

SYLLABUS
for
Choice Based Credit System
(CBCS)

ZOOLOGY HONOURS

PATNA WOMEN'S COLLEGE

Autonomous

PATNA UNIVERSITY

3rd Cycle NAAC Accredited at 'A' Grade with CGPA 3.58/4
"College with Potential for Excellence" (CPE) Status Accorded by UGC

Vision

Rooted in the life, vision, and teachings of Jesus Christ and inspired by Mother Veronica, the foundress of the Apostolic Carmel, Patna Women's College strives to become a center of academic excellence in higher education, social responsibility, and empowerment of women.

Mission Statement

Patna Women's College, the first college for women in Bihar, is committed to the holistic development of women so as to make an effective contribution to the creation of a better society.

To this end, we strive

- To become a center of excellence in higher education for women in an atmosphere of autonomy.
- To excel in teaching-learning, research, and consultancy.
- To provide education that promotes capacity building and holistic development of a person.
- To offer subjects for competency building and motivate/animate a workforce imbued with human values.
- To promote patriotism, communal harmony and cultural integration to maintain a free and peaceful atmosphere on the campus.
- To train the students in creative arts, social service, critical thinking, and leadership in order to make an effective contribution to the creation of a new and value based society.
- To create women leaders and to make them agents of social change.
- To develop skill oriented and value based courses, for the all-round development of individuals.
- To promote academic exchange and academia-industry interface.
- To form young women who are 'always wise' and who will dare to 'go ahead and conquer knowledge' through, competence, commitment, delicate conscience, and compassion.

Programme Outcomes

After the completion of B.Sc. Honours Degree Programme, the students will be able to achieve the following outcomes:

PO1: Professional knowledge: Acquire comprehensive knowledge of major concepts, theoretical principles and experimental findings of various subjects in pure sciences.

PO2: Critical thinking and Cognitive skills: Convey the intricate science information effectively and efficiently, analyze and solve the problems related to plants, animal sciences without relying on assumptions and guesses.

PO3: Environment and sustainability: Understand the impact of the scientific solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO4: Effective Communication: Demonstrate familiarity with and will be able to analyze both verbally and in writing issues and forms of contemporary art with a clear understanding of historical precedents.

PO5: Instruments and Experiments: Acquire the skills in handling scientific instruments, planning and performing in laboratory experiments and drawing logical inferences from the scientific experiments.

PO6: Research and Analysis: Demonstrate analytical skill and proficiency in a range of tools and techniques used in research in science and interdisciplinary programmes.

PO7: Employability and higher Education: Show proficiency in professional, employability and develop soft skills required for higher education and placements.

- PO8: Ethics:** Imbibe ethical, moral and social values in personal and social life leading to highly cultured and civilized personality in the field of science.
- PO9: Science and Society:** Apply reasoning acquired by the scientific knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional science practice.
- PO10: Interdisciplinary Learning:** Integrate academic curriculum with other co-curricular goals, such as career development, life-long learning, develop interdisciplinary learning and opportunity to extend their knowledge across all disciplines.
- PO11: Nation Building:** Introspect and evolve into dynamic and creative individuals capable of socially productive, constructive actions that positively impact our Nation and the World at large.

Programme Specific Outcomes UG

Students enrolled in B.Sc. (Hons.) degree program in Zoology will study and acquire complete knowledge of disciplinary as well as allied biological sciences. At the end of graduation they should possess expertise which will provide them competitive advantage in pursuing higher studies from India or abroad, seek jobs in academia, research or industries.

PSO1: Identify, classify and differentiate diverse chordates and non-chordates based on their morphological, anatomical and systemic organization.

PSO2: Describe economic, ecological and medical significance of various animals in human life. This will create a curiosity and awareness among them to explore the animal diversity and take up wild life photography or wild life exploration as a career option. The knowledge about identifying and classifying animals will provide students professional advantages in teaching,

research and taxonomist jobs in various government organizations; including Zoological Survey of India and National Parks/Sanctuaries.

PSO3: Acquire practical skills in cell & molecular biology, biochemistry, genetics, enzymology. These methodologies will provide an extra edge to our students, who wish to undertake higher studies.

PSO4: Understand comparative anatomy and developmental biology of various biological systems; and learning about the organisation, functions, strength and weaknesses of various systems will let student critically analyse the way evolution has shaped these traits in human body.

PSO5: Skill enhancement course like medical diagnostics will provide them opportunity to work in diagnostic or research laboratory.

PSO6: Students undertaking wild life management courses would gain expertise in identifying key factors of wild life management and be aware about different techniques of estimating, remote sensing and Global positioning of wild life. This course will motivate students to pursue career in the field of wildlife conservation and management.

PSO7: Acquire awareness towards gender, environment, sustainability, human values, and professional ethics and understand the difference between acting, responding, reacting to various social issues.

B.Sc. (Honours) Zoology

Note: 1 credit = 15 hours

1. Theory paper: 6 credits each (4Theory and 2 Practical).

Core Courses (6 credits each)

Core Course: A course, which should compulsorily be studied by a candidate as a core requirement is termed as a Core course.

Semester I

1. Non-Chordates I (Theory)
Non-Chordates I (Practical)

2. Principles of Ecology (Theory)
Principles of Ecology (Practical)

Semester II

3. Non-Chordates II (Theory)
Non-Chordates II (Practical)
4. Cell Biology (Theory)
Cell Biology (Practical)

Semester III

5. Diversity of Chordates (Theory)
Diversity of Chordates (Practical)
6. Physiology: Controlling and Coordinating Systems (Theory)
Physiology: Controlling and Coordinating Systems (Practical)
7. Fundamentals of Biochemistry (Theory)
Fundamentals of Biochemistry (Practical)

Semester IV

8. Comparative Anatomy of Vertebrates (Theory)
Comparative Anatomy of Vertebrates (Practical)
9. Physiology: Life Sustaining Systems (Theory)
Physiology: Life Sustaining Systems (Practical)
10. Biochemistry of Metabolic Processes (Theory)
Biochemistry of Metabolic Processes (Practical)

Semester V

11. Molecular Biology (Theory)
Molecular Biology (Practical)
12. Principles of Genetics (Theory)
Principles of Genetics (Practical)

Semester VI

13. Developmental Biology (Theory)
Developmental Biology (Practical)
14. Evolutionary Biology (Theory)
Evolutionary Biology (Practical)

Discipline Specific Elective (DSE) (6 credits each)

Discipline Specific Elective (DSE) Course: Elective courses may be offered by the main discipline/subject of study is referred to as Discipline Specific Elective. The University/Institute may also offer discipline related Elective courses of interdisciplinary nature (to be offered by main discipline/subject of study).

Semester V

DSE-1

1. Endocrinology /Human Reproductive Biology

DSE-2

2. Immunology / Genetic Engineering and Biotechnology

Semester VI

DSE-3

- Animal Behaviour and Chronobiology / Agrochemicals and Pest Management

DSE-4

- Wildlife Conservation and Management / Aquatic Biology

Skill Enhancement Course (SEC)(2Credits)

Skill Enhancement Courses (SEC): These courses may be chosen from a pool of courses designed to provide **value-based and/or skill-based knowledge**.

Semester III

- Inter Religious Studies (Value based)

Semester IV

- Medical Diagnostics

Generic Elective Papers (GE) (6 credits each)

Generic Elective (GE) Course: An elective course chosen generally from an unrelated discipline/subject, with an intention to seek exposure is called a Generic Elective.

P.S.: A core course offered in a discipline/subject may be treated as an elective by other discipline/ subject and vice versa and such electives may also be referred to as Generic Elective.

Semester I

- Animal Diversity

Semester II

- Environment and Public Health

Semester III

- Food Nutrition and Health

Semester IV

- Insect Vectors and Disease

Zoology (Hons.) CBCS Syllabus

Sem .	Core Course (14) <u>6 Credits each</u>	Ability Enhancement Compulsory Course AECC (2) <u>2 Credits each</u>	Skill Enhancement Course SEC (2) <u>2 Credits each</u>	Discipline Specific Elective DSE (4) <u>6 Credits each</u>	Generic Elective GE (4) <u>6 Credits each</u>
I	ZOO CC101: Non-Chordates I	English/ MIL Communication/ Environmental Science			ZOO GE101: Animal Diversity
	ZOO CC102: Principles of Ecology				
II	ZOO CC203: Non-Chordates II	English/ MIL Communication/			ZOO GE202: Environment and

	ZOO CC204: Cell Biology	Environmental Science			Public Health
III	ZOO CC305: Diversity of Chordates		IRS SEC301: Inter-Religious Studies (Value based)		ZOO GE303: Food Nutrition and Health
	ZOO CC306: Physiology: Controlling and Coordinating Systems				
	ZOO CC307: Fundamentals of Biochemistry				
IV	ZOO CC408: Comparative Anatomy of Vertebrates		ZOO SEC402: Medical Diagnostics		ZOO GE404: Insect Vectors and Diseases
	ZOO CC409: Physiology: Life Sustaining Systems				
	ZOO CC410: Biochemistry of Metabolic Processes				
V	ZOO CC511: Molecular Biology			ZOO DSE501: Endocrinology / Human Reproductive Biology ZOO DSE502: Immunology/ Genetic Engineering and Biotechnology	
	ZOO CC512: Principles of Genetics				
VI	ZOO CC613: Developmental Biology			ZOO DSE603: Animal Behaviour and Chronobiology/ Agrochemicals and Pest Management ZOO DSE604: Wildlife Conservation and Management/ Aquatic Biology	
	ZOO CC614: Evolutionary Biology				

Course Structure for B.Sc. Zoology (Hons.)

<u>Semester –I</u>	<u>Semester –II</u>
ZOO CC101: Non-Chordates I (Theory) Non-Chordates I (Practical)	ZOO CC203: Non-Chordates II (Theory) Non-Chordates II (Practical)
ZOO CC102: Principles of Ecology (Theory) Principles of Ecology (Practical)	ZOO CC204: Cell Biology (Theory) Cell Biology (Practical)
ENG AEC101 : English Communication HIN AEC101 : fgUnh O;kdj.k vkSj IEIzs"k.k	EVS AEC202 : Environmental Science
ZOO GE101: Animal Diversity	ZOO GE202: Environment and Public Health

<u>Semester –III</u>	<u>Semester –IV</u>
ZOO CC305: Diversity of Chordates (Theory) Diversity of Chordates (Practical)	ZOO CC408: Comparative Anatomy of Vertebrates (Theory) Comparative Anatomy of Vertebrates (Practical)
ZOO CC306: Physiology: Controlling and Coordinating Systems (Theory) Physiology: Controlling and Coordinating Systems (Practical)	ZOO CC409: Physiology: Life Sustaining Systems (Theory) Physiology: Life Sustaining Systems (Practical)
ZOO CC307: Fundamentals of Biochemistry (Theory) Fundamentals of Biochemistry (Practical)	ZOO CC41: Biochemistry of Metabolic Processes (Theory) Biochemistry of Metabolic Processes (Practical)
IRS SEC301: Inter-Religious Studies (Value Based)	ZOO SEC402: Medical Diagnostics
ZOO GE303: Food Nutrition and Health	ZOO GE404: Insect Vectors and Diseases
<u>Semester –V</u>	<u>Semester –VI</u>
ZOO CC511: Molecular Biology (Theory) Molecular Biology (Practical)	ZOO CC613: Developmental Biology (Theory) Developmental Biology (Practical)
ZOO CC512: Principles of Genetics (Theory) Principles of Genetics (Practical)	ZOO CC614: Evolutionary Biology (Theory) Evolutionary Biology (Practical)
ZOO DSE501: Endocrinology / Human Reproductive Biology.	ZOO DSE603: Animal Behaviour and Chronobiology/ Agrochemicals and Pest Management
ZOO DSE502: Immunology/ Genetic Engineering and Biotechnology	ZOO DSE604: Wildlife Conservation and Management / Aquatic Biology

Details of Credits for Courses under B.Sc. Zoology Honours

Semester	Course	Theory	Practical	Tutorial	Total Credits
	I. Core Course (14 Papers) – 06 credits each				
I	1. Non-Chordates I	4	2	-	6
	2. Principles of Ecology	4	2	-	6
II	3. Non-Chordates II	4	2	-	6
	4. Cell Biology	4	2	-	6
III	5. Diversity of Chordates	4	2	-	6
	6. Physiology: Controlling and Coordinating Systems	4	2	-	6
	7. Fundamentals of Biochemistry	4	2	-	6

IV	8. Comparative Anatomy of Vertebrates	4	2	-	6
	9. Physiology: Life Sustaining Systems	4	2	-	6
	10. Biochemistry of Metabolic systems	4	2	-	6
V	11. Molecular Biology	4	2	-	6
	12. Principles of Genetics	4	2	-	6
VI	13. Developmental Biology	4	2	-	6
	14. Evolutionary Biology	4	2	-	6
II. Elective Course – 06 credits each					
A. 1. Discipline Specific Elective- DSE(4 papers)					
V	1. Endocrinology/ Human Reproductive Biology	4	2	-	6
	2. Immunology/ Genetic Engineering and Biotechnology	4	2	-	6
VI	3. Animal Behaviour and Chronobiology/Agrochemicals and Pest Management	4	2	-	6
	4. Wildlife Conservation and Management / Aquatic Biology	4	2	-	6
B. 1. Generic Elective / Interdisciplinary (4 papers)					
I	1. Animal Diversity	4	2	-	6
II	2. Environment and Public Health	4	2	-	6
III	3. Food Nutrition and Health	4	2	-	6
IV	4. Insect Vectors and Diseases	4	2	-	6
III. Ability Enhancement Courses – 02 credits each					
1. Ability Enhancement Compulsory (AECC)					
I	English / Hindi Communication	2			2
II	Environmental Science	2			2
II. Skill Enhancement Course (SEC)					
III	1. Inter Religious Studies	2	-	-	2
IV	2. Medical Diagnostics	2	-	-	2
TOTAL					140

Institute should evolve a system/policy about ECA / General Interest / Hobby / Sports / NCC / NSS / related courses on its own.

*wherever there is practical there will be no tutorial and vice-versa.

Zoology (Honours) Details of CBCS Syllabus

Core Courses (6 credits each)

SEMESTER – I

Core Course: A course, which should compulsorily be studied by a candidate as a core requirement is termed as a Core course.

ZOO CC101 : Non-Chordates I : Protists To Pseudocoelomates

(Theory :4 credits + Practical: 2 credits)

Course Outcome:

On completion of the course students will be able

CO1- To learn & interpret the importance of taxonomy and classify Protista, Parazoa, Metazoa, Porifera, Cnidaria, Platyhelminthes and Nematelminthes.

CO2- To understand and explain the economic importance and describe the life cycle and pathogenicity of *P. vivax*, *E. histolytica*, *Schistosoma haematobium*, *Taenia solium*, *Ascaris lumbricoides* and *Wuchereria bancrofti*;

CO3- To appreciate the diversity and complexities exhibited by non-chordates and familiarize with the morphology, anatomy and functioning of different groups of non-chordates.

CO4- To Critically analyze the organization, complexity and adaptations in parasitic Nematelminthes and Platyhelminthes; affinities and Evolutionary significance of Ctenophora and to enhance collaborative learning through practical sessions, assignments and projects.

Units	Syllabus
1	<p>Protista, Parazoa and Metazoa: General characteristics & Classification up to orders; Life cycle and pathogenicity of <i>Plasmodium vivax</i>; life cycle & pathogenicity of <i>E. histolytica</i></p> <p>Locomotion and Reproduction in Protista</p>
2	<p>Porifera: General characteristics and Classification up to orders, Canal system, Spicules in sponges</p> <p>Cnidaria: General characteristics and Classification up to orders; Metagenesis in <i>Obelia</i>; Polymorphism in Cnidaria; Corals and coral reefs.</p> <p>Ctenophora: General characteristics, affinities and Evolutionary significance</p>
3	<p>Platyhelminthes: General characteristics and Classification up to orders; Life cycle and pathogenicity of <i>Schistosoma haematobium</i> and <i>Taenia solium</i>; Parasitic adaptations in Platyhelminthes</p>
4	<p>Nematelminthes: General characteristics and Classification up to orders; Life cycle, and pathogenicity of <i>Ascaris lumbricoides</i> and <i>Wuchereria bancrofti</i>. Parasitic adaptations in Nematelminthes</p>
	<p>Classification to be followed from Barnes,RD.(1982) Invertebrate Zoology, V Edition</p>
	<p>Practicals</p> <ol style="list-style-type: none"> 1. Study of WM of <i>Paramecium</i>, Binary fission & Conjugation in <i>Paramecium</i> 2. Examination of pond water collected from different places for diversity in protista 3. Study of <i>Sycon</i> (T.S. and L.S.), <i>Hyalonema</i>, <i>Euplectella</i>

	<p>4. Study of <i>Obelia</i>, <i>Physalia</i>, <i>Aurelia</i>, <i>Tubipora</i>, <i>Alcyonium</i>, <i>Metridium</i>, <i>Fungia</i>, <i>Meandrina</i>, <i>Madrepora</i></p> <p>5. One specimen/slide of any ctenophore</p> <p>6. Study of adult <i>Schistosoma haematobium</i>, <i>Taenia solium</i> and their life cycles (Slides/microphotographs)</p> <p>7. Study of adult <i>Ascaris lumbricoides</i> and its life stages (Slides/micro-photographs)</p> <p>8. To submit a Project Report on any related topic on life cycles/coral/ coral reef</p> <p>Note: Classification to be followed from “Ruppert and Barnes (2006) <i>Invertebrate Zoology</i>, 8th edition, Holt Saunders International Edition”</p>
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Reading List :

1. Ruppert and Barnes, R.D. (2006). *Invertebrate Zoology*, VIII Edition. Holt Saunders International Edition.
2. Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2002). *The Invertebrates: A New Synthesis*, III Edition, Blackwell Science
3. Barrington, E.J.W. (1979). *Invertebrate Structure and Functions*. II Edition, E.L.B.S. and Nelson
4. Verma P S, Jordan E L. (2009). *Invertebrate Zoology*. S. Chand publishers
5. Brusca R C (2016). *Invertebrates*. Published by Sinauer Associates, an imprint of Oxford University Press.

SEMESTER – I

ZOO CC102 : Principles of Ecology

(Theory :4 credits + Practical: 2 credits)

Course Outcome:

On completion of the course students will be able:

CO1-To understand and relate the key concepts in ecology with emphasis on historical perspective, role of physical factors and concept of limiting factors.

CO2- To understand and explain the population attributes; population growth models and population interactions and to understand and describe the community characteristics and ecological succession

CO3- To understand and describe the different ecosystems, food chains, energy flow & efficiency; biogeochemical cycles.

CO4- To learn and relate the application of the basic principles of ecology in wildlife conservation and management.

Units	Syllabus
1	<p>Introduction to Ecology: Laws of limiting factors, Study of physical factors History of ecology, Autecology and synecology, Levels of organization;</p> <p>Applied Ecology: Ecology in wildlife conservation and management</p>
2	<p>Population: Unitary and modular populations, Unique and group attributes of population, Density, Natality, Mortality, age ratio, sex ratio, dispersal and dispersion; life tables; fecundity tables, survivorship curves, Exponential and logistic growth, equation and patterns, r and K strategies Population regulation density-dependent and independent factors; Population interactions, Gause's Principle with laboratory density-dependent and independent factors; Population interactions, Gause's Principle with laboratory and field examples, Lotka-Volterra equation for competition and Predation, functional and numerical responses</p>
3	<p>Community: Community characteristics: species richness, dominance, diversity, abundance vertical stratification, Ecotone and edge effect; Ecological succession general concepts & theories pertaining to climax community; Ecological Succession: Hydrarch succession</p>
4	<p>Ecosystem: Types of ecosystems; Pond ecosystem in detail, Linear and Y-shaped food chains, Food chains, Food webs, Ecological pyramids, Energy flow through an ecosystem and Ecological efficiencies; General concepts of Nutrient and biogeochemical cycle. Nitrogen cycle and Human Modified Ecosystem</p>
	<p>PRACTICALS</p> <p>Study of life tables and plotting of survivorship curves of different types from the hypothetical/real data provided</p> <p>Determination of population density in a natural/hypothetical community by quadrat method and calculation of Shannon-Weiner diversity index for the same community</p> <p>Study of an aquatic ecosystem: Phytoplankton and zooplankton, Measurement of area, determination of pH, and Dissolved Oxygen content (Winkler's method)</p> <p>Report on a visit to National Park/Biodiversity Park/Wild life sanctuary</p>

Reading List :

1. Colinvaux, P. A. (1993). Ecology. II Edition. Wiley, John and Sons, Inc.
2. Krebs, C. J. (2001). Ecology. VI Edition. Benjamin Cummings.
3. Odum, E.P., (2008). Fundamentals of Ecology. Indian Edition. Brooks/Cole

4. Robert Leo Smith Ecology and field biology Harper and Row publisher
5. Ricklefs, R.E., (2000). Ecology. V Edition. Chiron Pres

Generic Elective Papers (GE) (6 credits each)

SEMESTER – I

Generic Elective (GE) Course: An elective course chosen generally from an unrelated discipline/subject, with an intention to seek exposure is called a Generic Elective.

P.S.: A core course offered in a discipline/subject may be treated as an elective by other discipline/ subject and vice versa and such electives may also be referred to as Generic Elective.

ZOO GE101 : Animal Diversity

(Theory :4 credits + Practical: 2 credits)

On completion of the course students will be able:

CO1- To understand and describe the features of Protista, Porifera, Radiata, Acoelomates and Pseudocoelomates.

CO2 - To understand and describe the features of Arthropoda, Mollusca and coelomate deuterostomes.

CO3- To understand and describe the features of Protochordates, Pisces and Amphibia.

CO4- To understand and describe the features of Reptiles, Aves and Mammalia.

Units	Syllabus
1	<p>Protista General characters of Protozoa; Life cycle of Plasmodium</p> <p>Porifera General characters and canal system in Porifera</p> <p>Radiata General characters of Cnidarians and polymorphism</p> <p>Aceolomates General characters of Helminthes; Life cycle of <i>Taenia solium</i></p> <p>Pseudocoelomates General characters of Nemethehelminthes; Parasitic adaptations in Nematodes</p> <p>Coelomate Protostomes General characters of Annelida ; Metamerism.</p>
2	<p>Arthropoda General characters. Social life in insects with respect to honey bees and termites</p> <p>Mollusca General characters of mollusca; Pearl Formation</p> <p>Coelomate Deuterostomes General characters of Echinodermata, Water Vascular system in Starfish.</p>
3	<p>Protochordata Salient features</p> <p>Pisces General Characters, Migration of Fishes, Parental Care</p> <p>Amphibia General characters, Adaptations for terrestrial life, Parental care in Amphibia.</p>
4	<p>Reptiles General Characters, Origin of reptiles</p> <p>Aves: General Characters, the origin of birds; Flight adaptations</p> <p>Mammalia General Characters, early evolution of mammals; Dentition in mammals.</p>

	<p>Practical :</p> <ol style="list-style-type: none"> 1. Study of following specimens: Non Chordates: <i>Euglena, Noctiluca, Paramecium, Sycon,, Physalia, Tubipora, Metridium, Taenia, Ascaris, Nereis, Aphrodite, Leech, Peripatus, Limulus, , Hermitcrab Daphnia, Millipede, Centipede, Beetle, Chiton, Octopus, Asterias, and Antedon.</i> Chordates: <i>Balanoglossus, Amphioxus, Petromyzon Hippocampus, Labeo, Ichthyophis Salamander, Draco, Uromastix, Naja, Viper, model of Archaeopteryx,</i> any three common birds- (<i>Psittacula, Hen, Sparrow</i>), Squirrel and Bat. 2. Study of following Permanent Slides: Cross section of <i>Sycon, Ascaris</i>(male and female). T. S. of Earthworm passing through pharynx, gizzard. <i>Bipinnaria</i> and <i>Pluteus</i> larva 3. Temporary mounts of <ul style="list-style-type: none"> <input type="checkbox"/> Septal & pharyngeal nephridia of earthworm. <input type="checkbox"/> Stained mounts of Placoid, cycloid and ctenoid scales.
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Reading List :

1. Barnes, R.D. (1992). Invertebrate Zoology. Saunders College Pub. USA.
2. Ruppert, Fox and Barnes (2006) Invertebrate Zoology. A functional Evolutionary Approach 7th Edition, Thomson Books/Cole
3. Campbell & Reece (2005). Biology, Pearson Education, (Singapore) Pvt. Ltd.
4. Kardong, K. V. (2002). Vertebrates Comparative Anatomy. Function and Evolution. Tata McGraw Hill Publishing Company. New Delhi.
5. Raven, P. H. and Johnson, G. B. (2004). Biology, 6th edition, Tata McGraw Hill Publications. New Delhi.

SEMESTER – II

ZOO CC203 : Non-chordates II: Coelomates

(Theory :4 credits + Practical: 2 credits)

Course Outcome:

On completion of the course students will be able:

CO1- To classify and compare phylum Annelida, Arthropoda, Mollusca and Echinodermata.

CO2 To understand and describe Excretion in Annelida; Vision and Respiration in Arthropoda; Metamorphosis in Insects; Social life in bees and termites.

CO3- To understand and describe Respiration in Mollusca; Torsion and detorsion in Gastropoda; Pearl formation in bivalves.

CO4- To understand and describe the Water-vascular system in Asteroidea; Larval forms in Echinodermata.

Units	Syllabus
1	Introduction to coelomates: Evolution of coelom and metamerism Annelida : General characteristics and Classification up to orders Excretion in Annelida
2	Arthropoda : General characteristics and Classification up to orders Vision and Respiration in Arthropoda; Metamorphosis in Insects; Social life in bees and termites Onychophora: General characteristics and Evolutionary significance
3	Mollusca : General characteristics and Classification up to orders; Respiration in Mollusca; Torsion and detorsion in Gastropoda; Pearl formation in bivalves; Evolutionary significance of trochophore larva
4	Echinodermata: General characteristics and Classification up to orders; Water-vascular system in Asteroidea; Larval forms in Echinodermata;
	<i>Classification to be followed from "Ruppert and Barnes (2006) Invertebrate Zoology, 8th edition, Holt Saunders International Edition"</i>
	Practical 1. Study of following specimens: Annelids - <i>Aphrodite, Nereis, Heteronereis, Pheretima, Hirudinaria</i> Arthropods - <i>Limulus, Palamnaeus, Palaemon, Daphnia, Megalopa, Nauplius, Cyclops, Zoa, Mysis, Sacculina, Cancer, Eupagurus, Scolopendra, Julus, Bombyx, Periplaneta</i> , termites and honey bees Onychophora - <i>Peripatus</i> Molluscs - <i>Chiton, Dentalium, Pila, Doris, Unio, Mytilus, Sepia, Loligo, Octopus,</i>

	<p><i>Nautilus</i></p> <p>Echinodermites - <i>Pentaceros/Asterias, Ophiocoma, Echinus, Cucumaria</i> and <i>Antedon</i></p> <p>2. T.S. through pharynx, gizzard of earthworm</p> <p>3. To submit a Project Report on any topic related to larval forms (crustacean, mollusc and echinoderm)</p>
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Reading List :

1. Ruppert and Barnes, R.D. (2006). *Invertebrate Zoology*, VIII Edition. Holt Saunders International Edition
2. Barnes, R.S.K., Calow, P., Olive, P. J. W., Golding, D.W. and Spicer, J.I. (2002). *The Invertebrates: A New Synthesis*, III Edition, Blackwell Science
3. Barrington, E.J.W. (1979). *Invertebrate Structure and Functions*. II Edition, E.L.B.S. and Nelson
4. Verma P S, Jordan E L. (2009). *Invertebrate Zoology*. S. Chand publishers
5. Brusca R C (2016). *Invertebrates*. Published by Sinauer Associates, an imprint of Oxford University Press.
6. Ganguli et al (2018). *Biology of Animals*. NCBA Publications.

SEMESTER – II

ZOO CC204 : Cell Biology

(Theory :4 credits + Practical: 2 credits)

Course outcome:

On completion of the course students will be able to:

CO 1- To understand the structures and purposes of basic components of Prokaryotic and Eukaryotic cells.

CO 2- To understand the structures and functions of Plasma Membrane, Endomembrane System and Cytoskeleton.

CO 3- To understand the detailed structure of Mitochondria and how energy is produced by it through the Respiratory chain.

CO 4- To understand the detailed structure of Nucleus and its associated structures, Cell Division, Cell Cycle and Cell Signaling

Units	Syllabus
1	Overview of Cells : Prokaryotic and Eukaryotic cells; Virus, Viroids, Mycoplasma, Prions
2	Plasma Membrane : Various models of plasma membrane structure; Transport across membranes: Cell junctions: Tight Junctions, Desmosomes, Gap junctions Active and Passive transport, Facilitated transport Endomembrane System : Structure & Functions: Endoplasmic Reticulum, Golgi Apparatus, lysosomes Cytoskeleton : Structure and Functions: Microtubules, Microfilaments and Intermediate filaments
3	Mitochondria: Mitochondria: Structure, Semi-autonomous nature, Endosymbiotic hypothesis; Mitochondrial Respiratory Chain, Oxidative phosphorylation with respect to Chemi-osmotic hypothesis; Peroxisomes
4	Nucleus: Nuclear envelope and Nuclear pore complex, Nucleolus, Chromatin packaging (nucleosome model); Chromatin: Euchromatin and Heterochromatin Cell cycle and its regulation (Role of CDK-cyclin complex) Cell Signaling : Receptors and Signaling molecules, GPCR and Role of second messenger (cAMP)
	Practical : Preparation of temporary stained squash of onion root tip to study various stages of mitosis Study of various stages of meiosis in grasshopper testis Preparation of temporary slide to show the presence of Barr body in human female blood cells/cheek cells Histochemical demonstration of DNA by Feulgen reaction

Reading List :

1. Karp, G. (2010). *Cell and Molecular Biology: Concepts and Experiments*. VI Edition. John Wiley and Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). *Cell and Molecular Biology*. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
3. Cooper, G.M. and Hausman, R.E. (2009). *The Cell: A Molecular Approach*. V Edition. ASM Press and Sunderland, Washington, D.C.; Sinauer Associates, MA.
4. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). *The World of the Cell*. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.
5. Bruce Albert, Bray Dennis, Levis Julian, Raff Martin, Roberts Keith and Watson James (2008). *Molecular Biology of the Cell*, V Edition, Garland publishing Inc., New York and London.

SEMESTER – II

ZOO GE202 : Environment and Public Health

(Theory :4 credits + Practical: 2 credits)

Course outcome:

On completion of the course students will be able to:

CO 1- To acquire knowledge about various sources of environmental hazards, their risk assessment, fate of toxic and persistent substances in the environment.

CO 2- To understand the factors of Climate change like Greenhouse gases, Global warming, Acid rain, Ozone layer destruction and Effect of Climate change on public health.

CO 3- To know about the sources and effects of Air, Water and Noise Pollution and their control methods, Waste Management Technologies, Bhopal Gas Tragedy, Chernobyl Disaster, Seveso Disaster and Three Mile Island Accident and their aftermath.

CO 4- To understand the causes, symptoms and control of Diseases like- Tuberculosis, Asthma, Silicosis, Asbestosis, Cholera, Minamata, Arsenicosis and Fluorosis

Units	Syllabus
1	Introduction Sources of Environmental hazards, hazard identification and risk assessment, fate of toxic and persistent substances in the environment, dose response evaluation
2	Climate Change Greenhouse gases and global warming, Acid rain, Ozone layer destruction, Effect of climate change on public health Pollution Air, water, noise pollution sources and effects, Pollution control
3	Waste Management Technologies Sources of waste, types and characteristics, Sewage disposal and its management, Solid waste disposal, Biomedical waste handling and disposal, Nuclear waste handling and disposal, Waste from thermal power plants, Case histories on Bhopal gas tragedy, Chernobyl disaster, Seveso disaster and Three Mile Island accident and their aftermath.
4	Diseases Causes, symptoms and control of tuberculosis, Asthma, Silicosis, Astestosis, Cholera, Minamata, Arsenicosis, Fluorosis
	Practical 1. To determine pH, Cl, NO ₃ in soil and water samples from different locations. 2. DO in water sample

Reading List :

1. Cutter, S.L., Environmental Risk and Hazards, Prentice-Hall of India Pvt. Ltd., New Delhi, 1999.

2. Kolluru Rao, Bartell Steven, Pitblado R and Stricoff “Risk Assessment and Management Handbook”, McGraw Hill Inc., New York,1996.
3. Kofi Asante Duah “Risk Assessment in Environmental management”, John Wiley and sons, Singapore, 1998.
4. Kasperson, J.X. and Kasperson, R.E. and Kasperson,R.E., Global Environmental Risks, V.N.University Press, New York, 2003.
5. Joseph F Louvar and B Diane Louver Health and Environmental Risk Analysis fundamentals with applications, Prentice Hall, New Jersey 1997.

ZOO CC305 : Diversity of Chordates

(Theory :4 credits + Practical: 2 credits)

Course outcome:

On completion of the course students will be able to:

CO1- To understand the General Characteristics and Classification of Hemichordata, Urochordata and Cephalochordata, the Larval forms of Protochordata and Retrogressive Metamorphosis in Urochordata.

CO2- To acquire knowledge about the General Characters and Classification of Agnatha, Pisces and Amphibia.

CO3- To understand the General Characteristics and Classification of Reptilia, Aves and Mammals, Biting Mechanism in Snakes, Flight Adaptations in Birds and Migration in Birds.

CO4- To know about the Zoogeographical Realms and Characteristic Fauna.

Units	Syllabus
1	Introduction to Chordates :General characteristics and outline classification Protochordata: General characteristics of Hemichordata, Urochordata and Cephalochordata; Study of larval forms in protochordates; Retrogressive metamorphosis in Urochordata
2	Agnatha :General characteristics and classification of cyclostomes up to order Pisces: General characteristics of Chondrichthyes and Osteichthyes, classification up to order; Parental care in fishes, Migration in Fishes Amphibia: General characteristics and classification up to order; Origin of <i>Tetrapoda</i> (Evolution of terrestrial ectotherms); Parental care in amphibians
3	Reptilia: General characteristics and classification up to order; Poison apparatus and Biting mechanism in snakes; Affinities of Sphenodon Aves :General characteristics and classification up to order <i>Archaeopteryx</i> -- a connecting link; Flight adaptations and Migration in birds Mammals: General characters and classification up to order; Affinities of Prototheria; Mammals: Adaptive radiation with reference to locomotory appendages
4	Zoogeography : Zoogeographical realms and Characteristic fauna, Theories pertaining to distribution of animals; Plate tectonic and continental drift theory

	<p>Practical :</p> <ol style="list-style-type: none"> 1. Protochordata <i>Balanoglossus, Herdmania, Branchiostoma</i>, Sections of <i>Amphioxus</i> through pharyngeal, intestinal and caudal regions. 2. Agnatha<i>Petromyzon</i> 3. Fishes <i>Scoliodon, Torpedo, Labeo, Exocoetus, Hippocampus</i>(male and female) <i>Tetrodon, Anabas, Pleuronectes</i> 4. Amphibia <i>Ichthyophis, Necturus, Bufo, Hyla, Alytes, Ambystoma</i> 5. Reptilia <i>Kachuga, Trionyx, Hemidactylus, Varanus, Draco, Bungarus, Vipera, Naja, Zamenis, Crocodylus</i> Key for Identification of poisonous and non-poisonous snakes 6. Aves Study of four common birds (<i>Passer, Columba, Gallus, Psittacula</i>) from different orders. Types of beaks and claws 7. Mammalia <i>Cynopterus</i> (Bat), <i>Funambulus</i>; 8. Temporary mount of Squamous epithelium
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Reading List :

1. Young, J. Z. (2004). *The Life of Vertebrates*. III Edition. Oxford university press.
2. Pough H. *Vertebrate life*, VIII Edition, Pearson International.
3. Darlington P.J. *The Geographical Distribution of Animals*, R.E. Krieger Pub Co.
4. Hall B.K. and Hallgrimsson B. (2008). *Strickberger's Evolution*. IV Edition. Jones and Bartlett Publishers Inc.
5. Classification from Young, J. Z. (2004) to be followed .

SEMESTER – III

ZOO CC306 : Animal Physiology: Controlling and Coordinating Systems (Theory :4 credits + Practical: 2 credits)

Course outcome:

On completion of the course students will be able to:

CO1- To know about different types of Tissues, Bone and Cartilage

CO2- To acquire knowledge of structure and function of muscular tissue.

CO3- To acquire knowledge about the structure and function of Nervous System.

CO4- To understand the structure and function of Male and Female Reproductive System.

Units	Syllabus
1	Tissues: Structure, location, classification and functions of epithelial tissue, connective tissue Bone and Cartilage: Structure & types of bones & cartilages
2	Muscle: Structure, location, classification and function of Muscular tissue; Histology of different types of muscle; Ultra structure of skeletal muscle; Molecular and chemical basis of muscle contraction
3	Nervous System: Structure, location, classification and function of Nervous tissue; Structure of neuron, resting membrane potential, Origin of action potential and its propagation across the myelinated and unmyelinated nerve fibers; Types of synapse, Synaptic transmission and, Neuromuscular junction; Reflex action and its types - reflex arc; Physiology of hearing and vision.
4	Reproductive System: Histology of testis & ovary; Physiology: male & female reproduction; Puberty .
	Practical : <ul style="list-style-type: none">• Demonstration of the unconditioned reflex action (Deep tendon reflex such as knee jerk reflex)• Preparation of temporary mounts: Striated muscle fibres• Study of permanent slides of Mammalian skin, Cartilage, Bone, Spinal cord, Testis, Ovary.

Reading List :

1. Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Herculat Asia PTE Ltd. /W.B. Saunders Company.
2. Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition John Wiley & sons
3. Victor P. Eroschenko. (2008). diFiore's Atlas of Histology with Functional correlations. XII Edition. Lippincott W. & Wilkins.
4. Vander A, Sherman J. and Luciano D. (2014). Vander's Human Physiology: The Mechanism of Body Function. XIII Edition, McGraw Hills
5. Geetha N. (2014). Textbook of Medical Physiology. Paras Medical Publisher.

SEMESTER – III

ZOO CC307 : Fundamentals of Biochemistry

(Theory :4 credits + Practical: 2 credits)

Course outcome:

On completion of the course students will be able to:

CO1- To understand the Structure, Classification and Importance of Carbohydrates and Proteins.

CO2- To understand the Structure and Significance of physiologically important Lipids.

CO3- To understand the Basic Structure and Types of DNA and RNA, Base pairing, Denaturation and Renaturation of DNA.

CO4- To understand the Types of Enzymes, Mechanism of Enzyme Action and Enzyme Kinetics.

Units	Syllabus
1	Carbohydrates: Structure and importance of Monosaccharides, Disaccharides, Polysaccharides and glycoconjugates Proteins: Classification; Proteins, Amino acids: Structure; General properties of alpha aminoacids; physiological importance of essential and non- essential alpha amino acids
2	Lipids : Structure and Significance: Physiologically important saturated and unsaturated fatty acids Tri-acylglycerols, Phospholipids, Glycolipids, Steroids
3	Nucleic Acids: Nucleic acids: Structure of Purines, pyrimidines, nucleosides, nucleotides, nucleic acids Basic structure of DNA and RNA; Types of DNA and RNA; Cot Curves: Base pairing, Denaturation and Renaturation of DNA
4	Enzymes : Nomenclature and classification of enzymes; Cofactors; Specificity of enzyme action; Isozymes; Mechanism of enzyme action; Enzyme kinetics; Factors affecting rate of enzyme-catalyzed reactions; Derivation of Michaelis-Menten equation; Enzyme inhibition; Allosteric enzymes and their kinetics
	Practical : 1. Qualitative tests for carbohydrates, proteins and lipids. 2. Paper chromatography of amino acids. 3. Action of salivary amylase under optimum conditions. 4. Effect of pH and temperature on the action of salivary amylase.

Reading List :

1. Cox, M.M and Nelson, D.L. (2008). *Lehninger's Principles of Biochemistry*, V Edition, W.H. Freeman and Co., New York.
2. Berg, J.M., Tymoczko, J.L. and Stryer, L. (2007). *Biochemistry*, VI Edition, W.H. Freeman and Co., New York.
3. Murray, R.K., Bender, D.A., Botham, K.M., Kennelly, P.J., Rodwell, V.W. and Well, P.A. (2009). *Harper's Illustrated Biochemistry*, XXVIII Edition, International Edition, The McGraw- Hill Companies Inc.
4. Hames, B.D. and Hooper, N.M. (2000). *Instant Notes in Biochemistry*, II Edition, BIOS Scientific Publishers Ltd., U.K.

Generic Elective Papers (GE) (6 credits each)

SEMESTER – III

Generic Elective (GE) Course: An elective course chosen generally from an unrelated discipline/subject, with an intention to seek exposure is called a Generic Elective.

P.S.: A core course offered in a discipline/subject may be treated as an elective by other discipline/ subject and vice versa and such electives may also be referred to as Generic Elective.

ZOO GE303 : Food, Nutrition and Health (Theory :4 credits + Practical: 2 credits)

Course outcome:

On completion of the course students will be able to:

CO 1- To explain the concept of balanced diet

CO 2- To compare nutrient needs and dietary pattern for various groups – adults, pregnant and nursing mothers.

CO 3- To understand the concept of Carbohydrate, lipids and proteins.

CO 4- To apply the knowledge of potable water and apply to methods of purification at domestic level.

Units	Syllabus
1	Basic concept of food and nutrition Concept of a balanced diet, nutrient needs and dietary pattern for various groups- adults, pregnant and nursing mothers, infants, school children, adolescents and elderly
2	Nutritional Biochemistry: Carbohydrates, Lipids, Proteins- Definition, Classification, their dietary source and role Vitamins- Fat-soluble and Water-soluble vitamins- their dietary source and importance Minerals- Iron, calcium, phosphorus, iodine, selenium and zinc: their biological functions
3	Health Introduction to health- Definition and concept of health Major nutritional Deficiency diseases- Protein Energy Malnutrition (kwashiorkor and marasmus), Vitamin A deficiency disorders, Iron deficiency disorders, Iodine deficiency disorders- their causes, symptoms, treatment, prevention and government programmes, if any. Life style related diseases- hypertension, diabetes mellitus, and obesity- their causes and prevention through dietary and lifestyle modifications Social health problems- smoking, alcoholism, drug dependence and Acquired Immuno Deficiency Syndrome (AIDS)-their causes, treatment and prevention Common ailments- cold, cough, and fevers, their causes and treatment
4	Food hygiene: Potable water- sources and methods of purification at domestic level

	<p>Food and Water borne infections: Bacterial infection Cholera, typhoid fever, dysentery; Viral infection: Hepatitis, Poliomyelitis, Protozoan infection: amoebiasis, giardiasis; Parasitic infection: ascariasis, its transmission, causative agent, sources of infection, symptoms and prevention Brief account of food spoilage: Causes of food spoilage and their preventive measures</p>
	<p>Practical</p> <ol style="list-style-type: none"> 1. To detect adulteration in a) Ghee b) Sugars c) Tea leaves and d) Turmeric 2. Estimation of Lactose in milk 3. Ascorbic acid estimation in food by titrimetry 4. Estimation of Calcium in foods by titrimetry 5. Study of the stored grain pests from slides/ photograph(<i>Sitophilus oryzae</i>, <i>Trogoderma granarium</i>, <i>Callosobruchus chinensis</i> and <i>Tribolium castaneum</i>): their identification, habitat and food sources, damage caused and control. Preparation of temporary mounts of the above stored grain pests. 6. Project- Prepare diet chart for different age groups. <p style="text-align: center;">OR</p> <p style="text-align: center;">Identify nutrient rich sources of foods (fruits and vegetables), their seasonal availability and price- Prepare chart</p> <p style="text-align: center;">OR</p> <p style="text-align: center;">Study of nutrition labelling on selected foods</p>

Reading List :

1. Mudambi, SR and Rajagopal, MV. Fundamentals of Foods, Nutrition and Diet Therapy; Fifth Ed; 2007; New Age International Publishers
2. Srilakshmi B. Food Science; Fourth Ed; 2007; New Age International (P) Ltd.
3. Swaminathan M. Handbook of Foods and Nutrition; Fifth Ed; 1986; BAPPCO.
4. Bamji MS, Rao NP, and Reddy V. Text Book of Human Nutrition; 2009; Oxford & IBH Publishing Co. Pvt Ltd.
5. Lakra P, Singh MD. Textbook of Nutrition and Health; First Ed; 2008; Academic Excellence.

Skill Enhancement Course (SEC) (2Credits)

SEMESTER – III

Skill Enhancement Courses (SEC): These courses may be chosen from a pool of courses designed to provide **value-based and/or skill-based knowledge**.

IRS SEC301 : Inter-Religious Studies (Value Based) (02credits)

Course outcome:

On completion of the course students will be able to:

CO1- Analyze the human values and ethics

CO2- Apply a holistic approach to corporate and professional ethics

CO3- Sensitize the students about the gender issues

CO4- Evaluate the contemporary perspectives on gender

Unit	Syllabus
1	Nature and Need of Inter-Religious study, Scope of Comparative Religion.
2	Salient Features of Hinduism, Jainism and Buddhism, Salient Features of Christianity, Islam and Sikhism.
3	Similarities and Differences among Religions, Conflicting Truth claims of different religions and inter-religious Harmony.
4	Religious Tolerance, Secularism.

Reading List :

1. Chaudhary, C. Neeraj (1979). "Hinduism", B.I. Publication, New Delhi.
2. Devraj, N.K., (1917)- "Hinduism and Christianity" Asian Publishing House.
3. Gordh, George, - "Christian Faith and its Cultural Expression", Printed in USA.
4. Hick, John, - "Philosophy of Religion", Prentice Hall of India.
5. Hopfe, M. Lewis (1983)- "Religion of the World", Macmillan Publishing Co. Inc, New York
6. Masih, Y. (1990)- "Comparative study of Religion", Motilal Banarasi Dass.
7. Sethi, S. Arijit, Pummer, Reinhard, (1979)- "Comparative Religion", Vikas Publishing House Pvt. Ltd, Delhi.
8. Singh, B.N., (1994)- "Vishwa Dharma Darshan ki Samasyain", Ratna Printing Works.
9. Tiwari, Nath Kedar, (1983)- "Comparative Religion", Motilal Banarasi Dass.
10. Ward, CHS (1998) – "Early Buddhism", Caxton Publication, Delhi.

SEMESTER – IV

ZOO CC408 : Comparative Anatomy of vertebrates (Theory :4 credits + Practical: 2 credits)

Course outcome:

On completion of the course students will be able to:

CO 1- To describe the function and derivative of integument

CO 2- To explain the Evolution of heart and aortic arches

CO 3- To compare structure and function of the Alimentary canal and associated glands

CO 4- To evaluate the techniques relating to the nervous system and how they within the body respond to challenges.

Units	Syllabus
1	Integumentary System: Structure of integumentary system; functions and derivatives of integument Skeletal System : Jaw suspensorium
2	Digestive System : Alimentary canal and associated glands, Dentition in mammals Respiratory System : Respiratory system: Skin, Gills Lungs and air sacs.
3	Circulatory System : General Plan of Circulation; Evolution of heart and aortic arches Urinogenital System : Succession of kidney, Evolution of urinogenital ducts,
4	Nervous System : Comparative account of brain; Spinal cord, cranial nerves in mammals; Classification of receptors
	Practical : 1.Study of placoid, cycloid and ctenoid scales through permanent slides. 2.Disarticulated skeleton of Frog, <i>Varanus</i> , Fowl, Rabbit 3.Carapace and plastron of turtle /tortoise 4.Mammalian skulls: One herbivorous and one carnivorous animal 5.Study of structure of any two organs based on models (heart, lung, kidney, eye and ear l) 6.Project on skeletal modifications in the forelimbs and hindlimbs of vertebrates

Reading List :

1. Kardong, K.V. (2005) *Vertebrates' Comparative Anatomy, Function and Evolution*. IV Edition. McGraw-Hill Higher Education
2. Kent, G.C. and Carr R.K. (2000). *Comparative Anatomy of Vertebrates*. IX Edition. The McGraw-Hill Companies
3. Hilderbrand, M and Gaslow G.E. *Analysis of Vertebrate Structure*, John Wiley and Sons
4. Walter, H.E. and Sayles, L.P; *Biology of Vertebrates*, Khosla Publishing House
5. Saxena R K (2008). *Comparative Anatomy of Vertebrates*. Viva Books Private Limited

SEMESTER – IV

ZOO CC409 : Animal Physiology: Life Sustaining Systems (Theory :4 credits + Practical: 2 credits)

Course outcome:

On completion of the course students will be able to:

CO 1- To compare the mechanical and chemical digestion of food

CO 2- To remember and understand hormonal control of secretion of enzymes in gastrointestinal tract

CO 3- To acquire knowledge of mechanism of breathing, Pulmonary ventilation and its control and to understand the concept of hemostasis and blood clotting system.

CO 4- To explain origin and conduction of cardiac impulses and cardiac cycles.

Units	Syllabus
1	Physiology of Digestion: Structural organization and functions of gastrointestinal tract and associated glands; Mechanical and chemical digestion of food; Hormonal control of secretion of enzymes in Gastrointestinal tract
2	Physiology of Respiration: Mechanism of breathing, Pulmonary ventilation and its control; Respiratory volumes and capacities Transport of oxygen and carbon dioxide in blood; Respiratory pigments, Carbon monoxide poisoning Dissociation curves and the factors influencing it
3	Renal Physiology Kidney: functional unit; Mechanism of urine formation; Regulation of water balance; Regulation of acid-base balance
4	Blood: Components of blood and their functions: structure and function of haemoglobin, Blood groups: Rh factor, ABO, MN; Haemostasis: Blood clotting system. Physiology of Heart: Structure of mammalian heart; coronary circulation, electrocardiogram; Structure and working of conducting myocardial fibers. Origin and conduction of cardiac impulses; Cardiac cycle
	PRACTICAL 1. Determination of ABO Blood group 2. Estimation of haemoglobin using Sahli's haemoglobinometer 3. Preparation of haemin crystals 4. Recording of blood pressure using a sphygmomanometer 5. Examination of sections of mammalian stomach, ileum, liver, lung, kidney

Reading List :

1. Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Hecourt Asia PTE Ltd. W.B. Saunders Company.
2. Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition John Wiley & sons,
3. Victor P. Eroschenko. (2008). diFiore's Atlas of Histology with Functional correlations. XII Edition. Lippincott W. & Wilkins.
4. Vander A, Sherman J. and Luciano D. (2014). Vander's Human Physiology: The Mechanism of Body Function. XIII Edition, McGraw Hills
5. Geetha N. (2014). Textbook of Medical Physiology. Paras Medical Publisher.

SEMESTER – IV

ZOO CC410 : Biochemistry of Metabolic Processes (Theory :4 credits + Practical: 2 credits)

Course outcome:

On completion of the course students will be able to:

CO 1- To compare catabolism with Anabolism, Compartmentalization of metabolic pathways and membrane transporters

CO 2- To construct a flowchart for the steps involved in sequence of reactions of glycolysis, citric acid and pentose phosphate pathway

CO 3- To acquire a comprehensive knowledge of β – oxidation of saturated fatty acids

CO 4- To understand the transamination and determination.

Units	Syllabus
1	Overview of Metabolism: Intermediary metabolism Catabolism vs Anabolism, Stages of catabolism, Compartmentalization of metabolic pathways, shuttle systems and membrane transporters
2	Carbohydrate Metabolism: Sequence of reactions of glycolysis, Citric acid cycle, Pentose phosphate pathway, Gluconeogenesis, Glycogenolysis and Glycogenesis; ATP and another energy rich compounds
3	Lipid Metabolism: β -oxidation of saturated fatty acids with even and odd number of carbon atoms
4	Protein Metabolism: Catabolism of amino acids: Transamination, Deamination, Urea cycle; Fate of C-skeleton of Glucogenic and Ketogenic amino acids
	Practical 1. Estimation of total protein in given solutions by Lowry's method 2. Detection of SGOT and SGPT or GST and GSH in serum/ tissue 3. Estimation of glycogen in goat liver 4. To perform the Acid and Alkaline phosphatase assay from serum/ tissue. 5. Project on Metabolic pathways.

Reading List :

1. Cox, M.M and Nelson, D.L. (2008). *Lehninger Principles of Biochemistry*, V Edition, W.H. Freeman and Co., New York.
2. Berg, J.M., Tymoczko, J.L. and Stryer, L. (2007). *Biochemistry*, VI Edition, W.H. Freeman and Co., New York.
3. Murray, R.K., Bender, D.A., Botham, K.M., Kennelly, P.J., Rodwell, V.W. and Well, P.A. (2009). *Harper's Illustrated Biochemistry*, XXVIII Edition, International Edition, The McGraw-Hill Companies Inc.

4. Hames, B.D. and Hooper, N.M. (2000). *Instant Notes in Biochemistry*, II Edition, BIOS Scientific Publishers Ltd., U.K.
5. Vasudevan D M. (2016). Textbook of Biochemistry for Medical Students. Publisher: Jaypee brothers

SEMESTER – IV

ZOO GE404 : Insect Vectors and Diseases

(Theory :4 credits + Practical: 2 credits)

Course outcome:

On completion of the course students will be able to:

CO 1- To understand and describe the morphological features of insects

CO 2- To understand the exemplify the important insect Vectors- mosquitoes, Sand fly and houseflies

CO 3- To understand and Explain mosquito-borne diseases live Malaria, Dengue, Chikungunya, Viral encephalitis

CO 4- To understand and describe the Hemipteran disease vectors

Units	Syllabus
1	Introduction to Insects General Features of Insects, Morphological features, Head – Eyes, Types of antennae, Mouth parts w.r.t. feeding habits
2	Concept of Vectors Brief introduction of Carrier and Vectors (mechanical and biological vector),Reservoirs, Host-vector relationship, Vectorial capacity, Adaptations as vectors, Host Specificity Insects as Vectors Insects as vectors – Diptera, Siphonaptera, Siphunculata, Hemiptera
3	Dipteran as Disease Vectors Dipterans as important insect vectors – Mosquitoes, Sand fly, Houseflies; Study of mosquito-borne diseases – Malaria, Dengue, Chikungunya, Viral encephalitis, Filariasis; Control of mosquitoes Study of sand fly-borne diseases – Visceral Leishmaniasis, Cutaneous Leishmaniasis, Phlebotomus fever; Control of Sand fly Study of house fly as important mechanical vector, Myiasis, Control of house fly
4	Siphonaptera as Disease Vectors Fleas as important insect vectors; Host-specificity, Study of Flea-borne diseases – Plague, Typhus fever; Control of fleas Hemiptera as Disease Vectors Bugs as insect vectors; Blood-sucking bugs; Chagas disease, Bed bugs as mechanical vectors, Control and prevention measures

	<p>Practical</p> <ol style="list-style-type: none"> 1. Study of different kinds of mouth parts of insects 2. Study of following insect vectors through permanent slides/ photographs: <i>Aedes, Culex, Anopheles, Musca domestica</i>, through permanent slides/ photographs 3. Study of different diseases transmitted by above insect vectors <p>Submission of a project report on any one of the insect vectors and disease transmitted</p>
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Reading List :

1. Imms, A.D. (1977). *A General Text Book of Entomology*. Chapman & Hall, UK
 2. Chapman, R.F. (1998). *The Insects: Structure and Function*. IV Edition, Cambridge University Press, UK
 3. Pedigo L.P. (2002). *Entomology and Pest Management*. Prentice Hall Publication
 4. Mathews, G. (2011). *Integrated Vector Management: Controlling Vectors of Malaria and Other Insect Vector Borne Diseases*. Wiley-Blackwell
- Peterson P G (2017). *Insect Ecology*. Meditech publication

SEMESTER – IV

ZOO SEC402 : Medical Diagnostics (2 credits)

Course Outcome:

On completion of the course students will be able to:

CO 1- To explain medical diagnostics and its importance.

CO 2- To concept of diagnostics methods used for analysis of blood and urine.

CO 3- To describe distinguish infectious diseases and non-infectious diseases, its causes, types, symptoms, complications, diagnosis and preventions.

CO 4- To describe and distinguish tumour, its types. Explain methods of detection such as medical imaging: X-ray of bone fracture, PET, MRI and CT Scan (using photographs).

Unit	Syllabus
1	Introduction to Medical Diagnostics and its Importance
2	Diagnostics Methods Used for Analysis of Blood : Blood composition, Preparation of blood smear and Differential Leukocyte Count (D.L.C) using Leishman's stain, Platelet count using haemocytometer, Erythrocyte Sedimentary Rate (E.S.R), Packed Cell Volume (P.C.V.) Diagnostic Methods Used for Urine Analysis : Urine Analysis: Physical characteristics; Abnormal constituents
3	Non-infectious Diseases : Causes, types, symptoms, complications, diagnosis and prevention of Diabetes (Type I and Type II), Hypertension (Primary and secondary), Testing of blood glucose using Glucometer/Kit Infectious Diseases : Causes, types, symptoms, diagnosis and prevention of Tuberculosis and Hepatitis
4	Tumours : Type (Benign/Malignant), Detection and metastasis; Medical imaging: X-ray of Bone fracture, PET, MRI and CT Scan (using photographs).

Reading List :

1. Leeuwen AMV, Bladh ML (2017). Davis's Comprehensive Handbook of Laboratory and Diagnostic Tests With Nursing Implications. F.A. Davis Company; 7 edition
2. Buckingham L (2011). Molecular Diagnostics: Fundamentals, Methods and Clinical Applications. F.A. Davis Company; 2 edition
3. Merck Editor (2011). The Merck Manual of Diagnosis and Therapy. Elsevier Health Sciences

4. Captain C, Banerjee P. (2014). Common Laboratory Tests Used by TCM Practitioners : When to Refer Patients for Lab Tests and How to Read and Interpret the Results. Jessica Kingsley Publishers.
5. Andersson D, Creations M (2018). Lab Values: Everything You Need to Know about Laboratory Medicine and its Importance in the Diagnosis of Diseases.

SEMESTER – V

ZOO CC511 : Molecular Biology

(Theory :4 credits + Practical: 2 credits)

Course outcome:

On completion of the course students will be able to:

CO 1- To understand Central dogma of molecular biology. Explain and distinguish mechanism of replication, transcription and translation in prokaryotes and eukaryotes.

CO 2- To understand and explain the post transcriptional modifications in eukaryotes.

CO 3- To explain and differentiate the mechanism of gene expression and regulation in prokaryotes and eukaryotes

CO 4- To describe the concept of regulatory RNAs, Ribo-switches and RNA interference and to enhance skill in molecular biology through relevant experiments.

Units	Syllabus
1	DNA Replication : Salient features of DNA, RNA; Watson and Crick model of DNA; DNA Replication in prokaryotes and brief account of mechanism in eukaryotes Transcription: RNA polymerase and transcription Unit, mechanism of transcription in prokaryotes, Synthesis of mRNA in eukaryotes, transcription factors
2	Translation: Ribosome structure and assembly in prokaryotes; Genetic code, Degeneracy of the genetic code and Wobble Hypothesis; Process of protein synthesis in prokaryotes, aminoacyl tRNA synthetases and charging of tRNA; Proteins involved in initiation, elongation and termination of polypeptide chain; Inhibitors of protein synthesis; Difference between prokaryotic and eukaryotic translation
3	Post Transcriptional Modifications and Processing of Eukaryotic RNA Structure of globin mRNA; Split genes: concept of introns and exons, splicing mechanism
4	Gene Regulation Transcription regulation in prokaryotes: Principles of transcriptional regulation with examples from lac operon; trp operon; Transcription regulation of eukaryotes; Activators, Repressors, Enhancers, silencer elements; Gene silencing, Genome imprinting. Regulatory RNAs Ribo-switches, RNA interference; miRNA, siRNA, piRNA
	Practical : 1. Study of Polytene chromosomes from Chironomous / Drosophila larvae 2. Preparation of liquid culture medium (LB) and raise culture of <i>E. coli</i> 3. Estimation of the growth kinetics of <i>E. coli</i> by turbidity method 4. Preparation of solid culture medium (LB) and growth of <i>E. coli</i> by spreading and streaking 5. Demonstration of antibiotic sensitivity/resistance of <i>E. coli</i> to antibiotic pressure and interpretation of results 6. Study and interpretation of electron micrographs/ photograph showing a. DNA replication b. Split genes

Reading List :

1. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). *The World of the Cell*. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.
2. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter:*Molecular Biology of the Cell*, IV Edition.
3. Cooper G. M. and Robert E. Hausman R. E. *The Cell: A Molecular Approach*, V Edition, ASM Press and Sinauer Associates.
4. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). *Cell and Molecular Biology*. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
5. Karp, G. (2010) *Cell and Molecular Biology: Concepts and Experiments*. VI Edition. John Wiley and Sons. Inc.

SEMESTER – V

ZOO CC512 : Principles of Genetics

(Theory :4 credits + Practical: 2 credits)

Course outcome:

On completion of the course students will be able to:

CO 1- To explain and discuss the genetic variation through linkage and crossing over.

CO 2- To describe sex-linked, sex limited and sex influenced inheritance.

CO 3- To understand the Concept behind genetic disorder, gene mutations and molecular basis of mutations and to explain the criteria for extra-chromosomal inheritance.

CO 4- To describe the molecular mechanisms of recombination in bacteria and to explain and distinguish the concept of transposable genetic elements in prokaryotes and eukaryotes. Solve genetic based problems.

Units	Syllabus
1	Principles of inheritance, incomplete dominance and co-dominance; multiple alleles, lethal alleles, Epistasis, Pleiotropy; Sex-linked , sex limited and sex influenced inheritance; Chromosomal Mechanism of sex determination in <i>Drosophila</i> and man Linkage, Crossing Over and Chromosomal Mapping : Linkage and crossing over, Cytological basis of crossing over, Molecular mechanisms of recombination including different models of recombination, Recombination frequency as a measure of linkage intensity, Two factor and threefactor crosses, Interference and coincidence
2	Mutations : Types of chromosomal aberrations (Classification, figures and with one suitable example each) Types of gene mutations (classification) Molecular basis of mutations in relation to UV light and chemical mutagens; Detection of mutations: CLB method, attached X method.
3	Extra-chromosomal Inheritance : Criteria for extra-chromosomal inheritance, Antibiotic resistance in Chlamydomonas, Maternal effects
4	Recombination in Bacteria: Transformation, Transduction, Conjugation in Bacteria ,Molecular mechanisms of recombination including different models of recombination Transposable Genetic Elements : Transposons in bacteria, Ac-Ds elements in maize and P elements in <i>Drosophila</i> ,

Practical :

- | |
|---|
| <ol style="list-style-type: none">1. To study the Mendelian laws and gene interactions.2. Chi-square analyses using seeds/beads/<i>Drosophila</i>.3. Linkage maps based on data from <i>Drosophila</i> crosses4. Study of human karyotype (normal and abnormal) based on photographs5. Pedigree analysis of some human inherited traits |
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Reading List :

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). *Principles of Genetics*. VIII Edition. Wiley India
2. Snustad, D.P., Simmons, M.J. (2009). *Principles of Genetics*. V Edition. John Wiley and Sons Inc
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). *Concepts of Genetics*. X Edition. Benjamin Cummings
4. Russell, P. J. (2009). *Genetics- A Molecular Approach*. III Edition. Benjamin Cummings
5. Fletcher H. and Hickey I. (2015). *Genetics*. IV Edition. GS, Taylor and Francis Group, New York and London.

Discipline Specific Elective (DSE) (6 credits each)

SEMESTER – V

Discipline Specific Elective (DSE) Course: Elective courses may be offered by the main discipline/subject of study is referred to as Discipline Specific Elective. The University/Institute may also offer discipline related Elective courses of interdisciplinary nature (to be offered by main discipline/subject of study).

ZOO DSE501 : Endocrinology

(Theory :4 credits+ Practical: 2 credits)

Course outcome:

On completion of the course students will be able to:

CO 1- Describe and of types of endocrine glands, classify hormones and explain their features.

CO 2- Explain structure ,functions and regulation of peripheral endocrine glands and associate function of aneuroendocrine system, epiphysis, and hypothalamo-hypophysial axis.

CO 3- Understand the mechanism of regulation of hormone action hormone action at cellular level and gain the knowledge of hormone receptors.

CO 4- Apply the knowledge by performing biochemical assays to detect level of hormones in plasma and visualize cross sections of endocrine glands.

Unit	Syllabus
1	Introduction to Endocrinology Types of endocrine glands, classification of hormones
2	Epiphysis, Hypothalamo-hypophysial Axis : Structure of pineal gland, Secretions and their functions in biological rhythms and reproduction. Structure of hypothalamus, Hypothalamic nuclei and their functions, Regulation of neuroendocrine glands, Characteristic and Transport of Hormones, Neurosecretions and Neurohormones; Feedback mechanisms. Structure of pituitary gland, Hormones and their functions, Disorders of Pituitary; Hypothalamo-hypophysial portal system.
3	Peripheral Endocrine Glands: Structure, Hormones, Functions and Regulation of Thyroid gland, Parathyroid; Adrenal, Pancreas, Ovary and Testis; Placental hormones
4	Regulation of Hormone Action Hormone action at Cellular level: Hormone receptors; Hormones in homeostasis, Disorders of endocrine glands
	Practical : 1. Dissect and display of Endocrine glands in laboratory bred 2.Study of the permanent slides of all the endocrine glands 3.Estimation of plasma level of any hormone using ELISA T ₃ , T ₄ , TSH

Reading List :

1. General Endocrinology C. Donnell Turner Pub- Saunders Toppan
2. Endocrinology: An Integrated Approach; Stephen Nussey and Saffron Whitehead. Oxford: BIOS Scientific Publishers; 2001.
3. Hadley, M.E. and Levine J.E. 2007. Endocrinology, 6th Edition. Pearson Prentice-Hall, Pearson Education Inc., New Jersey.
4. Vertebrate Endocrinology by David O. Norris
5. Melmed S, Polonsky K , Larsen P R , Kronenberg H M (2016). Williams Textbook of Endocrinology

SEMESTER – V

ZOO DSE501 : Human Reproductive Biology (Theory :4 credits+ Practical: 2 credits)

Course outcome:

On completion of the course students will be able to:

CO 1- To explain and contrast the processes of spermatogenesis, oogenesis and understanding of the hormonal control of reproduction in males and females.

CO 2- To distinguish between the main stages of embryonic, foetal and neonatal development and causes of foetal disorders.

CO 3- To understand the origin and characteristics of common congenital malformations.

CO 4- Know how sexually transmitted diseases may contribute to altered neonatal or reproductive function.

Unit	Syllabus
1	Human Reproductive system Structure and function of male reproduction; Formation of sperm and fertility of individual. Structure and function of female reproduction; Sexual differentiation, Puberty; Formation of ova. Physiology of ovulation, menstrual cycle; Nutrition and stress influences on the ovulatory cycle.
2	Fertilization, foetal development and senescence Process of fertilization; Implantation and formation of the foetus and placenta; Pregnancy, foetal development; Labour and birth, lactation and neonatal life; Reproductive Ageing; Menopause.
3	Evolution of reproductive mechanism and regulation Evolution of human reproductive strategy; Evolutionary impact on behaviour; Sexuality hormonal effects on maternal-infant bonding; Parturition; Endocrine disrupting chemicals.
4	Reproductive Health Sexual dysfunctions, sexually transmitted diseases; Cancers of the reproductive system; Adenomyosis: gland-like growth into myometrium; Birth Control; Assisted Reproduction Technologies; Intrauterine devices (IUD), endometriosis, fibroids, Endometritis: chronic infection of uterus, congenital uterine anomalies; Ovarian cysts, pelvic varicosities.
	Practical: 1. Examination of histological sections from photomicrographs/ permanent slides of rat/human: testis, epididymis and accessory glands of male reproductive systems; 2. Sections of ovary, fallopian tube, uterus (proliferative and secretory stages), cervix and vagina. 3. Sperm count and sperm motility in rat 4. Study of modern contraceptive devices

Reading List:

1. Jones, R. E. and Lopez, K. H. Human Reproductive Biology (4th edition).
2. Thomas W.S. Langman's Medical Embryology (14th edition) Lippincott, Williams & Wilkins, Baltimore.
3. Gary C.S.; Steven B.B.; Philip R.B. and Philippa H.F. Larsen's Human Embryology (6th edition) Elsevier.
4. Gilbert, S.F. Developmental Biology (12th edition) Sinauer.

SEMESTER – V

ZOO DSE502 : Immunology

(Theory :4 credits+ Practical: 2 credits)

Course outcome:

On completion of the course students will be able to:

CO 1- To explain cells and organs of the immune system, innate and adaptive immunity.

CO 2- To describe autoimmunity with reference to rheumatoid arthritis and tolerance and AIDS.

CO 3- To understand antigens and its type, structure and functions of immunoglobulins, antigen-antibody interactions and immunoassays (such as ELISA and RIA).

CO 4- To explain structure and functions major histocompatibility complex, know the concept of hypersensitivity and vaccines.

Unit	Syllabus
1	Overview of Immune System: Historical perspective of Immunology, Early theories of immunology; Cells and organs of the Immune system Innate and Adaptive Immunity Anatomical barriers, Inflammation, Cell and molecules involved in innate immunity, Adaptive immunity (Cell mediated and humoral), Passive: Artificial and natural Immunity, Active: Artificial and natural Immunity, Immune dysfunctions (brief account of autoimmunity with reference to Rheumatoid Arthritis and tolerance, AIDS)
2	Antigens Antigenicity and immunogenicity, Factors influencing immunogenicity; Immunogens, adjuvants and haptens
3	Immunoglobulins: Structure and functions of different classes of immunoglobulins, Antigen-antibody interactions, Immunoassays (ELISA and RIA), Polyclonal sera Major Histocompatibility Complex: Structure and functions of MHC molecules. Endogenous and exogenous pathways of antigen processing and presentation
4	Complement System: Components and pathways of complement activation. Hypersensitivity Gell and Coombs' classification and brief description of various types of hypersensitivities; Cytokines: properties and functions of cytokines, therapeutics Cytokines Vaccines Various types of vaccines
	Practical : 1. Demonstration of lymphoid organs. 2. Histological study of spleen, thymus and lymph nodes through slides/ photographs 3. Preparation of stained blood film to study various types of blood cells. 4. ABO blood group determination. Project : Different types of immunoglobulins.

Reading List :

1. Kindt, T. J., Goldsby, R.A., Osborne, B. A. and Kuby, J (2006). *Immunology*, VI Edition. W.H. Publication.
2. David, M., Jonathan, B., David, R. B. and Ivan R. (2006). *Immunology*, VII Edition, Mosby, Elsevier Edition. Saunders Publication.
3. Abbas, K. Abul and Lichtman H. Andrew (2003.) *Cellular and Molecular Immunology*. V
4. Owen J A, Punt J, Stanford S A (2013). *Kuby Immunology* W H Freeman & Co;
5. Wood P. (2007). *Basic Immunology*. Pearson publication

SEMESTER – V

ZOO DSE502 : Genetic Engineering and Biotechnology (Theory :4 credits+ Practical: 2 credits)

Course outcome:

On completion of the courses students will be able to:

CO 1- Develop an understanding of the fundamental molecular tools and their applications of DNA modification and cloning.

CO 2- Appreciate shifting their orientation of learning from a descriptive explanation of biology to a unique style of learning through graphic designs and quantitative parameters to realize how such research and innovations have made science interdisciplinary and applied.

CO 3- Develop future course of their career development in higher education and research with a sound base.

CO 4- Apply their knowledge with problem solving approach to recommend strategies of genetic engineering for possible applications in Biotechnology and allied industry.

Units	Syllabus
1.	Scope of genetic engineering: Introduction to Genetic Engineering and Biotechnology. Enzymes as Tools for Genetic Engineering: Restriction Enzymes, Restriction-Modification System, DNA-modifying enzymes, T4 and E. coli DNA Polymerase (Klenow), DNA-methylase, Polynucleotide Kinase, DNA-ligase, Taq DNA polymerase, Reverse Transcriptase, T7 and T3 RNA polymerases. Vehicles for DNA cloning: Plasmid DNA vectors, bacteriophage lambda derived vectors.
2.	Recombination and cloning: DNA (Gene) cloning, recombinant DNA, cDNA library, genomic library. Isolation of gene from gene library. Screening and identification of recombinant DNA clone from gene library. Expression of recombinant protein from a DNA clone in bacteria and purification of the protein. Some examples of the useful recombinant proteins: Insulin, Streptokinase, enzymes, antibodies, vaccines.
3.	Recent advances in gene technology: Polymerase Chain Reaction (PCR) and Site-directed, Restriction enzyme digestion. Transgenic animals, Ligation, Cloning, Transformation, Calculation of transformation efficiency. Mutagenesis. Recent trends in Gene technology. Gene Targeting: Knock-ins and Knock-outs. Targeted Genome Editing: ZFNs, TALENs, CRISPRs etc.

4.	Genomic studies; ethical issues in genetic engineering: DNA Sequencing and Genome Analysis, Model Genomes. Human Genome Project and Human Genome Sequences. Applications of Genetic Engineering and Biotechnology in agriculture, medicine and its economic and social implications, Ethical precautions.
	<p>Practical</p> <ol style="list-style-type: none"> 1. Video-graphic demonstrations on the above-mentioned topics. 2. Models and Presentations by students on the topics: Microbial degradation of waste materials, Antibiotics from microorganisms, Transgenic Tomato and Rice, Recombinant Interferon, Growth Hormone, Insulin, Colony Stimulating Factor, Streptokinase, Industrial Enzymes. 3. Restriction enzyme digestion. 4. Separation of molecules using electrophoresis, Cloning. 5. Transformation, Calculation of transformation efficiency.

Reading List :

1. Primrose, S.B. and Twyman, R. (2006) Principles of Gene manipulation and Genomics (7th edition) Blackwell Publishing.
2. Nicholl, D.S.T. (2008) An introduction to Genetic Engineering (3rd edition) Cambridge University Press.
3. Watson, J.D. (2006) Recombinant DNA (3rd edition) Cold Spring Harbor Laboratory Press.
4. Brown, T.A. (2001) Gene Cloning and DNA Analysis: An Introduction.
5. A PBS Documentary entitled, “Playing God” [History of Genetic Engineering]

SEMESTER – VI

ZOO CC613 : Developmental Biology

(Theory :4 credits + Practical: 2 credits)

Course outcome:

On completion of the course students will be able to:

CO 1- To describe the mechanism of gametogenesis, fertilization and blocks to polyspermy.

CO 2- To explain early embryonic development in frog and chick.

CO 3- To understand the concepts of late embryonic development in model organisms.

CO4 - To describe post embryonic development such as metamorphosis and regeneration with suitable examples and apply important experiments and project work.

Units	Syllabus
1	Gametogenesis : Spermatogenesis, Oogenesis; Types of eggs, Egg membranes; Fertilization (External and Internal) ,Blocks to polyspermy; Historical perspective and basic concepts: Phases of development
2	Early Embryonic Development : Planes and patterns of cleavage; Fate maps; Early development of frog and chick up to gastrulation; Embryonic induction and organizers; Cell-Cell interaction; Pattern formation, Differentiation and growth
3	Late Embryonic Development : Fate of Germ Layers; Extra-embryonic membranes in birds; Implantation of embryo in humans, Differential gene expression, Cytoplasmic determinants .
4	Post Embryonic Development : Metamorphosis: Changes, hormonal regulations in amphibians and insects; Regeneration: Modes of regeneration, epimorphosis , morphallaxis and compensatory regeneration(with one example each); Placenta (structure, types and functions of placenta)
	Practical : <ol style="list-style-type: none">1. Study of whole mounts and sections of developmental stages of frog through permanent slides: Cleavage stages, blastula, gastrula, tadpole (external and internal gill stages)2. Study of whole mounts of developmental stages of chick through permanent slides: Primitive streak (13 and 18 hours), 21, 24, 28, 33, 36, 48, 72, and 96 hours of incubation (Hamilton and Hamburger stages)3. Study of the developmental stages and life cycle of <i>Drosophila</i> from stock culture

	4. Study of different placenta types (models)
	5. Project report on <i>Drosophila</i> culture/chick embryo development

Reading List :

1. Gilbert, S. F. (2010). Developmental Biology, IX Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA
2. Balinsky B. I. and Fabian B. C. (1981). An Introduction to Embryology, V Edition, International Thompson Computer Press
3. Carlson, R. F. Patten's Foundations of Embryology
4. Kalthoff (2008). Analysis of Biological Development, II Edition, McGraw-Hill Publishers
5. Lewis Wolpert (2002). Principles of Development. II Edition, Oxford University Press

SEMESTER – VI

ZOO CC614 : Evolutionary Biology

(Theory :4 credits + Practical: 2 credits)

Course outcome:

On completion of the course students will be able to:

CO 1- To understand the basis of origin of life such as: chemogeny, RNA world, biogeny and evolution of eukaryotes.

CO 2- To obtain the various evolutionary concepts and heritable variation and to understand concept of species, isolating mechanisms, modes of speciation and adaptive radiation.

CO 3- To explain and different types of fossils, geological time scale, climatic conditions, hominid characteristics, primate phylogeny and evolution of horse and man.

CO 4- To understand Hardy-Weinberg principle of genetic equilibrium and its destabilizing forces such as Natural selection, Mutation, Migration and genetic drift.

Units	Syllabus
1	Origin of life: Chemogeny, RNA world, Biogeny, Evolution of eukaryotes
2	Evolutionary concepts: Lamarckism, Darwinism, Neo-Darwinism Heritable variations: sources and their role in evolution Species concept, Isolating mechanisms, modes of speciation—allopatric, sympatric, Adaptive radiation / macroevolution (exemplified by Galapagos finches); Product of evolution: micro-evolutionary changes (inter-population variations, clines, races)
3	Evidences of Evolution, types of fossils, geological time scale and climatic conditions and their fauna, evolution of horse Origin and evolution of man; Unique hominid characteristics contrasted with primate characteristics, primate phylogeny from <i>Dryopithecus</i> leading to <i>Homo sapiens</i> ; Extinctions, Back ground mass extinctions (causes and effects), detailed eg. of K-T extinction

4	Population genetics: Hardy-Weinberg Law (statement and derivation of equation, Evolutionary forces upsetting H-W equilibrium; Natural selection (concept of fitness, types of selection, kin selection), Genetic Drift (mechanism, founder's effect, bottleneck phenomenon); Phylogenetic trees, Multiple sequence alignment, construction of phylogenetic trees, interpretation of trees
	<p>Practical :</p> <ol style="list-style-type: none"> 1. Study of fossils from models/ pictures 2. Study of homology and analogy from suitable specimens 3. Study and verification of Hardy-Weinberg Law by chi square analysis 4. Study of role of natural selection and genetic drift in changing allele frequencies using data 5. Graphical representation and interpretation of data of height/ weight of a sample of 100 humans in relation to their age and sex. 6. Construction of cladogram

Reading List :

1. Ridley, M. (2004). Evolution III Edition Blackwell publishing
2. Hall, B.K. and Hallgrimson, B (2008). Evolution IV Edition. Jones and Barlett Publishers.
3. Douglas, J. Futuyma (1997). Evolutionary Biology. Sinauer Associates.
4. Snustad. S Principles of Genetics.
5. Pevsner, J (2009). Bioinformatics and Functional Genomics. II Edition Wiley-Blackwell

SEMESTER – VI

ZOO DSE603 : Animal Behavior and Chronobiology

(Theory :4 credits+ Practical: 2 credits)

Course outcome:

On completion of the course students will be able to:

CO 1- To understand various pattern of animal behaviours such as stereotyped, instinct, learnt, associative behaviour along with operant conditioning and habituation imprinting and to explain the concept of social and sexual behaviour.

CO 2- To provide the concept of biological rhythm, photoperiod and regulation of seasonal reproduction of vertebrates and role of melatonin.

CO 3- To understand the relevance of biological clock in terms of chronopharmacology, chronomedicine and chronotherapy.

CO 4- To develop the skill in this course by performing practical works such as studying nest and nesting habitat of birds and social insects and other significant experiments.

Unit	Syllabus
1	Patterns of Behaviour Stereotyped Behaviours (Orientation, Reflexes); Individual Behavioural patterns; Instinct vs. Learnt Behaviour; Associative learning, classical and operant conditioning, Habituation, Imprinting.
2	Social and Sexual Behaviour Social and Sexual Behaviour Insects' society with Honey bee as example; Foraging in honey bee significance of the bee dance. Social Behaviour: Concept of Society; Communication and the senses; Altruism; Sexual Behaviour: Asymmetry of sex, Sexual dimorphism, Mate choice, Intra-sexual selection (male rivalry), Inter-sexual selection (female choice), Sexual conflict in parental care.
3	Biological Rhythm Types and characteristics of biological rhythms: Short- and Long- term rhythms; Circadian rhythms; Tidal rhythms and Lunar rhythms; Concept of synchronization and masking; Photic and non-photic zeitgebers; Circannual rhythms; Photoperiod and regulation seasonal reproduction of vertebrates; Role of melatonin.
4	Biological Clocks

	Relevance of biological clocks; Chronopharmacology, Chronomedicine, Chronotherapy. Adaptive significance of biological clocks.
	<p>Practical :</p> <ol style="list-style-type: none"> 1. To study nests and nesting habits of the birds and social insects. 2. To study the behavioural responses of wood lice to dry and humid conditions. 3. To study geotaxis behaviour in earthworm/ <i>Drosophila</i> 4. To study the phototaxis/ chemotaxis behaviour in insect larvae. 5. Visit to Forest/ Wild life Sanctuary/Biodiversity Park/Zoological Park to study behavioural activities of animals and prepare a short report. 6. Study of circadian functions in humans (daily eating, sleep and temperature patterns).

Reading List :

1. David McFarland, Animal Behaviour, Pitman Publishing Limited, London, UK.
2. Manning, A. and Dawkins, M. S, An Introduction to Animal Behaviour, Cambridge, University Press, UK.
3. John Alcock, Animal Behaviour, Sinauer Associate Inc., USA.
4. Paul W. Sherman and John Alcock, Exploring Animal Behaviour, Sinauer Associate Inc., Massachusetts, USA.
5. Biological Rhythms: Vinod Kumar (2002) Narosa Publishing House, Delhi/ Springer-Verlag, Germany.

ZOO DSE603 : Agrochemicals and Pest Management

(Theory :4 credits+ Practical: 2 credits)

Course outcome:

On completion of the course students will be able to:

CO 1- To gain knowledge of pests, classification, morphology and internal systems of plant pests, causes of outbreak of pests, growth and development.

CO 2- To understand concept of agrochemicals, classification of agrochemicals and learn different composting technologies.

CO 3- To gain knowledge of agrochemicals for pest management and their modes of action and their fates in the agro-ecosystem.

CO 4- To explain concept of biopesticides, potential pesticidal plants, plant extracts and bio-organisms and their role in pest control and to learn concept of BT methodology, genetically modified and transgenic plants.

Unit	Syllabus
1	Concept of pest : Definition, classification, morphology and internal systems; Plant pests –weeds, bacteria, fungi, Viruses, nematodes, molluscs, Arthropods, birds, mammals; Causes of outbreak of pest, growth and development; Classification based on nature of damage: Public health pests, Agricultural pests, Domestic pests, Animal husbandry pests
2	Agrochemicals/ nutrients for increasing the health of plants: Manures: types, composition and value, sources of manures, Compost- Different composting technologies-Mechanical compost plants-Vermicomposting-Green manures-Oil cakes, Sewage sludge-Biogas plant slurry. Chemical fertilizers: Classification and value. N-fertilizers: Manufacturing of Ammonium Sulphate, Ammonium Chloride, Ammonium Nitrate and urea; P- fertilizers: sources, processing rock phosphate, bones for bone meal preparation; K- fertilizers: sources, Potassium Chloride, Potassium Sulphate and Potassium Nitrate; Biofertilizers: Classification and value; viz., <i>Rhizobium</i> , <i>Azatobactor</i> , <i>Azolla</i> , Blue Green Algae, VAM.
3	Agrochemicals for pest management: Coventional chemicals/ pesticides based on target species: Acaricides, Fungicides Rodenticides, Nematicides, Molluscicides, Fumigants and Repellents; Based on chemical nature: Organophosphates; Organochlorines, Carbamates etc.; Structure, chemical name, physical and chemical properties; Degradation metabolism, Mode of action, uses, toxicity; Application of Pesticides, devices used; dose estimation for field application.
4	Botanicals and other biopesticides: Potential pesticidal plants; Plant extracts and

	Bio-organisms: Azadirachtin and its role in pest control; Other biopesticides: Pyrethrins, Pyrethroids, Rotenone, Nicotine and Nicotinoids. Growth inhibitors or physiological antagonists, chemo-sterilants; pheromones and attractants; Insect growth regulators, juvenile hormones, moulting hormones; Chitin synthesis inhibitors. Moulting Inhibitors. BT methodology, genetically modified and transgenic plants.
	<p>Practical :</p> <ol style="list-style-type: none"> 1. Identification of common natural enemies of crop pests (parasitoids, predators, microbes). 2. Study the damage caused by the commonly occurring insect pests – Infected plant/plant parts. 3. Preparation of Neem and Lantana Camara based botanical pesticides. 4. Field trips to bio-control laboratories – IARI, CWC, FCI. <p>Group discussion or Seminar presentation on one or two related topics from the list.</p>

Reading List :

1. Hill, D.S. (1983) Agricultural insect pests of the tropics and their control- Cambridge Univ. Press.
2. Atwal, A. S. (1979) Agricultural pests of India and south East Asia.
3. Dent, D. (2000) Insect pest management (2nd edition) CAB International.
4. Roberts, D.A. (1978) Fundamentals of Plant Pest Control.
5. De Bach, P. (1964) Biological Control of Insect Pests and Weeds, Chapman & Hall, New York.
6. Koul, O. and Dhaliwal, G.S. (2003) Phytochemical Biopesticides, Harwood Academic Publishers, Amsterdam.
7. Pedigo, L.P. (1996) Entomology and pest management, Prentice Hall, N. Delhi

SEMESTER – VI

ZOO DSE604 : Wild Life Conservation and Management (Theory :4 credits+ Practical: 2 credits)

Course outcome:

On completion of the course students will be able to:

CO 1- To understand different physical and biological parameters for evaluation and management of wildlife.

CO 2- To get the knowledge of Grazing logging, cover construction, preservation of genetic diversity and restoration of degraded habitats under management of habitats.

CO 3- To estimate Population density, Natality, Birth rate, Mortality and fertility schedules.

CO 4- To get the concept of climax persistence, Rescue and rehabilitation, Quarantine, Common disease of wild animal and Man – Animal conflict and to enhance exposure through visit to Wild life Sanctuary, Biodiversity Park and Zoological Parks.

Unit	Syllabus
1	Evaluation and management of wild life: Values of wild life : positive and negative; Conservation ethics; Importance of conservation; Causes of depletion; Conservation strategies.Habitat analysis, Physical parameters: Topography, Geology, Soil and water; Biological Parameters: food, cover, forage, browse and cover estimation; Standard evaluation procedures: remote sensing and GIS.
2	Management of habitats: Setting back succession; Grazing logging; Mechanical treatment; Advancing the successional process; Cover construction; Preservation of general genetic diversity; Restoration of degraded habitats
3	Population estimation Population density, Natality, Birth rate, Mortality, fertility schedules and sex ratio computation;
4	Management planning of wild life: Estimation of carrying capacity; Eco tourism / wild life tourism in forests; Concept of climax persistence; Ecology of perturbation, Rescue and rehabilitation; Protected Areas: National parks & sanctuaries, Community reserve; Important features of protected areas in India; Tiger conservation - Tiger reserves in India; Management challenges in Tiger reserve. Bio- telemetry; Care of injured and diseased animal; Quarantine; Common diseases of wild animal, Man-Animal conflict; Faecal analysis of ungulates and carnivores: Faecal samples, slide preparation, Hair identification, Pug marks and census method.

	<p>Practical :</p> <ol style="list-style-type: none"> 1. Identification of mammalian fauna, avian fauna, herpeto-fauna 2. Demonstration of basic equipment needed in wildlife studies use, care and maintenance (Compass, Binoculars, Spotting scope, Global Positioning System, Various types of Cameras and lenses) 3. Familiarization and study of animal evidences in the field; Identification of animals through pug marks, hoof marks, scats, pellet groups, nest, antlers etc. 4. PCQ, Ten tree method, Circular, Square & rectangular plots, ground cover assessment, Tree canopy cover assessment, Shrub cover assessment. 5. Trail / transect monitoring for abundance and diversity estimation of mammals and bird (direct and indirect evidences)
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Reading List :

1. Caughley, G., and Sinclair, A.R.E. (1994). *Wildlife Ecology and Management*. Blackwell Science.
2. Woodroffe R., Thirgood, S. and Rabinowitz, A. (2005). *People and Wildlife, Conflict or Co-existence?* Cambridge University.
3. Bookhout, T.A. (1996). *Research and Management Techniques for Wildlife and Habitats*, 5 th edition. The Wildlife Society, Allen Press.
4. Sutherland, W.J. (2000). *The Conservation Handbook: Research, Management and Policy*. Blackwell Sciences
5. Hunter M.L., Gibbs, J.B. and Sterling, E.J. (2008). *Problem-Solving in Conservation Biology and Wildlife Management: Exercises for Class, Field, and Laboratory*. Blackwell Publishing.

ZOO DSE604 : Aquatic Biology
(Theory :4 credits+ Practical: 2 credits)

Course outcome:

On completion of the course students will be able to:

CO 1- Understand and apply relevant scientific principles in the area of aquatic biology

CO 2- Employ scientific methodologies such as experimentation and data analysis in the area of aquatic biology

CO 3- Explore some of the unique environmental problems dealing with aquatic environments.

CO 4- Develop employable skills in freshwater biological water quality analysis.

Unit	Syllabus
1.	Abiotic conditions of Freshwater ecosystems: Physical Properties of Water; chemical properties of water; Brief introduction of the aquatic ecosystem, Freshwater ecosystems (lakes, wetlands, streams and rivers). Physico-chemical Characteristics of fresh water bodies: Light, Temperature, Thermal stratification, Dissolved Solids, Carbonate, Bicarbonates, Phosphates and Nitrates, Turbidity: dissolved gases (Oxygen, Carbon dioxide). Origin and classification of lakes; Streams: Different stages of stream development.
2.	Aquatic organisms : Feeding in aquatic organisms; respiration in aquatic organisms; osmoregulation in freshwater and marine organisms; sensory world of aquatic organisms; Locomotion in water. Adaptation of hill-stream fishes. Adaptation of deep sea organisms.
3.	Abiotic conditions of marine ecosystems: Classification of marine ecosystem: Estuaries, intertidal zones, Oceanic pelagic zone, marine benthic zone. Coral reefs. Physico-chemical environment, Salinity and density of sea water and Continental shelf; other factors viz., Light, Temperature, Thermal stratification, Dissolved Solids, Turbidity: dissolved gases (Oxygen, Carbon dioxide).
4.	Management of Aquatic Resources: Aquatic pollution - Causes of pollution: Agricultural, Industrial, Sewage, Thermal and Oil spills, Eutrophication, Management and conservation. Water pollution acts of India. Sewage treatment and water quality assessment - BOD and COD.
	Practical: 1. Physico-Chemical analysis and biological analysis of a pond. 2. Biological – Zooplanktons – Identification and population density of Zooplanktons of a lake/ pond. 3. Determination of Turbidity / Transparency, Alkalinity in water collected from a nearby water body. 4. Instruments used in limnology (Secchi disc, conductivity meter, Turbidity meter) and their significance.

Reading list:

1. Goldman, C. (1994) Limnology (2nd edition).
2. Ananthkrishnan, T.N. (1989) Bioresources Ecology (3rd edition).
3. Odum, E.P. and Barrett, G.W. (2004) Fundamentals of Ecology (5th edition).
4. Pawlowski, L. (1980) Physicochemical Methods for water and Wastewater Treatment.
5. Wetzel, R. (2001) Limnology (3rd edition) Elsevier.
6. Trivedy, R.K. and Goyal, P.K. (1986) Chemical and biological methods for water pollution studies.
7. Welch, P.S. (2014) Limnology Vol. I-II.