^3 Understand different species of culturable fishes, ornamental fishes, fish culture practices, management of fish culture, fish processing and preservation.
CO^4 Discuss and demonstrate various techniques in the community.

Attendance Requirements:
Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.

Evaluation Criteria:

11. Mid Term Examination: 20
12. End Term Examination: 60
13. Continuous Internal Assessment: 20

Course Contents:

UNIT – I: SERICULTURE AND PISCICULTURE (4 hours)
Sericulture Silkworm and its strains, rearing of silkworms, sericulture and its components, silk reeling Pests, and diseases of silkmoth. Pisciculture Monocultuer and composite culture Fresh water, & marine fisheries, induced breeding & its technique in pisciculture; Haps & ponds for fish culture and their management. Fish diseases and their control.

UNIT – II: PEST CONTROL AND PEST MANAGEMENT (4 hours)
Pest Control Principles and practices of pest control. Methods of pest control-Chemical Biological, Microbial, Integrated control. organochlorine, Insecticides, Organisphosophorus insecticides, Carbamates, Acaricides, Nematicides, Rodenticides, Molluscicides and Botanical pesticides. Pheromonal and Hormonal control. Chemosterilants and genetic control. Crop Pests and their Management Biology and control of following insect pests of agricultural importance.

UNIT – III: MEDICAL ZOOLOGY **(4 hours)**

Medical Zoology Systematics, biology and control of following medically important organisms. Trichomonas, Onchocerca, Cyclops, sarcoptes, Dermacentor, Phlebotmus, Glossina. Mode of transmissionand of some important diseases. Cholera, Typhus, small pox, plague, Malaria, Dengue fever, Filariasis & AIDS. Metabolic and Muscular disorders Metabolic disorder with regard to major food stuffs absorption.

UNIT – IV: VACCINATION **(4 hours)**

Vaccination: Immunization; different types of vaccines; Current status of malarial vaccine.

UNIT – V: WILDLIFE CONSERVATION **(4 hours)**

Wild Life conservation and conservation strategies; Extinction of wild species meaning and cause; Wild life protection in India and classification of threatened species, protected wild animals, protected areas and their management in India Endangered fauna and special projects for endangered species.

SUGGESTED BOOKS:

1. Park, K. (2007). Preventive and Social Medicine. XVI Edition. B.B Publishers.
2. Arora, D. R and Arora, B. (2001). Medical Parasitology. II Edition. CBS Publicationsand Distributors.
3. Kumar and Corton. Pathological Basis of Diseases.
4. Atwal, A.S. (1986). Agricultural Pests of India and South East Asia, KalyaniPublishers.
5. Dennis, H. (2009). Agricultural Entomology. Timber Press (OR).
6. Hafez, E. S. E. (1962). Reproduction in Farm Animals. Lea &Fabiger Publisher
7. Dunham R.A. (2004). Aquaculture and Fisheries Biotechnology Genetic Approaches.
8. CABI publications, U.K.
9. Pedigo, L.P. (2002). Entomology and Pest Management, Prentice Hall.
10. Text Book of Applied Entomology Vol. I & II by K. P. Srivastava.

Course Articulation Matrix of ZOO 474- Applied Zoology

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	3	1	3	2		2	3	2
CO2	3	3	2	1		2	1	3
CO3	3	2	2	3		2	3	1
CO4	3	1	2	3		2	1	1

1. Partially Related
2. Moderately Related
3. Highly Related

Course Code: **ZOO 475**
Course Name: **Histology and Histochemistry**
Course Instructor: **Dr. Ranjit Kumar/Dr. Dixit Sharma**
Credits: **2**

Credits Equivalent: (One credit is equivalent to 10 hours of lectures / organized classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objectives:

- To acquaint the students with various techniques to study histology and histochemistry of various animal tissues and to know about fixation and staining techniques.
- To enable the students understand the molecular basis of cell-cell signalling, cell division and transport of ions across cell membranes.

Course Outcomes: Upon completion of the course, students should be able to:
CO[1] To identify the basic structure of cells, tissues and organs and describe their contribution to normal function.
CO[2] To interpret light- and electron-microscopic histologic images and identify the tissue source and structures.
CO[3] Apply the knowledge in disease diagnostic.
CO[4] Knowledge of basics and principle of staining.

Attendance Requirements:
Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.

Evaluation Criteria:
Mid Term Examination: 20
End Term Examination: 60
Continuous Internal Assessment: 20

Course Contents:

UNIT –I: TISSUE FIXATION (4 hours)
Fixation and Fixatives, Types of fixatives used in tissue fixation. Chemistry of fixation, Choice of Fixatives in histology

UNIT –II: TISSUE PROCESSING (4 hours)
Tissue processing, Dehydration, Clearing and Embedding, Microtomy of tissue sections. Types of microtomes. Sectioning paraffin blocks. Staining of paraffin sections

UNIT –III: PRINCIPLES AND METHODS OF STAINING (4 hours)
Principle and methods of staining. Histological stains. Haematoxylin and Eosin. Principles and methods of histochemical localization and identification of the following: Carbohydrate

moieties, Glycogen and glycoproteins with oxidizable vicinal diols by Periodic acid Schiff method. Glycoproteins with carboxyl groups and/or O-sulphate esters by Alcian blue methods.

UNIT –IV: PROTEIN ANALYSIS (4 hours)

Protein end groups, General proteins by Bromophenol blue method, –NH2 groups by Nihydrin-Schiff method, - SS groups by Performic acid –Schiff and performic acid- alcian blue methods. Lipid moieties. General lipids by Sudan black B method. Neutral lipids by total Sudan III and Sudan IV methods.

UNIT –V: NUCLEIC ACIDS ANALYSIS AND IHC (4 hours)

Nucleic acids, Methyl green pyronin for DNA and RNA. Feulgen reaction for DNA. Enzymes: Acid and alkaline phosphatases by Metal precipitation and Azo dye methods. Immunocytochemistry: Basic principles of IHC staining. Fluorescence histochemistry: Basic principles in Fluorescence histochemistry.

SUGGESTED BOOKS:

1. Boyd,W. (1976):A text book of Pathology. Structure and function in disease, 4 th edition. Lea and Fibiger, Philadephia.
2. Pearse, A.G.E. (1980): Histochemistry, theoretical and Applied ,J& A, Churchill Ltd., London.
3. Rogers, A.W.(1983): Cells and Tissues, An introduction to Histology and Cell Biology, Academic Press, NY.
4. Telford, I.R. and Bridgman,C.F.(1990). Introduction to Functional Histology, Harper and Row, NY.
5. Histochemistry in focus: A source book of techniques and research needs. (2007), K. Shyamasundari and K. Hanumantha Rao. Publisher - M. J. Publishers Chennai, India.
6. Histological and Histochemical methods: Theory and Practice. 4th edition (2008), J. A. Kiernan Publisher – Scion Publishing Ltd. Oxford shire. • Colour Atlas of Histology. 3rd edition (2000). L. P. Gartner and J. L. Hiat Publisher – Lippincott-Williams & Wilkins, Baltimore.
7. Histochemistry (Vol I –III). 4th Edition (1991), Stoward, P. J. & Pearse, A. G. E. Publisher – Churchill Livingstone Edinburgh, London.

Course Articulation Matrix of ZOO 475- Histology and Histochemistry

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	1	1	3	2		1	3	2
CO2	1	3	1	1		1	1	3
CO3	1	2	1	3		3	3	2
CO4	2	1	2	3		2	1	3
CO5	1	2	3	1		2	3	2
CO6								

1. Partially Related
2. Moderately Related
3. Highly Related

Course Code: **ZOO 476**
Course Name: **Traditional Uses of Animals For Sustainable Social and Health Welfare**
Course Instructor: **Dr. Sunil Kumar/Dr. Dixit Sharma**
Credits: **2**

Credits Equivalent: (One credit is equivalent to 10 hours of lectures / organized classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objectives:

- To comprehend the knowledge of traditional Indian system.
- To provide knowledge of traditional medicine and intellectual property issues, legal
- framework of traditional knowledge

Course Outcomes: Upon completion of the course, students should be able to:
CO^1 Discuss the concept of traditional knowledge
CO^2 Have a deeper understanding of Traditional Knowledge in Medicine
CO^3 Gain knowledge of Intellectual Property Issues in traditional knowledge
CO^4 Discuss and spread the information among the society.

Attendance Requirements:
Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.

Evaluation Criteria:
Mid Term Examination: 20
End Term Examination: 60
Continuous Internal Assessment: 20

Course Contents:

UNIT – I: INTRODUCTION TO TRADITIONAL KNOWLEDGE (4 hours)
Define traditional knowledge, nature and characteristics, scope and importance, kinds of traditional knowledge, Indigenous Knowledge (IK), characteristics. Protection of traditional knowledge. Traditional Knowledge in Different Sectors (Overview).

UNIT – II: THE MEDICAL TRADITION IN ANCIENT INDIA (4 hours)

Specialization into eight branches, The tradition of surgery, medical genetics in Ayurveda, inoculation for smallpox, microbiology and parasitology, communicable diseases and epidemics.

UNIT – III: USE OF ANIMALS FOR TREATING HUMAN AILMENTS (4 hours)
Use of Crustacean, Insects, Reptiles, Birds, Mammals, fishes etc. and their bi-product in traditional human healthcare system.

UNIT – IV: USE OF ANIMALS BI-PRODUCT IN AGRICULTURE AND FOR VETERINARY DISEASES (4 hours)

Use of Crustacean, Insects, Reptiles, Birds, Mammals, fishes etc. and their bi-product in Agriculture and Veterinary system.

UNIT – V: TRADITIONAL KNOWLEDGE AND INTELLECTUAL PROPERTY (4 hours)

Systems of traditional knowledge protection, Legal concepts for the protection of traditional knowledge, Patents and traditional knowledge, Strategies to increase protection of traditional knowledge.

SUGGESTED BOOKS:

1. Traditional Knowledge System in India, by Amit Jha, 2009.
2. Traditional Knowledge System in India by Amit Jha Atlantic publishers, 2002.
3. "Knowledge Traditions and Practices of India" Kapil Kapoor and Michel Danino.
4. Traditional Knowledge System and Technology in India (English, Hardcover,
5. Basanta Kumar Mohanta, Vipin Kumar Singh) Edition: 2012 Language English

Course Articulation Matrix of ZOO 476- Traditional Uses of Animals For Sustainable Social and Health Welfare

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	1	1	1	3		3	2	1
CO2	2	1	2	3		1	2	2
CO3	3	1	1	3		1	1	1
CO4	1	1	1	3		3	2	1

1. Partially Related
2. Moderately Related
3. Highly Related

Semester III

Course Code: **ZOO 501**
Course Name: **Entomology**
Course Instructor: **Dr. sunil Kumar/Dr. Ruchi Sharma**
Credits: **2**

Credits Equivalent: (One credit is equivalent to 10 hours of lectures / organized classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objectives:

- The course describes adverse effects of pesticides and management of crop pests by an Integrated Pest Management (IPM) approach.
- The course offers information on transmission of diseases, methods of surveillance for diseases, effective Integrated Management of Vector control and other methods of prevention of arthropod borne diseases

Course Outcomes: Upon completion of the course, students should be able to:
CO^1 Have knowledge about insects and their usage in agriculture
CO^2 To learn ill effects of pesticides and management of crop pests by bio-rational methods in an integrated approach (IPM)
CO^3 Identify pests of various crops, fruits and vegetables.
CO^4 Discuss pests with particular reference to their habits, nature of damage caused by them

Attendance Requirements:
Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.

Evaluation Criteria:
Mid Term Examination: 25
End Term Examination: 50
Continuous Internal Assessment: 25

Course Contents:

UNIT- I: INTRODUCTION (4 HOURS)
General Introduction of Class Insecta: Characteristic and adaptive features for diversity, Basis of classification and classification up to orders.
General Anatomical description of Insect body: Segmentation and Tagmosis; Integument-structure and function of cuticle, Moulting, Sclerotization and Colouration; Head-Structure of head, Appendages and Antennae, types of antennae; Thorax- Generalized thoracic structure, Appendages of thorax, Types of legs, Development of wings,Types of wing, Flight mechanism, Abdomen- Structure, Appendages; External genitalia.

UNIT-II: DIGESTIVE AND RESPIRATORY SYSTEM (4 HOURS)
Digestive system: Mouth parts, types and feeding mechanism, Structure of alimentary tract and accessary glands, mechanism of digestion and absorption; Respiratory system: Aerial respiration- spiracles, trachea and tracheoles;Aquatic respiration, mechanism of gas

exchange; Circulatory system: organs and mechanism of circulation, haemolymph and haemocytes.

UNIT-III: **EXCREATORY AND REPRODUCTIVE SYSTEM (4 HOURS)**

Excretory system: Organs and physiology of excretion, Osmoregulation; Reproductive system: Female & Male reproductive systems; Modes of reproduction; Endocrine system: Insect hormones, Metamorphosis; Nervous system- vision (Structure of compound eye, Formation of image)and acoustics (Sound production organs, structure and Mechanism of sound production).

UNIT-IV: SOCIAL INSECTS (4 HOURS)

Social Insects: Evolution of Sociality, Life cycle and Social organization of termites, honeybees and ants.

Beneficial and Harmful Insects: Pollinator and Edible insects, Agricultural insect pest and Medical Insect Vectors.

UNIT-V: COMMUNICATION IN INSECTS (4 HOURS)

Chemical Communication in Insects: Pheromones and allomones-chemistry and functions; Bioluminescence : Structure of organs and mechanism of light production; Insect development: Types of larvae and pupae.

Books:

1. Imms , A. D., A general text book of entomology, Chapman & Hall, UK
2. Borror, D. J., Triplehorn, C. A., and Johnson, Introduction to the study of insects, N. F.,M Saunders College Publication, USA
3. Gullan, P. J., and Cranston, P. S.,The Insects, An outline of Entomology, Wiley Blackwell, UK
4. Snodgrass, R. E., Principles of Insect Morphology, Cornell Univ. Press, USA
5. Chapman, R. F., The Insects: Structure and function, Cambridge University Press, UK
6. Wilson, E. O., The Insect Societies, Harvard Univ. Press, UK .
7. Wigglesworth, Vincent B, The Principles of Insect Physiology, Chapman & Hall Ltd. USA.
8. Klowden, M. J., Physiological system in Insects, Academic Press, USA

Course Articulation Matrix of ZOO 501- Entomology

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	1	1	3	3		3	3	2
CO2	1	3	1	3		3	1	3
CO3	1	2	1	3		3	3	2
CO4	2	1	2	3		2	1	3

Course Code: **ZOO 502**
Course Name: **Immunology**
Course Instructor: **Dr. Ranjit/Dr. Amit**
Credits: **4**

Credits Equivalent: (One credit is equivalent to 10 hours of lectures / organized classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objectives:
This course has been designed to equip the student with a balanced and complete scientific understanding of fisheries concepts.

Course Outcomes: Upon completion of the course, students should be able to:
CO^1 Demonstrate the basic knowledge of immunological processes at a cellular and molecular level
CO^2 Integrate knowledge of each subsystem to see their contribution to the functioning of higher-level systems in health and disease including basis of vaccination, autoimmunity, immunodeficiency, hypersensitivity and tolerance.
CO^3 Outline, compare and contrast the key mechanisms and cellular players of innate and adaptive immunity and how they related
CO^4 Define immunological principles and concepts

Attendance Requirements:
Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.

Evaluation Criteria:
Mid Term Examination: 50
End Term Examination: 100
Continuous Internal Assessment: 50

Course Contents:

UNIT –I: INTRODUCTION (4 HOURS)
Overview of the immune system:Components of the immune system, principles of innate and adaptive immunity, antigen and immunogenicity, clonal selection theory; Evolution of immune system.

UNIT –II: ANTIGEN RECOGNITION (4 HOURS)
Antigen recognition by immune cells: Innate Immunity- Pattern recognition in the innate immune system, TLRs and their role in innate immune response; Adaptive immunity- Antibody structure, antigen recognition by B lymphocytes; molecular mechanism behind BCR formation; B lymphocyte development and survival. Structure and function of MHC complex: antigen processing cells, antigen processing and presentation to T lymphocytes, MHC restriction.

UNIT –III: TCR STRUCTURE (4 HOURS)

TCR structure and function: T-cell receptor gene rearrangement; T lymphocyte development and survival; Antigen recognition by T-cells, signaling through TCR and T-cell activation, co- receptors and their role in T –cell functioning; co-stimulation.

UNIT –IV: EFFECTOR MECHNANISM (4 HOURS)

Effector mechanisms and regulation of immune responses: Induced innate response to infection, Innate memory, Complement system, NK and NKT cell functions, Humoral immune response, Production of effector T- cells, cytotoxic T- cell effector mechanisms.

UNIT –V: REGULATION OF IMMUNE RESPONSE (4 HOURS)

Regulation of immune response: Leukocyte activation and migration, Cytokines, innate regulation of the immune response, T-cell mediated immune response, Immunological tolerance. Mucosal immunity. Immunity in health and disease: Allergy and hypersensitivity, Autoimmunity, Immunodeficiency diseases

Suggested Literature:

1. Kuby Immunology, Richard, Thomas, Barbara, Janis , W. H. Freeman and Company [Latest edition].
2. Immuno Biology- The immune system in health and disease, Janeway, Travers, Walport and Shlomchik, Garland Science Publishing [Latest edition].
3. Essentials of Immunology, David, Brostoff and Roitt, Mosby & Elsevier Publishing[Latest edition].
4. Fundamentals of Immunology by William E. Paul, Lippincott Williams & Wilkins Publishing[Latest edition].
5. Cellular and Molecular Immunology by Abul K. Abbas, Andrew H. Lichtman, Shiv Pillai, Elsevier Publishing [Latest edition].

Course Articulation Matrix of ZOO 502- Immunology

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	3	1	3	2		3	3	2
CO2	3	3	3	1		3	1	3
CO3	3	2	3	3		3	3	2
CO4	3	1	2	3		3	1	3

1. Partially Related
2. Moderately Related
3. Highly Related

Course Code: **ZOO 503**
Course Name: **Ichthyology**
Course Instructor: **Dr. Rakesh Kumar**
Credits: **2**

Credits Equivalent: (One credit is equivalent to 10 hours of lectures / organized classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objectives:
This course has been designed to equip the student with a balanced and complete scientific understanding of fisheries concepts.

Course Outcomes: Upon completion of the course, students should be able to:

CO^1 Acquire knowledge of physiology, reproduction of fishes.
CO^2 Analyse different kinds of water and identify/differentiate different kinds of fishes.
CO^3 Know about different kinds of fishing methods and fish preservation which can be employed for export and storage of commercial fishes.
CO^4 Find the reasons behind the depletion of fisheries resources

Attendance Requirements:
Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.

Evaluation Criteria:
Mid Term Examination: 25
End Term Examination: 50
Continuous Internal Assessment: 25

Course Contents:

UNIT- I: INTRODUCTION AND HISTORY OF ICHTHYOLOGY (4 HOURS)
Classification and diagnostic characters (up to orders) of extant Cyclostomata, Chondrichthyes and Osteichthyes (9 major orders of fishes) ,Extinct fish group Origin, Evolution and Phylogeny of fishes External morphology, body form, appendages, pigmentation, Principles of morphometry, Locomotion

UNIT-II: EXO SKELETON (4 HOURS)
Structure and development of Placoid and Non placoid scales Food and feeding habits, Digestive system and its anatomical modifications Respiration: Structure and functions of gills; adaptations for air breathing; role of air bladder. Mechanism of gas exchange

UNIT-III: EXCRETION AND OSMOREGULATION (4 HOURS)
Glomerular and aglomerular kidneys; Nitrogen(ammonia,urea, TMAO) excretions; Mechanism of water and salt balance in fresh water, marine, estuarine fishes. Role of skin

and gills Reproduction: Structure of gonads, gametogenic cycles; spawning, Parental care Fish migration – types and regulation

UNIT-IV: BRIEF INTRODUCTION TO THERMOREGULATION OF FISHES (4 HOURS)

Nervous system and Sense organs: Organization of the central and peripheral nervous systems. Eye, lateral line organs and chemoreceptors, Electric Organ Endocrine organs: Functions of the pituitary, thyroid, inter-renal and chromaffin tissues, ultimaobranchial and corpuscles of Stannius

UNIT-V: BUOYANCY MECHANISMS (4 HOURS)

Role of fat and swim bladder Applied Ichthyology: Integrated fish farming, Carp farming, Snow trout farming Construction and Maintenance of Aquaria, ornamental fishes, indigenous and exotic fishes Economic importance of fish and fish products.

Books Recommended:

1. H.S. Bhamra and Kavita Juneja. 2001. An Introduction to Fishes
2. Arvind Kumar. 2004. Fishery Management
3. Heatranpf. 2002. handbook on Ingredients for Aquaculture feeds.
4. V.G. Jhingran. 1975. Fish and Fisheries of India.

Course Articulation Matrix of ZOO 503- Ichthyology

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	1	1	3	2		1	3	2
CO2	1	3	1	1		1	1	3
CO3	1	2	1	3		3	3	2
CO4	2	1	2	3		2	1	3

1. Partially Related
2. Moderately Related
3. Highly Related

Course Code: **ZOO 504**
Course Name: **Animal Behaviour**
Course Instructor: **Dr. Amit Kumar**
Credits: **2**

Credits Equivalent: (One credit is equivalent to 10 hours of lectures / organized classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objectives:

- The course describes adverse effects of pesticides and management of crop pests by an Integrated Pest Management (IPM) approach.
- The course offers information on transmission of diseases, methods of surveillance for diseases, effective Integrated Management of Vector control and other methods of prevention of arthropod borne diseases

Course Outcomes: Upon completion of the course, students should be able to:
CO^1 Exhibit critical and integrative thinking skills
CO^2 Understand the importance of imagination, feelings and dignity of a common man.
CO^3 Demonstrate knowledge of key concepts in animal behavior
CO^4 Understand techniques used to study animal behavior in a variety of different organisms

Attendance Requirements:
Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.

Evaluation Criteria:
Mid Term Examination: 25
End Term Examination: 50
Continuous Internal Assessment: 25

Course Contents:

UNIT- I: INTRODUCTION (4 HOURS)
Definition, Ethology, History of the study of animal behavior and contribution of scientists; significance of Animal behaviour, objectives of behaviour; Approaches and methods in study of behaviour.

UNIT- II: PATTERNS OF BEHAVIOUR (4 HOURS)
Reflexes- reflex action, types of reflexes, reflex arch, characteristics of reflexes; Orientation and Navigation, Migration in fishes and birds; Individual behaviouralpatterns; Fixed action pattern, Instinct and Learnt Behaviour; Associative learning, classical andoperant conditioning, Habituation, Imprinting; Learning and memory.

UNIT- III : IMPORTANCE OF BRAIN (4 HOURS)

Role of brain, hormones and pheromones in regulation of behaviour; Motivation; Mimicry, mimetic releaser and code breakers; Biological rhythms- Types and characteristics.

UNIT- IV: SOCIAL BEHAVIOUR (4 HOURS)

An over view of Sociality in animal systems, Aggregations- Schooling in fishes, Flocking in birds, Herding in mammals, Social organization in honey bee, Various type of communications

Altruism: Reciprocal altruism, group selection, kin selection and inclusive fitness, cooperation, alarm call and Parental care.

UNIT- V: ECOLOGICAL ASPECTS OF BEHAVIOUR (4 HOURS)

Habitat selection, Homing, Territoriality, Dispersal, Foraging; Reproductive behaviour: Asymmetry and Sexual Dimorphism, Mate choice, Sexual selection and sexual conflicts.

Suggested Books:

1. Peter Marler and J. Hamilton, Mechanism of Animal Behaviour, John Wiley & Sons, USA
2. David McFarland,Animal Behaviour, Pitman Publishing Limited, London, UK
3. John Alcock, Animal Behaviour, Sinauer Associate Inc., USA
4. Goodenough, McGuire and Wallace, Perspective on Animal Behaviour, John Wiley & Sons, USA
5. Sherman P. W. and John Alcock, Exploring Animal Behaviour, Sinauer Associate Inc.,Massachusetts, USA
6. Manning A. and DawkinsM.S., An Introduction to Animal Behaviour, Cambridge University Press, UK
7. Richard Dawkins, The Selfish Gene, Oxford University Press, 2016.

Course Articulation Matrix of ZOO 504- Animal Behaviour

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	1	1	1	2		3	1	2
CO2	2	3	2	1		1	1	1
CO3	1	1	1	3		3	3	2
CO4	2	1	2	1		2	1	3

1. Partially Related
2. Moderately Related
3. Highly Related

Course Code: **ZOO 505**
Course Name: **Biodiversity**
Course Instructor: **Dr. Ruchi Sharma**
Credits: **2**

Credits Equivalent: (One credit is equivalent to 10 hours of lectures / organized classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objectives:
To enable the students to develop an appreciation for the biodiversity of invertebrate and vertebrates.

Course Outcomes: Upon completion of the course, students should be able to:
CO^1 Understand the totality of the interactions among organisms and their biophysical environment.
CO^2 **To** develop understanding of the importance of biodiversity.
CO^3 Apply their literary knowledge to tackle the problem of encroachment and loss.
CO^4 Apply the basic principles of ecology in wildlife conservation and management
CO^4 Knowledge of various biodiversity preservation techniques.

Attendance Requirements:
Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.

Evaluation Criteria:
Mid Term Examination: 25
End Term Examination: 50
Continuous Internal Assessment: 25

Course Contents:

UNIT-I: ORIGIN AND DIVERSIFICATION OF BACTERIA AND ARCHEA (4 HOURS)

Origin and diversification of bacteria and archea; diversification of genomes; the nature of bacterial and archeal genomes; origin of genomes by horizontal gene transfer; role of plasmid and genomic islands in DNA transfer.

UNIT – II: SPECIATION (4 HOURS)

Mode of speciation- factors responsible for speciation; tempo of evolution; systematic - definition and role in biology, biological classification- theories and objectives, types of taxonomy, taxonomic diversity- definition and types, origination and extinction, rates of change in origination and extinction, causes of extinction, causes of differential rates of diversification,

UNIT-III: BIODIVERSITY (4 HOURS)

Current status and future of biodiversity; human evolution- human evolutionary history; placing humans on tree of life; genomics and humanness; current issues in human evolution.

UNIT-IV: APPLIED ECOLOGY (4 HOURS)

Applied ecology: Environmental pollution; global environmental change; biodiversity-status, monitoring and documentation; major drivers of biodiversity change; biodiversity management approaches. Conservation biology: Principles of conservation, major approaches to management, Indian case studies on conservation/management strategy (Project Tiger, Biosphere reserves).

UNIT – V: BIODIVERSITY (4 HOURS)

Biodiversity – assessment, conservation and management, biodiversity act and related international conventions. Sustainable development, natural resource management in changing environment. Molecular ecology, genetic analysis of single and multiple population, phylogeography, molecular approach to behavioural ecology, conservation genetics.

Suggested Books:

1. Evolution, Barton, N. H., Briggs, D. E.G., Eisen, J. A., Goldstein, A. E., Patel, N. H., Cold Spring Harbor Laboratory Press, New York, USA
2. Evolution, Hall, B. K. and Hallgrimsson, B., Jones and Bartlett Publisher, Sudbury, USA
3. Evolution, Futuyma, D. J., Sinauer Associates, Inc., Sunderland, USA
4. What Evolution Is, Mayr, E., (2001), Basic Books, New York, USA

Course Articulation Matrix of ZOO 505- Biodiversity

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	2	2	3	2		2	3	2
CO2	1	3	2	1		1	1	1
CO3	2	2	1	3		2	3	2
CO4	2	1	2	3		2	1	1

1. Partially Related
2. Moderately Related
3. Highly Related

Course Code: **ZOO 506**
Course Name: **Animal Biotechnology**
Course Instructor **Dr. Ruchi Sharma**
Credits: **2**

Credits Equivalent: (One credit is equivalent to 10 hours of lectures / organized classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objectives:
The course aims to introduce students to the biotechnology, understand its importance and apply in the nature.

Course Outcomes: Upon completion of the course, students should be able to:
CO^1 Define biotechnological principles and concepts.
CO^2 Explain various biotechnological procedures.
CO^3 Apply their knowledge to understand IPR, patents and copyrights.
CO^4 Understand and determine molecular biomarkers.

Attendance Requirements:
Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.

Evaluation Criteria:
Mid Term Examination: 25
End Term Examination: 50
Continuous Internal Assessment: 25

Course Contents:

UNIT – I: BIOTECHNOLOGY (4 HOURS)
Scope significance, microbes and microbial systems and their improvement for biotechnological use, Principles and techniques of plant and animal cell culture.

UNIT – II: ENVIRONMENTAL BIOTECHNOLOGY (4 HOURS)
Understanding biotechnology, Concept and outlines of various applications- GM crops and GMO: Environmental implications; Biodegradation, Phytoremediation: types and applications Bio-fuel production, Bio fertilizer, Bio pesticides; Integrated Pest Management,

UNIT – III: PRINCIPLES AND APPLICATIONS OF DNA RECOMBINANT TECHNOLOGY (4 HOURS)
Principles and applications of DNA recombinant technology to agricultural and human diseases. Intellectual property rights, PCR and DNA finger printing. Fermentation technology, bioremediation, biopesticides and biosensors, single cell protein.

UNIT – IV: ANIMAL BIOTECHNOLOGY (4 HOURS)

Development Biology; fertilization and organogenesis, Stem cells; potency and differentiation, different signaling for development, Morphogenesis in different model systems, Cloning; Transgenic and knockout systems. Animal cell Culture methods.

UNIT – V: MEDICAL BIOTECHNOLOGY(4 HOURS) (4 HOURS)

Role of biotechnology in medical science and disease identification and management. Role of molecular markers in disease identification and development of molecular marlers. Drug delivery and drug development.

Course Articulation Matrix of ZOO 506- Biotechnology

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	1	1	3	2		3	3	2
CO2	1	3	1	1		1	1	1
CO3	1	2	1	2		3	2	1
CO4	1	1	2	3		3	1	3

1. Partially Related
2. Moderately Related
3. Highly Related

Course Code: **ZOO 507**
Course Name: **Medical Biochemistry and Health**
Course Instructor: **Dr. Ranjit Kumar/ Dr. Ruchi Sharma**
Credits: **2**

Credits Equivalent: (One credit is equivalent to 10 hours of lectures / organized classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objectives:
To make the study relevant, interesting, encouraging to the students to join the industry or to prepare them for higher studies including research. Demonstrate foundation knowledge in biochemistry; synthesis of proteins, lipids, nucleic acids, and carbohydrates; and their role in metabolic pathways along with their regulation.

Course Outcomes: Upon completion of the course, students should be able to:
CO^1 Gain knowledge and skill in the fundamentals of biochemical sciences, interactions and interdependence of physiological and biochemical processes.
CO^2 Demonstrate foundation knowledge in biochemistry; synthesis of proteins, lipids, nucleic acids, and carbohydrates; and their role in metabolic pathways along with their regulation.
CO^3 To understand biological reactions, structure of protein, carbohydrates fats,nucleic acids and their metabolism.
CO^4 Explain principles of biophysical chemistry

Attendance Requirements:
Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.

Evaluation Criteria:
Mid Term Examination: 25
End Term Examination: 50
Continuous Internal Assessment: 25

Course Contents:

UNIT-I : INTRODUCTION (4 HOURS)
Introduction: Definition and scope of clinical biochemistry in diagnosis, use of clinical laboratory and interpretation of results. Body Fluids: Biochemistry of urine, blood and cerebrospinal fluid, normal and abnormal constituents and clinical entities in body fluids. Water, Electrolyte and Acid Base Balance: maintenance of body pH, disorders of acid base balance

UNIT-II: DISORDERS (4 HOURS)

Disorders of Metabolism: Disorders of carbohydrate metabolism: diabetes mellitus, ketoacidosis, hypoglycemia, glycogen storage diseases, galactosemia, lactose intolerance, and lactic acidosis. Disorders of lipids: lipid mal-absorption and steatorrhea, sphingolipidosis, clinical interrelationships of lipids, lipoproteins and apolipoproteins. Disorders of amino acid metabolism: inborn errors of amino acid metabolism-alkaptonuria, phenylketouria, albinism, gout, hyperglycemia, phenylalaninemia, homocystineuria, tyrosinemia, aminoacidurias. Disorders of nucleic acid metabolism (Purine and Pyrimidine metabolism), Disorders of iron, porphyrin and mineral metabolism. Metabolism under stress conditions.

UNIT-III : CLINICAL ENZYMOLOGY (4 HOURS)

Clinical Enzymology: Principles of diagnostic enzymology, clinical significance of alkaline and acid phosphatase, SGOT, SGPT, LDH, CPK, aspartate aminotransferase, alanine aminotransferase, creatine kinase.

UNIT-IV: HORMONAL DISTURBANCES (4 HOURS)

Hormonal Disturbances: Hormones their mode of action and functions. Clinical aspects of protein hormones, anterior pituitary hormones, posterior pituitary hormones, steroid hormones, adrenocortical steroids and thyroid hormones.

UNIT-V: ORGAN FUNCTION TEST (4 HOURS)

Organ Function Tests: Renal function test, liver function test, gastric function test and thyroid functions test.

Books Recommended

1. Palmer T and Bonner PL (2007) Enzymes: Biochemistry, Biotechnology and Clinical Chemistry, 2nd Edition, Woodhead Publishing.
2. Vasudevan D, Sreeekumari S and Vaidyanathan K (2010) Textbook of Biochemistry for Medical Students.6th Revised edition. Jaypee Brothers Publishers

Course Articulation Matrix of ZOO 507- Medical Biochemistry and Health

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	2	1	3	2		3	3	2
CO2	2	3	2	2		3	1	2
CO3	2	2	2	3		3	3	2
CO4	2	1	2	3		3	1	2

1. Partially Related
2. Moderately Related
3. Highly Related

Course Code: **ZOO 508**
Course Name: **Pesticides Hazards and Environment**
Course Instructor: **Dr. Ranjit/Dr. Amit**
Credits: **2**

Credits Equivalent: (One credit is equivalent to 10 hours of lectures / organized classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objectives:
The course describes adverse effects of pesticides and management of crop pests by an Integrated Pest Management (IPM) approach.

Course Outcomes: Upon completion of the course, students should be able to:

CO[1] Understand principles of toxicology and mode of action of toxins
CO[2] Acquire information about the risks associated with the use of pesticides.
CO[3] Interpret pesticide labels and images.
CO[4] Define integrated pest management and other pesticide alternatives

Attendance Requirements:
Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.

Evaluation Criteria:
Mid Term Examination: 25
End Term Examination: 50
Continuous Internal Assessment: 25

Course Contents:

UNIT- I: INTRODUCTION (4 HOURS)

Definition, classification, brief history, pesticides registration, pesticide industries and markets in world and India;

Chemical nature of pesticide; Group characteristics and function of pesticides (organochlorides, organophosphates, carbamates, pyrethroids, insect growth regulator, botanical) and persistence in environment; Routes and site of exposure: Inhalation, injection through food and intestine; Problems of pesticide hazards and environmental pollution.

UNIT-II: PRINCIPLES OF TOXICOLOGY (4 HOURS)

Principles of toxicology: toxicants, toxicity, LD_{50} and LC_{50}, dose-response relationship; Effects of pesticides: carcinogenic, mutagenic, teratogenic and other health hazards (ecological effect, immunotoxicity, synergetic and antagonistic action);Evaluation of toxicity.

UNIT-III: MODE OF ACTION (4 HOURS)

Mode of action: Central Nervous system, Acetylcholinesterase and unknown modes of action; Metabolism of insecticides: Phase I and Phase II reactions and metabolism of other pesticides; Nano-pesticides: Use of nano-pesticides in plant protection, delivery technology and their behaviour in different ecosystem.Therapy and Antidot procedure and precaution.

UNIT-IV : INSECTS AND ITS ENVIRONMENT (4 HOURS)

Insects and its environment: Inter relations with living and non-living environment;Fluctuation in insect population and insect dispersal;Extreme environmentand insect adaptation in Desert, cave, high altitude and terrestrial stream;Entomophagousinsects.

UNIT-V: GLOBAL CLIMATE CHANGE (4 HOURS)

Impact of global climatic changes on insect behaviour, physiology and reproduction; Insect biodiversity and their functioning in Terrestrial and aquatic ecosystem and their restoration.

Suggested Books

1. Greim H., and Snyder, R., Toxicology and Risk Assesssment: A Comprehensive Introduction, (ed), John Wiley and Sons, UK
2. Whitford, F.,The Complete Book of pesticide management, Wiley Interscience, John Wiley and Sons, UK
3. Hodgson, E., and Kuhr, R. J., (ed), Safer Insecticides, Marcel Dekker Inc., New York, USA
4. Matthews, G, A., Pesticide Application Methods, Blackwell Science, London, UK
5. Wilkinson, C. F., Pesticide Biochemistry and Physiology, Plenum Press, New York, UK
6. Roberts, T. R., and Hutson, D. H. Metabolic pathways of agrochemicals Part II, The Royal Society of Chemistry, UK
7. Carde, R. T., and Bell, W. J., Chemical Ecology of Insects, Chapman & Hall, New York, USA

Course Articulation Matrix of ZOO 508- Pesticides Hazards and Environment

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	1	1	3	2		2	3	2
CO2	1	2	2	2		1	2	1
CO3	1	1	2	1		3	3	1
CO4	3	1	2	1		2	1	3

1. Partially Related
2. Moderately Related
3. Highly Related

Code: **ZOO 509**
Course Name: **Insect Control and IPM**
Course Instructor: **Dr. Sunil Kumar/Dr. Ruchi Sharma**
Credits: **2**

Credits Equivalent: (One credit is equivalent to 10 hours of lectures / organized classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objectives:

- The course aims to provide students with modern concept of pest management.
- To enable students understand history, principles and different strategies of insect control.
- To acquaint students with knowledge of Integrated pest management.

Course Outcomes: Upon completion of the course, students should be able to:

CO^1 Identify the different types of pests
CO^2 Define main concepts in field of insect control.
CO^3 Understand various insect control methods- physical, chemical and biotechnological.
CO^4 Discuss about definition, logic and necessity 'Integrated Pest Management'

Attendance Requirements:
Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.

Evaluation Criteria:
Mid Term Examination: 25
End Term Examination: 50
Continuous Internal Assessment: 25

Course Contents:

UNIT-I: INTRODUCTION **(4 HOURS)**
Causes of success of insects, Origin of insect pests, Factors affecting the abundance of insects; History of insect pest control; Basic principles and components of insect pest management;

Mechanical control: Handpicking and crushing, use of sticky barriers, electrical grid, low and high temperature, destruction of crop residues, weeds and trash;

UNIT-II: CULTURAL CONTROL **(4 HOURS)**
Cultural control: Crop rotation, tilling the soil, destruction of places of breeding or over wintering refuge, destruction or provision of alternate hosts, time of planting and harvesting, trap crops, nutrient management;

Physical control: Chemosterilants, Radiation, Sterile insect release method (SIRM), Pheromones and hormones: use in insect pest management.

UNIT-III: CHEMICAL CONTROL (4 HOURS)

Chemical control: classification of insecticides, properties of insecticides and their mode of action, synergists, formulations, application and appliances, repellents, attractants, botanicals, Synthetic organic insecticides, IGR, Pest resurgence and physiology of insecticidal resistance**.**

UNIT-IV: PLANT RESISTANCE TO INSECTS (4 HOURS)

Plant resistance to insects: Types and mechanism of resistance- antibiosis, antixenosis, tolerance, factors mediating resistance, JH Mimics & MH-agonist;

Transgenic plants: history, *Bacillus thuriengensis*and its mode of action on insect, different sub species of *Bt* , development of *Bt*plant by recombinant DNA technology, resistance management of *Bt*crop, prospective and controversies of *Bt*crop.

Inoculation, augmentation and conservation of natural enemies (Pathogens, predators and parasitoids),

UNIT-V: IPM (4 HOURS)

Integrated Pest Management**:** History, principle, concept of pest and pest status, practices and different phases of pest control, Quarantine, genetic and biotechnological methods of control.

Suggested Books:

1. Schoonhoven, L. M., van Loon, J.A., &Dicke, M., Insect Plant Biology, Publisher Oxford University Press, USA
2. Jolivet, P., Interrelationship between insects and Plants, CRC Press, USA
3. Pedigo, L. P.,Entomology & Pest Management, Prentice Hall, New Jersey, USA
4. Norris, Caswell-Chen and Kogan, Concepts of IPM, Prentice-Hall, USA
5. Hill, D. S., Agricultural insects pests of the tropics and their control, Cambridge University Press, UK
6. Pedigo, L. P., Entomology & Pest Management, Prentice Hall, New Jersey, USA
7. Norris, Caswell-Chen and Kogan, Concepts of IPM, Prentice-Hall, USA
8. Hill, D. S., Agricultural insects pests of the tropics and their control, Cambridge University Press, UK .

Course Articulation Matrix of ZOO 509- Insect Control and IPM

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	1	2	3	2		3	3	2
CO2	3	3	1	1		3	1	3
CO3	2	2	2	3		3	3	1
CO4	2	1	2	3		2	1	3

1. Partially Related; 2. Moderately Related; 3. Highly Related

Course Code: **ZOO 510**
Course Name: **Agricultural Entomology**
Course Instructor: **Dr. Sunil Kumar**
Credits: **2**

Credits Equivalent: (One credit is equivalent to 10 hours of lectures / organized classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objectives:

- To acquaint students with broad knowledge of the ecological and physiological aspects that pertain to the field of agricultural entomology and pest management.
- To aware students about the impacts that insects of have on agricultural entomology and pest management.
- Preparation to be professionals in agricultural entomology

Course Outcomes: Upon completion of the course, students should be able to:
CO^1 Have knowledge about insects and their usage in agriculture
CO^2 Understand basic concepts of agricultural entomology and pest management.
CO^3 Identify pests of various crops, fruits and vegetables.
CO^4 Discuss pests with particular reference to their habits, nature of damage caused by them

Attendance Requirements:
Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.

Evaluation Criteria:
Mid Term Examination: 25
End Term Examination: 50
Continuous Internal Assessment: 25

Course Contents:

UNIT –I: INTRODUCTION (4 HOURS)
Definition of pest, pest status, factors responsible for achieving the status of pest, General equilibrium position (GEP), Economic injury level (EIL), economic threshold level (ETL), action threshold, Damage boundary (DB), pest spectrum, pest complex, carrying capacity, causes of pest outbreak, secondary pest outbreak, pest surveillance and sampling.
Theory of co-evolution, role of allelochemicals in host plant mediation, tritrophic interaction, host-plant selection by phytophagous insects, establishment of insect population on a plant surface.

UNIT-II: TAXONOMIC POSITION (4 HOURS)
Systematic position, host plants, seasonal history, nature of damage and outlines of the life cycle of the following pests of field crops, vegetables and fruits:

Paddy: *Scirpophaga incertulas* (yellow stem borer), *Hieroglyphus banian* (Rice grass hopper), *Dicladispa armigera* (Rice Hispa), *Leptocorisa varicornis* (Gundhi bug).
Wheat: *Macrosiphum miscanthi* (wheat aphid), *Tanymecus indicus* (Ghujhia weevil), *Pseudaletia separata* (Army worm), *Sesamia inferens* (Wheat stem borer).
Maize : *Chilo partellus* (maize stem borer), *Helicoverpa armigera* (corn worm), *Agrotis ipsilon* (cut worm).

UNIT-III: ECONOMIC INSECTS (4 HOURS)
Cotton: *Pectinophora gossypiella* (Pink bollworm), *Empoasca devastans* (cotton jassid), *Bemisia tabaci* (cotton white fly), *Dysdercus cingulatus* (Red cotton bug), *Myllocerus maculosus* (Cotton grey weevil).
Sugarcane: *Pyrilla perpusilla* (Sugarcane leaf hopper), *Aleurolobus barodensis* (Sugarcane white fly), *Scirpophaga nivella* (Sugarcane top borer), *Chilo infuscatellus* (Sugarcane shoot borer).
Oilseed: *Lipaphis erysimi* (mustard aphid), *Spodoptra littura* (tobacco caterpillar), *Dasineura lini* (linseed gall midge), *Spilosoma obliqua* (Bihar hairy caterpillar)
Pulses: *Helicoverpa armigera* (Gram pod borer), *Maruca testulalis* (spotted pod borer), *Riptortus pedestris* (pod bug), *mylabris phalerata* (blister beetle), *Chromatomyia horticola* (leaf miner)

UNIT-IV: PLANT PESTS (4 HOURS)
Vegetables: *Pieris brassicae* (Cabbage caterpillar), *Plutella xylostella* (Diamond-black moth), *Phthorimaea operculela* (potato tuber moth), *Epilachna vigintioctopunctata* (Hadda beetle), *Raphidopalpa foveicollis* (Red Pumpkin beetle), *Bactrocera cucurbitae* (fruit fly).
Fruits: *Drosicha mangiferae* (Mango mealy bug), *Dacus dorsalis* (Mango fruit fly), *Diaphorina citri* (Citrus psylla), *Qudraspidiotus pernicious* (san jose scale), *Erisoma lanigerum* (wooly apple aphid).

UNIT –V: GRAIN PESTS (4 HOURS)
Pests of stored food products with particular reference to their habits, nature of damage caused by them and outlines of their life cycles :
Callosobruchus maculatus (Pulse beetle), *Sitophilus oryzae* (Rice weevil), *Rhizopertha dominica* (Lesser grain borer), *Trogoderma granarium* (Khapra beetle), *Tribolium castaneum* (Rust-red flour beetle), *Sitotroga cerealella* (Angoumois grain moth);
Locust- different species and phases, phase transition, periodicity, migration, biology and control measures.

Suggested Books:

1. Matthews, Robert W., **Matthews**, Janice R., Insect Behaviour, Springer, Dordrecht
2. Pedigo, L. P., Entomology & Pest Management, Prentice Hall, New Jersey, USA
3. Norris, Caswell-Chen and Kogan, Concepts of IPM, Prentice-Hall, USA
4. Hill, D. S., Agricultural insects pests of the tropics and their control, Cambridge University Press, UK

S. Pradhan, Agriculture Entomology and Pest Control, Indian Council of Agriculture Research

Course Articulation Matrix of ZOO 510- Agricultural Entomology

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	2	1	3	2		1	3	2
CO2	2	1	2	3		1	1	1
CO3	1	2	2	3		3	1	1
CO4	2	1	2	3		2	1	3

1. Partially Related
2. Moderately Related
3. Highly Related

Course Code: **ZOO 511**
Course Name: **Entomology Lab I**
Course Instructor: **Dr. Sunil Kumar/ Dr. Ruchi Kumar**
Credits: **2**

Credits Equivalent: (One credit is equivalent to 10 hours of lectures / organized classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objectives:

- Develop an appreciation for the diversity and impact of insects
- Understand the function and use of a dichotomous key to identify insects to order
- Understand the scientific method and the basics of literature searches and be able to communicate the results of a scientific experiment

Course Outcomes: Upon completion of the course, students should be able to:
CO[1]Become familiar with the diversity of fields that study insects
CO[2] Identify insects on basis of morphological characters.
CO[3] Understand basic physiology of insects.
CO[4] Construct an insect collection using appropriate collection and curation techniques.

Attendance Requirements:
Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.

Evaluation Criteria:
End Term Examination: 50
Continuous Internal Assessment: 50

Course Contents:

1. Morphology: Study of head and its sclerites.
2. Study of wings and their venation,
3. Study of different types of mouth parts of Insects
4. Study of different types of antennae and legs of insects.
5. Taxonomy: Identification of insects belonging to different groups up to orders and sub orders.
6. Study of various types of social insects and their nests.
7. Dissection/Demonstration of Alimentary canal, Reproductive system, Circulatory system, Excretory system and Nervous system of insects
8. Estimation of LD50 and LC 50 through data provided.
9. Agricultural Entomology: Collection and identification of economically important insects and various stages of their life history.
10. Identification of important insect pests of different crop plants and stored products.

11. Visits to agricultural fields and forests for on spot study of pests and damage caused by them.
12. Study of life history stages of medically important insects.
13. Identification and anatomical studies of major vector species of Anopheles, Culex and Aedes.

Suggested Books:

1. Pedigo, L. P., Entomology & Pest Management, Prentice Hall, New Jersey, USA
2. Norris, Caswell-Chen and Kogan, Concepts of IPM, Prentice-Hall, USA
3. Hill, D. S., Agricultural insects pests of the tropics and their control, Cambridge University Press, UK
4. S. Pradhan, Agriculture Entomology and Pest Control, Indian Council of Agriculture Research.

Course Articulation Matrix of ZOO 511- Entomology Lab I

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	3	1	3	2		1	3	2
CO2	3	3	2	1		1	3	3
CO3	1	1	2	3		3	3	1
CO4	2	1	2	3		2	1	3

1. Partially Related
2. Moderately Related
3. Highly Related

Course Code: **ZOO 512**
Course Name: **Fish Physiology**
Course Instructor: **Dr. Rakesh Kumar/ Dr. Amit Kumar**
Credits: **2**

Credits Equivalent: (One credit is equivalent to 10 hours of lectures / organized classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objectives:

- To acquaint the students to major groups of fishes and their characters
- To introduce the students to Structure and function of skin and scales of fishes
- To teach students about physiology, reproduction of fishes.

Course Outcomes: Upon completion of the course, students should be able to:
CO^1 Develop understanding of Natural food, feeding habits and concurrent feeding adaptations of fishes, and
CO^2 Understand Structure and function of respiratory organs such as gills and accessory respiratory organs in various groups of fishes along with structure of heart and vascular systems and kidneys in fishes
CO^3 Acquire knowledge of fish physiology,
CO^4 Understand various aspects of reproductive biology in fishes.

Attendance Requirements:
Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.

Evaluation Criteria:
Mid Term Examination: 25
End Term Examination: 50
Continuous Internal Assessment: 25

Course Contents:

UNIT I: CHARACTERS AND CLASSIFICATION (4 HOURS)
Outline classification of fishes with special reference to distinctive features, geographical distribution classification and typical examples of the following sub- divisions: 1. Chondrichthyes 2. Actinopterygi 3. Crossopterygi 4. Dipnoi
Epidermis and Exoskeleton: Histology, Functions of Integument, Coloration, mechanism of colour change, Significance & uses of coloration, Types of scales & their uses.
Fins and their origin: Structure, median fins, caudal fin & its types; Paired fins & their origin

UNIT II: CARDIO- VASCULAR SYSTEM (4 HOURS)

Structure of heart in *Scoliodon* , Structure of heart in teleosts & its working, composition of blood.
Brain and Cranial Nerves: Fore brain, Mid Brain, Hind Brain, Spinal Cord and Nerves.
Respiratory organs**:** Structure and functions of gills, air breathing organs, swim bladder and weberian ossicles

UNIT III: FOOD, FEEDING HABITS AND RESPIRATION (4 HOURS)
Feeding habits of Teleosts, Carnivorous, Herbivorous and Omnivorous fishes, Alimentary canal and its diversity in fishes, Fish Nutrition and artificial food.

UNIT IV: EXCRETION AND OSMOREGULATION (4 HOURS)
Structure of Kidney, Histology of Kidney, Functions and Osmoregulation, Stenohaline and Euryhaline Fishes.

UNIT V: REPRODUCTION, DEVELOPMENT AND SPAWNING (4 HOURS)
Reproductive organs & their histology, Stages in maturation of an Oocyte, Fecundity, Survival and mortality in fishes, Sex dimorphism, mating and Parental care,

Books Recommended
1. Lynwood, S. Smith. Narendra Publ. House, Delhi. 2003. Introduction to the fish physiology.
2.Arvind Kumar and Pushaplata Dubey. Daya Publ. House, Delhi. 2006. Fish Management and Aquatic Environment
3. Lagler, Bardock, Miller & Possino, John Wiley & Sons, N.Y., London: 2012. Icthyology, 2nd Ed.
4. Halver and Hardy. Acad. Press. 2002: Ash Nutrition . An Imprint

Course Articulation Matrix of ZOO 512- Fish Physiology

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	1	1	3	2		1	3	2
CO2	1	3	1	1		1	1	3
CO3	1	2	1	3		3	3	2
CO4	2	1	2	3		2	1	3
CO5	1	2	3	1		2	3	2
CO6								

1. Partially Related
2. Moderately Related
3. Highly Related

Course Code: **ZOO 513**
Course Name: **Fish Taxonomy and Fisheries**
Course Instructor: **Dr. Rakesh Kumar**
Credits: **2**

Credits Equivalent: (One credit is equivalent to 10 hours of lectures / organized classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objectives:

- Define, comprehend, scope and significance of aquaculture
- Examine the types and practices of Aquaculture and describe the management and marketing of fishes
- To enable students understand the concept of preservation and induced breeding in fish.

Course Outcomes: Upon completion of the course, students should be able to:
CO^1 Explain the functioning of different Aqua farms and report healthy practices.
CO^2 Report commercial production of ornamental fishes, their disease control and apply marketing strategy.
CO^3 Acquire knowledge on culture phases, preservation and management practices.
CO^4 Understand and explain the concept of induced breeding.

Attendance Requirements:
Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.

Evaluation Criteria:
Mid Term Examination: 25
End Term Examination: 50
Continuous Internal Assessment: 25

Course Contents:

UNIT I: INTRODUCTION (4 HOURS)
Introduction, scope & status of fishery science. Pisciculture, Advantage of pisciculture, Freshwater water Culturable fishes, Economic importance of fishes.

UNIT II: AQUACULTURE (4 HOURS)
Definition, Purpose, Scope and Status of Aquaculture, Types of culture – Traditional, Extensive, Semi- Intensive, Intensive and Super- intensive culture, Criteria for selection of Sites, Culture Techniques: Carp culture, Trout Culture, Cage Culture.

UNIT III: FISH MANAGEMENT (4 HOURS)

Fish Management and Marketing: Fishery management- Selection of cultivable species, Improvement of fish pond, Use of artificial food and correct stocking rate, Weeds of fish pond and their control, Fish enemies and their control,

UNIT IV: FISH PRESERVATION (4 HOURS)

Biochemical Composition, Preservation, Fish spoilage and Rigor mortis, Fish Processing, Principles and processes of: Drying, Salting, Freezing, Refrigeration.

UNIT V: INDUCED BREEDING (4 HOURS)

Induced breeding- Advantages of induced breeding, technique of induced breeding, factors affecting induced breeding. Migration in Fishes.

Books Recommended:

1. H.S. Bhamra and Kavita Juneja. 2001. An Introduction to Fishes
2. Arvind Kumar. 2004. Fishery Management
3. Heatranpf. 2002. handbook on Ingredients for Aquaculture feeds.
4. V.G. Jhingran. 1975. Fish and Fisheries of India.

Course Articulation Matrix of ZOO 513- Fish Taxonomy and Fisheries

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	1	2	3	2		3	3	2
CO2	1	1	1	1		1	2	1
CO3	2	1	1	1		3	3	1
CO4	2	1	2	3		2	1	3

1. Partially Related
2. Moderately Related
3. Highly Related

Course Code: **ZOO 514**
Course Name: **Limnology of Lakes, Streams and Ponds**
Course Instructor: **Dr. Rakesh Kumar/Dr. Amit Kumar**
Credits: **2**

Credits Equivalent: (One credit is equivalent to 10 hours of lectures / organized classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objectives:

- To acquaint the students to factors influencing freshwater ecosystem.
- To help students to understand about various lentic and lotic inland water bodies, and major rivers and lakes of India
- To study different water parameters and effect on aquatic organisms.

Course Outcomes: Upon completion of the course, students should be able to:
CO^1 Have knowledge of morphometry, physico-chemical and biological characteristics of fresh water bodies
CO^2 Understand the significance of aquatic flora, fauna, insects, birds and macrophytes in water bodies.
CO^3 Have knowledge of pollution of rivers, causes and control measures
CO^4 Discuss anomalous properties of water and their influence on biota

Attendance Requirements:
Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.

Evaluation Criteria:
Mid Term Examination: 25
End Term Examination: 50
Continuous Internal Assessment: 25

Course Contents:

UNIT – I: LIMNOLOGY (4 HOURS)
Limnology, its history and scope. Origin and classification of water bodies – Lakes and ponds Hydrological cycle. Ecology of ponds and lakes – Structure and dynamics

UNIT – II: PHYSICO-CHEMICAL CHARACTERISTICS (4 HOURS)
Abiotic (Physicochemical Factors in Freshwater Ecosystem): Physical characteristics of water: Temperature, thermal stratification, Light, Density, Water movement and thermal exchange.
Chemical characteristics of water: Hydrogen ion concentration (pH), Dissolved oxygen, Free carbon-dioxide, Total dissolved solids (T.D.S), Carbonates and Bicarbonates.
Turbidity: Causes and impact on aquatic organisms.

UNIT – III: FISHERIES (4 HOURS)

Inland Fisheries Resources: Riverine fisheries- Ganga river system, Brahmaputra river system, East coast river system. Aquatic/Natorial adaptations of freshwater fauna. Productivity of water bodies – Primary, secondary, tertiary - Factors affecting primary production.

UNIT – IV: PLANKTON (4 HOURS)

Plankton of freshwater biotopes – Phyto and Zooplankton, Plankton sampling: Methods of collection, preservation and identification.

UNIT V: POLLUTION (4 HOURS)

Aquatic pollution: Sources and kinds, effect of pollution on physico- chemical parameters of water, Effect of pollution on biota.

International problems and future: Acidification, Global warming, Biomagnification, Eutrophication.

Reference Books:

1. Welch, P.S. Limnology. McGrawHill, NY, 1952.
2. Hutchinson, G.E. A Treatise on Limnology, Vols. I & II. John Wiley & Sons, 1957.
3. Ruttner, F. Fundamentals of Limnology. Translated by D.G. Frey and F.E.Fry. University of Toronto Press, 1968.
4. Wetzel, R.G. Limnology. W.B. Saunders Co., 1975.
5. Reid, G.K. & R.D. wood. Ecology of inland waters and Estuaries. Van Nostrand Company, 1976.

Course Articulation Matrix of ZOO 514- Limnology of Lakes, Streams and Ponds

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	1	1	3	2		3	3	1
CO2	2	1	1	2		3	1	3
CO3	1	2	2	3		3	2	1
CO4	2	1	2	3		3	1	3

1. Partially Related
2. Moderately Related
3. Highly Related

Course Code: **ZOO 515**
Course Name: **Fisheries and Limnology Lab-I**
Course Instructor: **Dr. Rakesh Kumar**
Credits: **2**

Credits Equivalent: (One credit is equivalent to 10 hours of lectures / organized classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objectives:

- To study about the Inland Water bodies
- To acquaint the students to Classification and general characteristics of lotic and lentic water bodies.
- To know Classification and general characteristics of fish and fish diseases.

Course Outcomes: Upon completion of the course, students should be able to:
CO^1 Identify different fish on basis of morphology.
CO^2 Understand distribution and dynamics of freshwater bodies
CO^3 Estimate different water parameters.
CO^4 Have a deeper understanding of fish diseases.

Attendance Requirements:
Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.

Evaluation Criteria:
End Term Examination: 50
Continuous Internal Assessment: 50

Course Contents:

1. To estimate the dissolved oxygen in water.
2. To estimate the pH of water.
3. To estimate the phosphate of water.
4. To determine the BOD of water.
5. To study the benthic organisms.
6. To study the different types of fishing gears.
7. To study the Indian culturable fishes.
8. To study the Exotic culturable fishes.
9. Estimation of total alkalinity in a given water sample.
10. Estimation of total chlorides in a given water sample.
11. Estimation of total hardness in a given water sample.

Books recommended:
1. Fish and Fisheries of India by V.G. Jhingran, Hindustan Publ. House, N. Delhi,1991.
2. Aquaculture Production FAO Fisheries Circular No.815 by FAO Rome,1991.
3. Aquaculture in Asia by M.M. Joseph, Asian Fisheries Soc., Mangalore, 1990.

4. Inland Fisheries of India Vol. I & II by P.K. Talwar and A.G. Jhingran, Oxford & IBH, New Delhi, 1991.
5. Freshwater Fishery Biology by K.F. Lagler, WmC. Brown Co. Publ. Dubuque, IOWA, 1969.
6. Methods for Assessment of Fish Production in Freshwaters, IBH Handbook No.3, Blackwell Scientific Publ., Oxford, 1970.
7. Fundamentals of Ecology by E.P. Odum, W.B. Saunders Co. Philadelphia, 1971.
8. Limnology by P.S. Welch McGraw Hill Book Co., New York, 1952.
9. Limnology by R.G. Watzel, R.G., W.B. Saunders Co Philadelphia, 1983.
10. The Biology of Polluted Waters by H.B.N. Hynes, Liverpool Univ. press, Liverpool, 1978.
11. Fundamentals of Limnology by F. Ruttner, Univ. Press Toronto, 1975.
12. Fishes : An Introduction to Ichthyology by P.B. Moyle and J.C. Cech. Prentice Hall Inc. Jersey USA, 1986.
13. Fishery Development by S.C. Agarwal and M.S. Johal. Narendra Publishing House, Delhi, 2004.
14. History of Fishes by J. Norman revised by P.H. Greenwood. Ernst Brown, London 1999.
15. Biology of Fishes by Kyle H.M. Biotech. Books, Delhi, 2007.
16. Freshwater Ecology : Concepts and environmental applications. Dodds, Walter K. Academic Press. USA., 2002.
17. The Biology of Fishes. New Introduction by Dr. Vijay Dev Singh. M. Hary. Kyle. Biotech. Books, 2007. 18. Fish Management and Aquatic Environment. Arvind Kumar and Pushplata Dukey. Daya Publishing House, 2006.

Course Articulation Matrix of ZOO 515- Fisheries and Limnology Lab-I

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	1	1	3	2		1	3	2
CO2	1	3	1	1		1	1	3
CO3	1	2	1	3		3	3	2
CO4	2	1	2	3		2	1	3
CO5	1	2	3	1		2	3	2
CO6								

1. Partially Related
2. Moderately Related
3. Highly Related

Course Code: **ZOO 516**
Course Name: **Advances in Molecular Biology**
Course Instructor: **Dr. Ranjit Kumar**
Credits: **2**

Credits Equivalent: (One credit is equivalent to 10 hours of lectures / organized classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objectives:

- To learn and develop an understanding of a cell as a basic unit of life.
- To understand the functions of cellular organelles and how a cell carries out and regulates cellular functions
- To understand the basic concepts of biomolecules, cell membrane

Course Outcomes: Upon completion of the course, students should be able to:
CO^1 Identify the interaction and communication between various cell organelles.
CO^2 Understand the Structure and functions of cell membrane.
CO^3 Understand the fundamental processes of Cell Biology.
CO^4 Recognize and explain how all basic techniques contribute in study of cellular processes.

Attendance Requirements:
Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.

Evaluation Criteria:
Mid Term Examination: 25
End Term Examination: 50
Continuous Internal Assessment: 25

Course Contents:

UNIT-I: CELL DIVISION (4 HOURS)
Mitosis and meiosis, their regulation, steps in cell cycle, and control of cell cycle. Regulation of Cell cycle progression: Maturation promoting factors (MPF), Cyclins and Cyclins dependent kinases, growth factors and growth inhibitory factors. Cell death and apoptosis.

UNIT-II: DNA REPLICATION (4 HOURS)
DNA replication, repair and recombination (Unit of replication, enzymes involved, replication origin and replication fork, fidelity of replication, extrachromosomal replicons, DNA damage and repair mechanisms, homologous and site-specific recombination).

UNIT-III: RNA (4 HOURS)
RNA synthesis and processing (transcription factors and machinery, formation of initiation complex, transcription activator and repressor, RNA polymerases, capping, elongation, and termination, RNA processing, RNA editing, splicing, and polyadenylation, structure and function of different types of RNA, RNA transport).

UNIT-IV: CONTROL OF GENE EXPRESSION AT TRANSCRIPTION AND TRANSLATION LEVEL IN PROKARYOTES (4 HOURS)

Constitutive, Inducible and Repressible gene expression, Positive and Negative control of gene expression, Lac, Tryptophan, arabinose operons; lysogenic repression in lambda bacteriophage.

UNIT-V: CONTROL OF GENE EXPRESSION AT TRANSCRIPTION AND TRANSLATION LEVEL IN EUKARYOTES (4 HOURS)

Eukaroytic genome organization, Proteins involved in the control of transcription, Protein, protein interactions, Post-translational control, DNA methylation, Cell Signaling, Ligand binding to membrane receptors and its role in regulating transcription, phosphorylation cascade and amplification of signal.

SUGGESTED BOOKS:

1. Lewin, B. 2000. Genes VIII Oxford University, Press, New York
2. Alberts, B. Bray, D., Lewis, J. Raff, M., Roberts, K. and Watson, J.D. 1999, Molecular biology of the cell. Garland Publishing, Inc. New York.
3. Wolfe, S.L. 1993, Gruissem, W. and Jones, R.L. 2000, Biochemistry and molecular biology of plants, American society of plant physiologists, Maryland, USA
4. Frifelder, D. Molecular Biology. John and Bartlett Publishers, inc., Boston, USA

Course Articulation Matrix of ZOO 516- Advances in Molecular Biology

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	1	2	3	2		3	3	2
CO2	2	3	2	2		1	2	1
CO3	2	1	1	1		3	3	2
CO4	2	1	2	3		3	1	1

1. Partially Related
2. Moderately Related
3. Highly Related

Course Code: **ZOO 517**
Course Name: **Genomics and Proteomics**
Course Instructor: **Dr. Dixit/Dr. Ruchi Sharma**
Credits: **2**

Credits Equivalent: (One credit is equivalent to 10 hours of lectures / organized classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objectives:
After successful completion of the course the student should be able to design and comprehend experimental strategies for whole genome, transcriptome and proteome analysis.

Course Outcomes: Upon completion of the course, students should be able to:
CO^1 Identify the modifications in the protein and DNA sequences.
CO^2 Have a deeper understanding of the varied branches of the biological sciences like microbiology, evolutionary biology, genomics and metagenomics.
CO^3 Knowledge of principles of PCR, molecular markers and primers.
CO^4 Understand and explain the application of proteomics.

Attendance Requirements:
Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.

Evaluation Criteria:
Mid Term Examination: 25
End Term Examination: 50
Continuous Internal Assessment: 25

Course Contents:

UNIT-I: HUMAN GENOME (4 HOURS)
Physical structure and genetic content of Human genome, Nature of genetic variations: Single nucleotide polymorphism, Large scale variations, conserved and variable domains.

UNIT-II: GENOME SEQUENCING (4 HOURS)
Methods for studying variation: RFLPs, VNTR and minisatellites, SSCP and direct Sequencing. Determination of gene function, Role of genetic footprinting in assigning function of a gene, Patterns of gene expression.

UNIT-III: HUMAN GENOME PROJECT (4 HOURS)
Human genome project: DNA Chips and Microarray: Chemical DNA synthesis, Printing of oligonucleotides Genome analysis for global patterns of gene expression using fluorescent labeled cDNA. or end-belled RNA probes. Advantages and Disadvantages of DNA microarray.

UNIT-IV: TRANSLATION (4 HOURS)

Protein synthesis and processing (Ribosome, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, genetic code, aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase, and translational proof-reading, translational inhibitors, Post- translational modification of proteins).

UNIT-V: PROTEOMICS (4 HOURS)

Introduction to proteomics, Techniques in proteomic research:Two dimensional separation of total cellular proteins, isolation and sequence analysis of individual protein, spots by mass spectroscopy, Protein microarrays. Pharmacogenomics, Introduction of metabolomics. Application of proteomics.

Course Articulation Matrix of ZOO 517- Genomics and Proteomics

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	1	1	1	2		3	3	1
CO2	2	1	1	1		3	1	1
CO3	2	2	1	3		3	3	1
CO4	2	1	2	3		2	1	3

1. Partially Related
2. Moderately Related
3. Highly Related

Course Code: **ZOO 518**
Course Name: **Genetic Disorders and Cancer**
Course Instructor: **Dr. Ranjit Kumar**
Credits: **2**

Credits Equivalent: (One credit is equivalent to 10 hours of lectures / organized classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objectives: To inculcate a holistic understanding about the genetic basis of a particular clinical disorder and cancer.

Course Outcomes: Upon completion of the course, students should be able to:
CO^1 Learn about structural organization of chromosomes.
CO^2 Understand cell cycle check points, role of cyclin and cyclin dependent kinases in cell cycle regulation.
CO^3 Gain knowledge of the basic principles of cancer spread and control.
CO^4 Recognize and explain different disorders due to chromosomal anomalies.

Attendance Requirements:
Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.

Evaluation Criteria:
Mid Term Examination: 25
End Term Examination: 50
Continuous Internal Assessment: 25

Course Contents:

UNIT- I: INTRODUCTION (4 HOURS)
Genetic Disorders and Single Gene Inheritance: Overview of genetic disorders: consequences and mechanisms; nomenclature of mutations, importance of the position of a base, databases of known mutations; from genotype to phenotype: loss of function mutations, gain of function mutations, expanding repeats.

UNIT- II: GENE ACTION (4 HOURS)
Gene Action _ Tracing Defects in Gene Function: (a) haemoglobinopathies-, beta-thalassemia and sickle cell anaemia (b)fragile X syndrome (c) hearing impairment (d) epilepsy (e) Gauchers Disease and Glycogen Storage disorders (f) Noonan syndrome and Rasopathies.

UNIT - III: GENETIC DISORDERS (4 HOURS)
Sex Linked Disorders, Sex Limited, Sex Influenced Traits, Genomic Imprinting

UNIT-IV: GENETIC REGULATION (4 HOURS)
Genetic regulation of cell cycle and apoptosis, Common cellular changes in cancer, Tumor progression: angiogenesis, metastasis.

UNIT-V: Cancer **(4 HOURS)**

Cell transformation and tumorigenesis, Oncogenes, Tumour suppressor genes, DNA repair genes and genomic instability.

Books Recommended:

- Stem Cells for Cancer and Genetic Disease Treatment. (2018). Germany: Springer International Publishing.
- Cancer Cytogenetics: Chromosomal and Molecular Genetic Aberrations of Tumor Cells. (2015). United Kingdom: Wiley.
- Bamshad, M. J., Jorde, L. B., Carey, J. C., Bamshad, M. J., Jorde, L. B., Carey, J. C. (2009). Medical Genetics E-Book. United Kingdom: Elsevier Health Sciences.
- Jorde, L. B., Bamshad, M. J., Carey, J. C., Jorde, L. B., Bamshad, M. J., Carey, J. C. (2016). Medical Genetics. Netherlands: Elsevier.
- Fitzsimmons, J. S., Fitzsimmons, J. S. (2013). A Handbook of Clinical Genetics. United Kingdom: Elsevier Science.

Course Articulation Matrix of ZOO 518- Genetic Disorders and Cancer

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	1	1	3	2		1	3	2
CO2	1	3	3	1		3	1	3
CO3	2	1	1	1		3	3	2
CO4	2	1	2	3		2	1	3

1. Partially Related
2. Moderately Related
3. Highly Related

Course Code: **ZOO 519**
Course Name: **Molecular Biology Lab – I**
Course Instructor: **Dr. Ranjit Kumar**
Credits: **2**

Credits Equivalent: (One credit is equivalent to 10 hours of lectures / organized classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objectives:
Provide knowledge about the complex organization in the eukaryotic cell and the molecular mechanisms of the cellular processes that exist in all cell types.

Course Outcomes: Upon completion of the course, students should be able to:
CO^1 Have hands on knowledge of DNA and RNA extraction technique**.**
CO^2 Knowledge of PCR, ELISA and FISH like techniques.
CO^3 Apply their knowledge in research.
CO^4 Able to perform simple molecular techniques.

Attendance Requirements:
Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.

Evaluation Criteria:
End Term Examination: 50
Continuous Internal Assessment: 50

Course Contents:

- DNA Isolation Techniques for both Prokaryote and Eukaryote
- RNA Isolation Techniques for both Prokaryote and Eukaryote
- Chromosome Isolation Techniques
- FISH (Fluroscence Insitu Hybridization Technique.
- DNA and RNA Staining Techniques.
- Plasmid DNA Isolation and Genomic DNA Isolation.
- PCR and Electrophoresis Techniques in Genetics.

Course Articulation Matrix of ZOO 519- Molecular Biology Lab – I

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	1	1	3	2		1	3	2
CO2	2	3	2	1		2	1	1
CO3	2	2	1	2		3	3	2
CO4	2	1	2	3		1	1	3

1. Partially Related
2. Moderately Related
3. Highly Related

SEMESTER IV

Course Code: **ZOO 551**
Course Name: **Animal physiology**
Course Instructor: **Dr. Ranjit**
Credits: **4**

Credits Equivalent: (One credit is equivalent to 10 hours of lectures / organized classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objectives:

- To enable the students to know about all the physiological processes going on in animal/human body.
- To make the students understand the functions of hormones and their mode of action at molecular level.
- To allow the students to understand difference between healthy body and an abnormal physiology.

Course Outcomes: Upon completion of the course, students should be able to:
CO^1 Understand the structure, function and regulation of endocrine & neuroendocrine glands
CO^2 Correlate the comparative physiology of the systems and understand their regulation & control
CO^3 Compare the structure, functions and regulation of the organ systems of vertebrates
CO^4 Recognize and explain how all physiological systems work in unison to maintain homeostasis in the body; and use of feedback loops to control the same.

Attendance Requirements:
Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.

Evaluation Criteria:
Mid Term Examination: 50
End Term Examination: 100
Continuous Internal Assessment: 50

Course Contents:

UNIT - I : DIGESTION AND RESPIRATION (4 HOURS)
Digestion: Mechanism of digestion & absorption of Carbohydrates, Proteins, Lipids and Nucleic acids. Composition of bile, Saliva, Pancreatic, gastric and intestinal juices.
Respiration: Exchange of gases, Transport of O2 and CO2, Oxygen dissociation curve, Chloride shift.
UNIT - II : CIRCULATION AND CARDIAC SYSTEM (4 HOURS)

Composition of blood, Plasma proteins and their role, blood cells, Haemopoisis, Mechanism of coagulation of blood. Mechanism of working of heart: Cardiac output, Cardiac cycle, origin and conduction of heart beat.

UNIT - III : EXCRETION AND MUSCLE CONTRACTION (4 HOURS)

Excretion: modes of excretion, Ornithine cycle, Mechanism of urine formation. Structure of Cardiac, Smooth & Skeletal muscles, threshold stimulus, All or None rule, single muscle twitch, muscle tone, isotonic and isomatric contraction, Physical, chemical & electrical events of mechanism of muscle contraction.

UNIT – IV: NERVOUS SYSTEM AND NEUROTRANSMITTER (4 HOURS)

Neurons, action potential, gross neuroanatomy of the brain and spinal cord, central and peripheral nervous system, neural control of muscle tone and posture. Mechanism of generation and propogation of nerve impulse, structure of synapse, synaptic conduction, saltatory conduction, Neurotransmitters.

UNIT – V: ENDOCRINOLOGY AND REPRODUCTION (4 HOURS)

Mechanism of hormone action (insulin and steroids) Different Endocrine glands- Hypothalamus, Pituitary, pineal, thymus, thyroid, parathyroid and adrenals, hypo & hyper-secretions. Male and female reproductive system, spermatogenesis and oogenesis.

SUGGESTED READINGS:

1. Ruegg, J.C., Calcium in muscle activation, Springer Verlag Berlin Heidelberg, New York. 25

2. Hoar, W.S. General and comparative physiology, Prentice, Hall Inc./England Wood cliffs, New Jersey.

3. Guyton, A.C. and Hall, J.E.; Text book of medical physiology, 10th Ed, Saunders, Harcourt, India.

4. Heilmeyer, L.M.G. Cellular regulation of protein phosphorylation, springer-verlag, Berlian Heidelberg, New York.

5. Prosser, C.L. and Brown, F.A. comparative Animal Physiology 2nd Ed. W.B. Sunders, Philadelplina.

6. Karpati, G., Jones, D.H. and Griggs. R.C. Disorders of Voluntary Muscle, 7th Edn, Cambridge University Press.

7. Turner, C.D. General Endocrinology, 4th Ed. W.B. Saunders, Philadelphia London.

8. Prosser, C.L., Comparative Animal Physiology, W.B. Saunders, Toppen Publication.

Course Articulation Matrix of ZOO 551- Animal Physiology

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	2	2	1	2		1	2	1
CO2	3	3	3	2		2	3	1

CO3	2	2	1	2		3	2	1
CO4	1	1	2	1		3	2	2

1. Partially Related; 2. Moderately Related; 3. Highly Related

Course Code: **ZOO 552**
Course Name: **Developmental Biology**
Course Instructor: **Dr. Reshma Sinha**
Credits: **4**

Credits Equivalent: (One credit is equivalent to 10 hours of lectures / organized classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objectives:

- The course explains the basic principles and concepts underlying the developmental processes at the cellular and molecular level.
- The main objective of Developmental Biology course is to provide four-dimensional thinking of students to truly understand the patterns and process of embryonic development, body plan, fate map, induction, competence, regulative and mosaic
- development, molecular and genetic approach for the study of developing embryo which is not necessarily shared with any other disciplines in the biological sciences.
- To provide knowledge about post-embryonic development processes including metamorphosis and regeneration apoptosis and disorders and diseases related to development in humans.

Course Outcomes: Upon completion of the course, students should be able to:
CO[1] Understand the events that lead to formation of a multicellular organism from a single fertilized egg, the zygote.
CO[2] Describe the general patterns and sequential developmental stages during embryogenesis
CO[3] Understand how the developmental processes lead to establishment of body plan of multicellular organisms.
CO[4] Discuss the general mechanisms involved in morphogenesis and to explain how different cells and tissues interact in a coordinated way to form various tissues and organs.

Attendance Requirements:
Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.

Evaluation Criteria:
Mid Term Examination: 50
End Term Examination: 100
Continuous Internal Assessment: 50

Course Contents:

UNIT I: INTRODUCTION (4 HOURS)

History of developmental biology- evolution, cell theory, mosaic and regulative development, discovery of induction, genetics and developmental.

Basic concepts of developmental biology- cell division, cell differentiation, signaling, patterning;

Model systems: vertebrates model organisms- *Xenopus laevis*, chicken, mammals, zebrafish; invertebrate model organism- *Drosophila melanogaster*, *Caenorhabditis elegans*;

UNIT II: EMBRYONIC DEVELOPMENT AND FERTILIZATION (4 HOURS)

Embryonic development in vertebrates and invertebrates: Structure of the gametes– the sperm, the egg; Molecular basis of spermatogenesis, Oogenesis.

Fertilization, Cleavage types and significance, comparative account of gastrulation, axes and germ layers, Fate maps

Morphogenesis- movement and formation of germ layers;

Gastrulation in amphibian and birds

UNIT III: EARLY EMBRYONIC DEVELOPMENT (4 HOURS)

Early embryonic development- of vertebrates and invertebrates- Cleavage and formation of blastula, gastrulation, neural tube formation, cell migration;

General concept of potency, commitment, specification, induction, competence and determination

Axis specification in Drosophila; origin of anterior- posterior and dorsal- ventral patterning- role of maternal genes, patterning of early embryo by zygotic genes; segmentation genes- the gap genes, the pair– rule genes, the segment polarity genes, the homeotic selector genes- bithorax and antennapedia complex.

Late embryonic development- Vulva formation in Caenorhabditis, Formation of neural tube in vertebrates

UNIT IV: POSTEMBRYONIC DEVELOPMENT (4 HOURS)

Concept of organogenesis- Development and patterning of vertebrate limb, homeobox genes in patterning, signaling in patterning of the limb;

Insect imaginal discs–organizing center in patterning of the leg and wing, the homeotic selector genes for segmental identity; insect compound eye.

Postembryonic development: growth, cell proliferation, growth hormones; aging- genes and senescence

Hormonal regulation of metamorphosis in insects and amphibians; Regeneration- epimorphic and morphollaxis

UNIT V: MEDICAL IMPLICATIONS OF DEVELOPMENTAL BIOLOGY(4HOURS)

Medical implications of developmental biology-Teratogenesis: environmental assaults on development; teratogenic agents; teratological abnormalities

Basic Concepts of Experimental Embryology-Standard techniques and methods of experimental embryology:Experiments on the analysis of early development and differentiation (Experiments of Spemann and Mangold), vital dyeing, extirpation, isolation, transplantation; Role of nucleus, cytoplasm and yolk;

Stem cells and their applications; Programmed cell death- apoptosis, autophagy and necrosis

Suggested Reading

1. Developmental Biology, Scott F Gilbert, 8thed 2006, Sinauers.
2. Essentials of Developmental Biology, JMW Slack 3rd ed, Wiley-Blackwell .
3. Principles of Development, Louis Wolpert, 3rd ed 2007, Oxford.

4. An introduction to Embryology, Balinsky, 5thed 1981, Saunders.
5. Analysis of Biological development, Kalthoff:, 1996, McGraw.

Course Articulation Matrix of ZOO 552- Developmental Biology

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	1	2	1	2		1	3	2
CO2	2	3	2	2		2	2	1
CO3	2	2	1	3		1	3	2
CO4	2	1	2	3		2	1	1

1. Partially Related
2. Moderately Related
3. Highly Related

Course Code: **ZOO 553**
Course Name: **Parasitology**
Course Instructor: **Dr. Sunil Kumar / Dr. Reshma Sinha**
Credits: **2**

Credits Equivalent: (One credit is equivalent to 10 hours of lectures / organized classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objectives:

- To enable the students to know about Morphology, biology, life-cycle, mode of infection of parasites.
- To make the students understand parasitism, parasites and their examples.
- To acquaint the students to basic knowledge of parasitism, the different biological inter-relationships and the host parasite relationships.

Course Outcomes: Upon completion of the course, students should be able to:
CO^1 Identify parasitism, parasites and their examples.
CO^2 Describe parasitic diseases and modes of diagnosis.
CO^3 Trace control of parasitic infections.
CO^4 Understand host-parasite relationship.

Attendance Requirements:
Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.

Evaluation Criteria:
Mid Term Examination: 25
End Term Examination: 50
Continuous Internal Assessment: 25

Course Contents:

UNIT – I: INTRODUCTION (4 HOURS)
Introduction to parasitology; animal associations and host – parasite relationship; distribution of diseases and disease caused by animal parasites.

UNIT –II: PLASMODIUM AND LEISHMANIA (4 HOURS)
Morphology, life-cycle, mode of infection of *Plasmodium*, molecular biology of *Plasmodium* – drug targets, mechanism of drug resistance; morphology, life-cycle, mode of infection of *Leishmania*, molecular biology of *Leishmania* – drug targets, drug resistance and vaccine strategies.

UNIT – III: ENTAMOEBA, WUCHERIA (4 HOURS)

Morphology, biology, life-cycle, mode of infection of *Entamoeba*, morphology, biology, life-cycles, mode of infection of *Giardia*; gastro-intestinal nematodes, morphology, biology, life-cycles, modes of entry of *Wuchereria, Trichinella* and *Dracanculus*; molecular biology of nematodes, vaccine strategies.

UNIT – IV: IMMUNE RESPONSE (4 HOURS)

Immune response and self-defense mechanisms, immune evasion and biochemical adaptations of parasites; parasites of veterinary importance.

UNIT – V: PARASITES (4 HOURS)

Parasites of insects and their significance; nematode parasites of plants, morphology, biology, lifecycle and infection of crop plants by plant parasitic nematodes, plant parasitic nematodes, host parasite interactions.

Suggested readings

1. Arora DR and Arora B (2001). Medical Parasitology, II Edition. CBS Publications and Distributors
2. Chatterjee, K. D. (2018). Parasitology (protozoology and helminthology) in relation to clinical medicine. Parasitology (protozoology and helminthology) in relation to clinical medicine.,
3. John, D. T., & Petri, W. A. (2013). Markell and Voge's medical parasitology-e-book. Elsevier Health Sciences.
4. Parija, S. C. (2008). Textbook of medical parasitology, Protozoology & Helminthology. Revista do Instituto de Medicina Tropical de São Paulo, 50, 282-282.

Course Articulation Matrix of ZOO 553- Parasitology

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	1	1	3	2		1	3	2
CO2	1	3	1	1		1	1	3
CO3	1	2	1	3		3	3	2
CO4	2	1	2	3		2	1	3

1. Partially Related
2. Moderately Related
3. Highly Related

Course Code: **ZOO 554**
Course Name: **Applied Zoology**
Course Instructor: **Dr. Reshma Sinha/ Dr. Sunil Kumar**
Credits: **2**

Credits Equivalent: (One credit is equivalent to 10 hours of lectures / organized classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objectives:

- To make the students aware of various pests of food crops and food products and various insect control methods.
- To educate the students about economic importance and techniques of Apiculture and sericulture
- Discuss Wild Life conservation and conservation strategies.

Course Outcomes: Upon completion of the course, students should be able to:
CO^1 Understand vaccines and their current status.
CO^2 Understand pests of food crops and food products and various insect control methods.
CO^3 Understand different honey bee species, bee products, silk worm species and sericulture.
CO^4 Understand different species of culturable fishes, ornamental fishes, fish culture practices, management of fish culture, fish processing and preservation.

Attendance Requirements:
Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.

Evaluation Criteria:
Mid Term Examination: 25
End Term Examination: 50
Continuous Internal Assessment: 25

Course Contents:

UNIT – I: SERICULTURE AND PISCICULTURE (4 HOURS)
Sericulture Silkworm and its strains, rearing of silkworms, sericulture and its components, silk reeling Pests, and diseases of silkmoth. Pisciculture Monocultuer and composite culture Fresh water, & marine fisheries, induced breeding & its technique in pisciculture; Haps & ponds for fish culture and their management. Fish diseases and their control.

UNIT – II: PEST CONTROL AND PEST MANAGEMENT (4 HOURS)
Pest Control Principles and practices of pest control. Methods of pest control-Chemical Biological, Microbial, Integrated control. organochlorine, Insecticides, Organisphosophorus insecticides, Carbamates, Acaricides, Nematicides, Rodenticides, Molluscicides and Botanical pesticides. Pheromonal and Hormonal control. Chemosterilants and genetic control.

Crop Pests and their Management Biology and control of following insect pests of agricultural importance.

UNIT – III: MEDICAL ZOOLOGY (4 HOURS)

Medical Zoology Systematics, biology and control of following medically important organisms. Trichomonas, Onchocerca, Cyclops, sarcoptes, Dermacentor, Phlebotmus, Glossina. Mode of transmissionand of some important diseases. Cholera, Typhus, small pox, plague, Malaria, Dengue fever, Filariasis & AIDS. Metabolic and Muscular disorders Metabolic disorder with regard to major food stuffs absorption.

UNIT – IV: VACCINATION (4 HOURS)

Vaccination: Immunization; different types of vaccines; Current status of malarial vaccine.

UNIT – V: WILD LIFE CONSERVATION AND CONSERVATION STRATEGIES (4 HOURS)

Wild Life conservation and conservation strategies; Extinction of wild species meaning and cause; Wild life protection in India and classification of threatened species, protected wild animals, protected areas and their management in India Endangered fauna and special projects for endangered species.

SUGGESTED READINGS:

- Jabde, P. V. (2005). Text Book of Applied Zoology. Discovery Publishing House.
- Wardle, R. A. (1929). The Principles of Applied Zoology. *The Principles of Applied Zoology*.
- Hill, D. S. (1994). *Agricultural entomology*. Timber Press.

Course Articulation Matrix of ZOO 554- Applied Zoology

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	1	1	3	2		1	3	2
CO2	1	3	1	1		1	1	3
CO3	1	2	1	3		3	3	2
CO4	2	1	2	3		2	1	3

1. Partially Related
2. Moderately Related
3. Highly Related

Course Code: **ZOO 555**
Course Name: **Medical Microbiology**
Course Instructor: **Dr. Ranjit/ Dr. Amit**
Credits: **2**

Credits Equivalent: (One credit is equivalent to 10 hours of lectures / organized classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objectives:

- The main objective of this course is to provide basic knowledge to students on various microbiological practices in the laboratory.
- To elaborate their knowledge in basic microbiology techniques and performing experiments to identify unknown bacteria by biochemical tests, fungal cultivation and staining, special media.
- Gain theoretical knowledge of various diseased conditions generated due to microbial pathogens.

Course Outcomes: Upon completion of the dissertation, students should be able to:
CO[1] Understand the methods of cultivation of microorganisms
CO[2] Understand and perform various biochemical tests to identify unknown microorganisms, practical exposure to fungus cultivation and staining.
CO[3] Understand the basics of microbiology like Characterization and classification of microorganisms, cultivation, nutrition, physiology and growth of microbial cells.
CO[4] Learn about Media for Industrial Fermentation, Large scale production and commercial applications of enzymes, solvents and antibiotics

Attendance Requirements:
Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.

Evaluation Criteria:
Mid Term Examination: 25
End Term Examination: 50
Continuous Internal Assessment: 25

Course Contents:

UNIT I: PRINCIPLE OF CLASSIFICATION (4 HOURS)
Principles of classification of microbes; morphological, metabolic and molecular criteria for the classification, A brief introduction to major group of bacteria. Ultra structure of bacteria. Microbial Cultivation, Growth curve and factors influencing growth. Nutritional types requirements of bacteria.

UNIT II: DISINFECTION AND STERILIZATION (4 HOURS)

Disinfection and sterilization: Staining characteristics and techniques. Serological characteristics, Bacterial respiration, Microbial Diversity.

UNIT III: FOOD MICROBIOLOGY (4 HOURS)

Food Microbiology: Microbiology of dairy industry and beverage fermentation. Role of microorganisms in beverages tea and coffee fermentations. Vinegar Fermentation, microbiology of wine industry. Genetically modified foods. Biosensors in food.

UNIT IV: ANTIBIOTICS (4 HOURS)

Antibiotics and their Mechanism of action Molecular principles of drug targeting. Bacterial resistance to antibiotics. New vaccine technology, DNA vaccines, synthetic peptide vaccines, multivalent subunit vaccines. Vaccine clinical trials.

UNIT V: MEDICAL MICROBIOLOGY (4 HOURS)

Medical Microbiology: Diseases caused by Gram positive bacteria, Diseases caused by Gram negative bacteria, Disease caused by toxigenic bacteria, Diseases caused by Gram negative bacteria of family Enterobacteriaceae, sexually transmitted diseases, Overview of medical mycology, Overview of medical parasitology.

Course Articulation Matrix of ZOO 555- Medical Microbiology

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	1	1	3	2		1	3	2
CO2	1	3	1	1		1	1	3
CO3	1	2	1	3		3	3	2
CO4	2	1	2	3		2	1	3
CO5	1	2	3	1		2	3	2
CO6								

1. Partially Related
2. Moderately Related
3. Highly Related

Course Code: **ZOO 556**
Course Name: **Endocrinology**
Course Instructor: **Dr. Reshma Sinha/Dr. Ranjit Kumar**
Credits: **2**

Credits Equivalent: (One credit is equivalent to 10 hours of lectures / organized classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objectives:

- The main objective of this course is to provide basic knowledge to students on various microbiological practices in the laboratory.
- To elaborate their knowledge in basic microbiology techniques and performing experiments to identify unknown bacteria by biochemical tests, fungal cultivation and staining, special media.
- Gain theoretical knowledge of various diseased conditions generated due to microbial pathogens.

Course Outcomes: Upon completion of the dissertation, students should be able to:
CO[1] Understand the methods of cultivation of microorganisms
CO[2] Understand and perform various biochemical tests to identify unknown microorganisms, practical exposure to fungus cultivation and staining.
CO[3] Understand the basics of microbiology like Characterization and classification of microorganisms, cultivation, nutrition, physiology and growth of microbial cells.
CO[4] Learn about Media for Industrial Fermentation, Large scale production and commercial applications of enzymes, solvents and antibiotics

Attendance Requirements:
Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.

Evaluation Criteria:
Mid Term Examination: 25
End Term Examination: 50
Continuous Internal Assessment: 25

Course Contents:

UNIT I: PRINCIPLE OF CLASSIFICATION (4 HOURS)
Principles of classification of microbes; morphological, metabolic and molecular criteria for the classification, A brief introduction to major group of bacteria. Ultra structure of bacteria. Microbial Cultivation, Growth curve and factors influencing growth. Nutritional types requirements of bacteria.

UNIT II: DISINFECTION AND STERILIZATION (4 HOURS)

Disinfection and sterilization: Staining characteristics and techniques. Serological characteristics, Bacterial respiration, Microbial Diversity.

UNIT III: FOOD MICROBIOLOGY (4 HOURS)

Food Microbiology: Microbiology of dairy industry and beverage fermentation. Role of microorganisms in beverages tea and coffee fermentations. Vinegar Fermentation, microbiology of wine industry. Genetically modified foods. Biosensors in food.

UNIT IV: ANTIBIOTICS (4 HOURS)

Antibiotics and their Mechanism of action Molecular principles of drug targeting. Bacterial resistance to antibiotics. New vaccine technology, DNA vaccines, synthetic peptide vaccines, multivalent subunit vaccines. Vaccine clinical trials.

UNIT V: MEDICAL MICROBIOLOGY (4 HOURS)

Medical Microbiology: Diseases caused by Gram positive bacteria, Diseases caused by Gram negative bacteria, Disease caused by toxigenic bacteria, Diseases caused by Gram negative bacteria of family Enterobacteriaceae, sexually transmitted diseases, Overview of medical mycology, Overview of medical parasitology.

Course Articulation Matrix of ZOO 556- Endocrinology

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	1	2	3	2		1	3	1
CO2	2	3	1	1		1	1	1
CO3	2	2	1	3		3	1	1
CO4	2	1	2	3		2	1	1

1. Partially Related
2. Moderately Related
3. Highly Related

Course Code: **ZOO 559**
Course Name: **Fish Diseases and Control**
Course Instructor: **Dr. Rakesh Kumar**
Credits: **2**

Credits Equivalent: (One credit is equivalent to 10 hours of lectures / organized classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objectives:

- To learn the fish and shellfish diseases associated with bacteria, virus, parasite and protozoan.
- To understand the gross and clinical signs of different diseases and defense mechanisms in fish and shellfish against disease causing microorganisms.
- To learn the preventive and therapeutic measures of fish and shellfish diseases

Course Outcomes: Upon completion of the course, students should be able to:
CO^1 Explain different disease conditions which is associated with different microorganisms.
CO^2 Understand significance of fish diseases in relation to aquaculture.
CO^3 Understand tools and techniques available to diagnose and manage fish diseases.
CO^4 Identify different therapeutic and preventive measurement of fish and shellfish diseases.

Attendance Requirements:
Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.

Evaluation Criteria:
Mid Term Examination: 25
End Term Examination: 50
Continuous Internal Assessment: 25

Course Contents:

UNIT – I: INTRODUCTION TO FISH DISEASE (4 HOURS)
Introduction to Fish Disease, Need for Healthy Fish, Factors Favouring Diseases, General Symptoms of diseases of fish, Tests for Healthy Fish, Modes of Infection, Water Quality Management.

UNIT – II: FISH DISEASES (4 HOURS)
Fish Diseases: Stress in aquaculture and its role in disease development. Infectious, Nutritional and Environmental Disease (*Causative agent, symptoms and Control)*
Infectious Diseases: Bacterial Diseases (Dropsy, Furunculosis, Tail Rot), Fungal Diseases(*Gill rot),* Viral Diseases (*IPN, IHN, VH, CCVD),* Protozoan Diseases (*Costiasis*, *Ichthyophthiriasis*).

Nutritional Diseases: Pin head, Lipoid Hepatic Degeneration, Avitaminosis, Cataract.

Environmental Diseases: Role of physical (injuries, health, cold) chemical (pH, salinity, toxins, ammonia, nitrogenous waste, endogenous chemicals and metabolites, free radicals, oxidants) soil and water parameters in fish health.

UNIT – III: DISEASE MANAGEMENT TOOLS (4 HOURS)

Disease Management Tools: Immunostimulants, Probiotics, Bioremediators, Enzymes, and Nutritional Supplements, Vaccines, Use of Specific Pathogen Free (SPF) and Specific Pathogen Resistant Broodstock (SPR).

UNIT –IV: TECHNIQUES IN AQUATIC ANIMAL HEALTH (4 HOURS)

Techniques in Aquatic Animal Health:Gross Observations, Procedures for collection of diseased live and dead samples for analysis. Preservation of tissue samples. Record keeping in aquatic animal health management.

UNIT V: CONTROL OF FISH DISEASES AND PARASITES (4 HOURS)

Control of Fish Diseases and Parasites: Rules for using fish drugs, correct use of fish drug, Preventive measures of Infectious Diseases, Preventive measures of Nutritional Diseases, Preventive measures of Environmental Diseases (*Therapeutic methods for treatment of fish, treatment by immersion, administration of drugs with food).*

Books recommended

1. Fish and Fisheries of India by V.G. Jhingran, Hindustan Publ. House, N. Delhi,1991.
2. Probiotics, an Alternative Measure to Chemotherapy in Fish .. by O A Akanmu - . 2018
3. Handbook of Probiotics and Prebiotics, Second Edition Editor(s): Yuan Kun Lee And Seppo Salminen John Wiley & Sons, Inc.
4. Inland Fisheries of India Vol. I & II by P.K. Talwar and A.G. Jhingran, Oxford & IBH, New Delhi, 1991.
5. Handbook of Fish Diseasesby Dieter Untergasser.
6. Fish Diseases: Prevention and Control Strategies – BioOne by J.R. Winton-2018
7.Fish viruses and bacteria Pathobiology and Protection Patrick T K Woo and Rocco C and M.S. Johal. Narendra Publishing House, Delhi, 2004.
14. History of Fishes by J. Norman revised by P.H. Greenwood. Ernst Brown, London 1999.
15. Probitics an alternative measures to chemotherapy in fish production by Olumuyiwa Ayodeji Akanmu.

Course Articulation Matrix of ZOO 559- Fish Diseases and Control

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	1	1	3	2		1	3	2
CO2	1	3	1	1		1	1	3
CO3	1	2	1	3		3	3	2

CO4	2	1	2	3		2	1	3

1. Partially Related; 2. Moderately Related; 3. Highly Related

Course Code: **ZOO 560**
Course Name: **Fisheries and Limnology Lab-II**
Course Instructor: **Dr. Rakesh Kumar/Dr. Amit Kumar**
Credits: **2**

Credits Equivalent: (One credit is equivalent to 10 hours of lectures / organized classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objectives:

- To study about the Inland Water bodies
- To acquaint the students toClassification and general characteristics of lotic and lentic water bodies.
- To know Classification and general characteristics of fish and fish diseases.

Course Outcomes: Upon completion of the course, students should be able to:
CO^1 Identify different fish on basis of morphology.
CO^2 Understand distribution and dynamics of freshwater bodies
CO^3 Estimate different water parameters.
CO^4 Have a deeper understanding of fish diseases.

Attendance Requirements:
Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.

Evaluation Criteria:
End Term Examination: 50
Continuous Internal Assessment: 50

Course Contents:

1. To estimate the dissolved oxygen in water.
2. To estimate the pH of water.
3. To study the benthic organisms.
4. To study the Exotic culturable fishes.
5. Estimation of total hardness in a given water sample.
6. To study the different common diseases of fishes caused by virus, bacteria, protozoan and Helminth

Course Articulation Matrix of ZOO 560- Fisheries and Limnology Lab-II

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	1	1	3	2		3	3	2
CO2	3	2	1	1		3	1	1
CO3	1	2	2	3		3	3	1
CO4	3	1	1	3		2	1	3

1. Partially Related
2. Moderately Related
3. Highly Related

Course Code: **ZOO 557**
Course Name: **Medical Entomology**
Course Instructor: **Dr. Sunil Kumar/ Dr. Reshma Sinha**
Credits: **2**

Credits Equivalent: (One credit is equivalent to 10 hours of lectures / organized classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objectives:

- To acquaint the students to characteristics, classification and life cycle of medically important insects.
- To help students to learn the taxonomy, morphology, life history, ecology, and behavior of the insects of public health importance and the epidemiology of the disease pathogens they transmit.
- To enable students to analyze, discuss and assess scientific data and hypotheses surrounding the controversies of emerging diseases and present this information in a logical and scientific manner.

Course Outcomes: Upon completion of the course, students should be able to:
CO^1 Master the essential biological aspects of medical arthropods.
CO^2 Examine the role of insects as vectors of diseases and their effects on human populations.
CO^3 Understand role of insects in forensic sciences.
CO^4 Explain pest management (IPM) techniques that are helpful in diagnosing, preventing, and controlling disease vectors.

Attendance Requirements:
Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.

Evaluation Criteria:
Mid Term Examination: 25
End Term Examination: 50
Continuous Internal Assessment: 25

Course Contents:

UNIT-I: MEDICALLY IMPORTANT INSECTS (4 HOURS)
Classification of medically important Insects and other arthropods,
Characteristic features of insects orders categorised as vectors (Diptera, Siphonaptera, Siphunculata, Hemiptera) and their evolutionary, anatomical, physiological, cellular and molecular adaptations as vectors;

UNIT-II: MEDICAL IMPORTANT INSECT VECTORS OF ORDER DIPTERA

(4 HOURS)

Medical important insect vectors of order Diptera- their life cycle, epidemiology and management: Mosquitoes, Sand flies, Tsetse flies, Houseflies;

Study of Transmission; Epidemiology; Occurrence, Causative agents and Control of: Mosquito borne diseases- Malaria, Dengue, Yellow fever,Chikungunya, Viral encephalitis, Filariasis; Control of mosquitoes;

Sand-fly borne diseases- Leishmaniasis, phlebotomus fever; Control of sand flies;

Tsetse fly-borne disease-sleeping sickness.

Study of house fly as important mechanical vector; Myiasis; Control of housefly

UNIT-III: VECTOR BORNE DISEASES (4 HOURS)

Vector borne diseases spread through: Siphonapterans-Fleas-Host-specificity; Study of flea borne diseases- Plague, typhus fever; Control of sand flies.

Siphunculata- Human louse (head, body and pubic louse) as disease vectors; study of louse borne diseases-Typhus fever, relapsing fever, trench fever, vagabond's disease, phthiriasis; Control of human louse;

Hemipterans-Bugs as insect vectors; Blood sucking bugs; Chagas disease; Bed bugs as mechanical vectors; Control and prevention methods.

Vectors and diseases spread through class arachnida, crustacean ticks, mites, cyclops, their life cycle and control measures

UNIT-IV: VECTOR MANAGEMENT STRATEGIES (4 HOURS)

Vector management strategies: Chemical and Non-chemical methods of control i.e., quarantine, cultural, mechanical, chemical, biological, behavioural; Integrated Vector Management.

UNIT-V: FORENSIC ENTOMOLOGY (4 HOURS)

Forensic Entomology: important insects as Forensic tools, role of insects/arthropods in criminal investigation, by predicting time and cause of death.

SUGGESTED BOOKS:

1. Medical and Veterinary Entomology Mullen, G. , Durden, L., Academic Press, USA
2. Medical and Veterinary Entomology, Kettle, D. S., Cabi Press, USA
3. Medical Entomology for students, Service, M. Cambridge University Press, UK
4. The Insects, An outline of Entomology, Gullan, P. J. , and Cranston, P. S., Wiley Blackwell, UK
5. Park K. (2007) Preventive and social medicine XVI edition, B.B. Publisher
6. Arora DR and Arora B (2001). Medical Parasitology, II Edition. CBS Publications and Distributors
7. Imms A.D. (1977) A General Text Book of Entomology. Chapman and Hall UK

Course Articulation Matrix of ZOO 557- Medical Entomology

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	1	1	3	2		1	3	2
CO2	1	3	1	1		1	1	3
CO3	1	2	1	3		3	3	2
CO4	2	1	2	3		2	1	3

1. Partially Related
2. Moderately Related
3. Highly Related

Course Code: **ZOO 558**
Course Name: **Entomology Lab - II**
Course Instructor: **Dr. Sunil Kumar/ Dr. Reshma Sinha**
Credits: **2**

Credits Equivalent: (One credit is equivalent to 10 hours of lectures / organized classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objectives:
To acquaint the students to economic importance, ecology and biology of insect of medical and agricultural importance, insect pest of important tropical crops, insect pest management techniques, types of insecticides and problem associated with their use.

Course Outcomes: Upon completion of the course, students should be able to:
CO^1 Have an understanding of mouthparts and their modification in medically important insects.
CO^2 Understand the life stages of major insects.
CO^3 Apply their literary knowledge to identify medically important insects.
CO^4 Recognize and identify diseases transmitted by insect vectors.

Attendance Requirements:
Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.

Evaluation Criteria:
End Term Examination: 50
Continuous Internal Assessment: 50

Course Contents:

1. Study of mouthparts and their modification in medically important insects
2. Study of life history stages of medically important insect vectors through permanent slides or photographs: *Aedes, Culex,Anopheles*, lice (head, body, pubic), bed bug, *Phlebotomus* (sand fly), *Musca domestica* (house fly).
3. Study of life stages of medically important ticks and mites.
4. Study of different diseases transmitted by above insect vectors.
5. Field visit/Project report on any one disease transmitted by insect vector/important forensic insects

Course Articulation Matrix of ZOO 558- Entomology Lab - II

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	3	1	3	2		3	3	2
CO2	1	3	1	1		1	1	1
CO3	3	2	3	3		3	1	1
CO4	2	1	2	3		2	1	1

1. Partially Related

2. Moderately Related

3. Highly Related

Course Code: **ZOO 561**
Course Name: **Molecular Genetics**
Course Instructor: **Dr. Ranjit Kumar**
Credits: **2**

Credits Equivalent: (One credit is equivalent to 10 hours of lectures / organized classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objectives:
To introduce students to the world of genetics and develop understanding of various molecular mechanism and their regulation.

Course Outcomes: Upon completion of the course, students should be able to:
CO^1 Explain DNA structure and replication.

CO^2 Understand the concept of transcription and translation.

CO^3 Discuss RNA modification and their fate

CO^4 Explore the field and as base for research.

Attendance Requirements:
Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.

Evaluation Criteria:
Mid Term Examination: 25
End Term Examination: 50
Continuous Internal Assessment: 25

Course Contents:

UNIT I: GENETIC MATERIAL (4 HOURS)
The genetic material - Structure of nucleic acids - folding motifs, conformation flexibilities, super-coiling of DNA; Packaging of DNA in the nucleus- structure of chromatin, Function of the genetic material; Evolution of genetic material;

UNIT II: PROKARYOTIC AND EUKARYOTIC GENETIC MATERIAL (4 HOURS)
Difference between prokaryotic and eukaryotic DNA replication initiation; Termination of replication; Proof- reading activity; Transcription initiation by RNA polymerases, regulation of transcription-factor activity, elongation and termination of transcription.

UNIT III: STABILITY AND VARIATION IN THE GENETIC MATERIAL

(4 HOURS)

Mechanism of DNA repair; Genome instability; Homologous and site-specific recombination. Mechanism of homologous recombination in prokaryotes and eukaryotes;

UNIT IV: POST-TRANSCRIPTIONAL REGULATION (4 HOURS)

Post-transcriptional gene control mechanism and nuclear transport - Processing of the 5' and 3' ends of eukaryotic mRNA; Types of introns and their splicing, Micro RNA and other noncoding RNAs; Transport across the nuclear envelope- Structure of the nuclear membrane and the nuclear pore complexes.

UNIT V: FATE OF RNAs EXPORTED FROM THE NUCLEUS (4 HOURS)

Fate of RNAs exported from the nucleus- Stability of different types of RNA; Translational machinery and translational control- Energetics of amino acid polymerization, tRNAs and their modifications; Amino-acylt-RNA synthetases; Initiation of translation in prokaryotes and eukaryotes and its regulation; elongation and its control, Termination of translation.

Suggested Books:

1. Molecular Biology of the Gene, Watson et al. (7th Ed. 2017), Pearson Education, Delhi, INDIA
2. Lewin's Genes XI (2014), Jones and Bartlett Publishers, Boston, USA
3. Molecular Cell Biology, Lodishet al., W.H. Freeman and Company (8th Ed. 2016)
4. Accuracy in Molecular Processes: Its Control and Relevance to Living System, TBL Kirkwood, RF Rosenberger, and DJ Gala (1989), Chapman and Hall, NY, USA.

Course Articulation Matrix of ZOO 561- Molecular Genetics

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	1	1	3	2		1	3	2
CO2	1	3	1	1		1	1	3
CO3	1	2	1	3		3	3	2
CO4	2	1	2	3		2	1	3

1. Partially Related
2. Moderately Related
3. Highly Related

Course Code: **ZOO 562**
Course Name: **Molecular Genetics Lab I**
Course Instructor: **Dr. Ranjit Kumar/Dr. Dixit Kumar**
Credits: **2**

Credits Equivalent: (One credit is equivalent to 10 hours of lectures / organized classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objectives:

- To introduce students to Fundamentals of advanced softwares like Biorender, GIS etc.
- To acquaint the students to referencing styles and introduction of Mendley .
- To introduce students to Turnitin and its applications in research.

Course Outcomes: Upon completion of the course, students should be able to:
CO^1 Use biorender for better presentation of their research work.
CO^2 Understand the concept of plagiarism and use softwares to check plagiarism.
CO^3 Discuss different referencing styles and use referencing software- Mendeley.
CO^4 Use mentioned software and apply them in their research process.

Attendance Requirements:
Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.

Evaluation Criteria:
End Term Examination: 50
Continuous Internal Assessment: 50

Course Contents:

1. DNA isolation of prokaryote and eukaryote
2. Chromosome analysis
3. Protein analysis
4. Study oh chromosomal imbalance
5. Polytene and lampbrush chromosome.

Course Articulation Matrix of ZOO 562- Molecular Genetics Lab I

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	1	1	3	2		1	3	2
CO2	1	3	1	1		1	1	3
CO3	1	2	1	3		3	3	2
CO4	2	1	2	3		2	1	3

1. Partially Related
2. Moderately Related
3. Highly Related

Course Code: **ZOO 599**
Course Name: **Dissertation**
Course Instructor: **Respective Guides**
Credits: **4**

Credits Equivalent: (One credit is equivalent to 10 hours of lectures / organized classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objectives:
The course of dissertation is based on their specialization field to get more learning in particular field with Practical knowledge.

Course Outcomes: Upon completion of the dissertation, students should be able to:
CO[1] Identify and formulate research problems.
CO[2] Have hands on training on the techniques used.
CO[3] Apply their knowledge in benefitting society and further research projects.
CO[4] Can publish paper in the scientific journal.

Attendance Requirements:
Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.

Evaluation Criteria:
Dissertation, Viva voce and assessment: 200

Course Contents:
On different selected topics like entomology, fisheries, toxicology, ornithology, Parasitology, cell biology, genetics and ecology etc.

Course Articulation Matrix of ZOO 599- Dissertation

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	2	2	3	2		2	3	2
CO2	2	3	2	2		1	1	3
CO3	2	2	2	3		3	3	2
CO4	2	1	2	3		2	2	3

1. Partially Related; 2. Moderately Related; 3. Highly Related