

UNIVERSITY OF NORTH BENGAL

Accredited by NAAC with grade "B++"

B.Sc. Zoology FOUR YEAR UNDERGRADUATE PROGRAM
(FYUGP)
w.e.f. 2023-2024

Course Curriculum for B.Sc. Zoology (Major)

Under
THE NEW CURRICULUM AND CREDIT FRAMEWORK, 2022



समानो मन्त्रः समितिः समानी

B.Sc. Zoology Major

UNIVERSITY OF NORTH BENGAL
RAJA RAMMOHANPUR, DARJEELING
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FYUGP COURSE STRUCTURE OF ZOOLOGY (MAJOR)

Semester	Major Courses (Credit)	Skill Enhancement Courses (Credit)	Minor Courses (Credit)	Inter-disciplinary Courses (Credit)	Ability Enhancement Compulsory Courses (Credit)	Value Added Courses (Credit)	Semester-wise Credit
I	MAJ-1 Biology of Non-Chordates (4)	SEC-1 Sericulture and Apiculture (3)	MIN-(A)-1(4) (Any-one from the list provided by the college)	MDC-1 (3) (Any-one from the list provided by the college)	AECC- MIL/ ALT. ENG.-1 (2)	VAC- Understanding India/Digital Marketing (4)	20
II	MAJ-2 Biology of Chordates (4)	SEC-2 Aquaculture & Fisheries and Poultry Farming (3)	MIN-(B)-1(4) (Any-one from the list provided by the college)	MDC-2 (3) (Any-one from the list provided by the college)	AECC-ENG.-1(2)	VAC- Environmental Education (4)	20
III	MAJ-3 Cell Biology (4)	SEC-3 Pest Management and Medical Diagnostics (3)	MIN-A-2(4)		AECC- MIL/ ALT. ENG.-2 (2)		21
	MAJ-4 Biochemistry: Fundamentals (4)						
	MAJ-5 Ecology (4)						
IV	MAJ-6 Genetics (4)		MIN-B-2(4)	MDC-3 (3) (Any-one from the list provided by the college)	AECC-ENG.-2(2)		21
	MAJ-7 Ethology and Chronobiology (4)						
	MAJ-8 Environment and Public Health (4)						
V	MAJ-9 Biochemistry: Metabolic processes (4)	Internship (2)	MIN-A-3(4)				22
	MAJ-10 Molecular Biology (4)						
	MAJ-11 Immunology (4)						
VI	MAJ-12 Parasitology and Medical Microbiology (4)		MIN-B-3(4)				20
	MAJ-13 Physiology (4)						
	MAJ-14 Endocrinology and Reproductive Biology (4)						
VII	MAJ-15 Gamete biology and embryology (4)		MIN-A-4(4)				16
	MAJ-16 Adaptation, Evolution and Taxonomy (4)						
	MAJ-17 Biotechnology (4)						
VIII	MAJ-18 Wildlife conservation and Biodiversity (4)		MIN-B-4(4)				20
	MAJ-19 Comparative Anatomy and Functional Biology (4)						
	MAJ-20 Biostatistics and Bioinstrumentation (4)						
	MAJ-21 Research Methodology (4)*						
	MAJ-22 Field Work/Industry Visit (4)*						
MAJ-23 Group Discussion/Seminar Presentation/Grand Viva (4)*							
	Research Project/Dissertation (12)**						

* Candidates for 'without research'

** Candidates for 'with research'

Semester I

MAJOR 1: Biology of Non-Chordates (Paper Code: UZ00MAJ1101)

Paper Type: Theory + Practical Lab Based [TH+PLB]

Credit: 4 (Theory 3+ Practical 1)

Class Hours: 75 (Theory 45 hrs. + Practical 30 hrs.)

Full Marks: 75 (Theory 40 + Practical 20 + Continuous evaluation 10 + Attendance 05)

Duration of end semester examination: (Theory 2 hrs. + Practical 2 hrs.)

Syllabus:

Theory	Class Hour(s)
Unit I: Introduction to Non-chordates	01
<ul style="list-style-type: none">• Introduction to Five Kingdoms System.• General characters of Kingdom Animalia.• Basis of classification of Kingdom Animalia into different phyla.	
Unit II: Protista	06
<ul style="list-style-type: none">• General characteristics and classification up to phyla.• Locomotion in <i>Amoeba</i>, <i>Euglena</i> and <i>Paramoecium</i>• Conjugation in <i>Paramoecium</i>.• Life cycle of <i>Plasmodium vivax</i>.	
Unit III: Porifera	03
<ul style="list-style-type: none">• General characteristics and classification up to classes.• Canal system in sponges.	
Unit IV: Cnidaria and Ctenophora	05
<ul style="list-style-type: none">• General characteristics and classification up to classes.• Polymorphism in Cnidaria.• Corals and coral reefs.	
Unit V: Platyhelminthes and Nematoda	06
<ul style="list-style-type: none">• General characteristics and classification up to classes.• Reproductive system and life cycle of <i>Fasciola hepatica</i> and <i>Ascaris lumbricoides</i>.• Parasitic adaptations of helminths.	
Unit VI: Annelida	05
<ul style="list-style-type: none">• General characteristics and classification up to classes.• Locomotion in <i>Nereis</i>.• Excretion in Annelida.	
Unit VII: Arthropoda and Onychophora	07
<ul style="list-style-type: none">• General characteristics and classification up to classes.• Structure and affinities of Xiphosura.• Tracheal respiration in cockroach.• Vision in Insecta.• General characteristics and evolutionary significance of Onychophora.	

Unit VIII: Mollusca	05
<ul style="list-style-type: none"> • General characteristics and classification up to classes. • Respiration in <i>Pila</i>. • Nervous system in Gastropoda. • Torsion and detorsion in Gastropoda. 	
Unit IX: Echinodermata	05
<ul style="list-style-type: none"> • General characteristics and classification up to classes. • Water-vascular System in Asteroidea. • Affinities with chordates. 	
Unit X: Hemichordata	02
<ul style="list-style-type: none"> • General characteristics. • Affinities with non-chordates and chordates. 	

Note: Outline classification of the kingdom Protista up to phyla to be followed from Levine et al. (1980) and that of other phyla up to classes to be followed from "Ruppert, Fox and Barnes (2003): Invertebrate Zoology: A Functional Evolutionary Approach". VII Edition or from Brusca, R.C and Brusca, G. J (2003): Invertebrate (2nd ed.) Sinauer Associates Inc., Publishers Sunderland.

Practical	30 Hours
<ul style="list-style-type: none"> • Museum study <ul style="list-style-type: none"> (i) Protozoa: <i>Euglena</i>, <i>Paramecium</i> (including binary fission and conjugation), <i>Amoeba</i>, <i>Plasmodium vivax</i> (trophozoite/signet ring stage). (ii) Porifera: <i>Sycon</i>, <i>Hyalonema</i>, <i>Spongilla</i>. (iii) Cnidaria: <i>Hydra</i>, <i>Obelia</i>, <i>Aurelia</i>, <i>Gorgonia</i>, <i>Pennatula</i>, <i>Fungia</i>, <i>Metridium</i>. (iv) Platyhelminthes: <i>Planeria</i>, <i>Fasciola hepatica</i>, <i>Taenia solium</i>. (v) Nematoda: <i>Ascaris lumbricoides</i> (male and female). (vi) Annelida: <i>Neries</i>, <i>Chaetopterus</i>, <i>Pheretima</i>, <i>Hirudinaria</i>. (vii) Arthropoda: <i>Limulus</i>, <i>Palamnaeus</i>, <i>Palaemon</i>, <i>Daphnia</i>, <i>Balanus</i>, <i>Cancer</i>, <i>Eupagurus</i>, <i>Scolopendra</i>, <i>Julus</i>, <i>Bombyx</i>, <i>Periplanta</i>, <i>Apis</i>. (viii) Mollusca: <i>Chiton</i>, <i>Dentalium</i>, <i>Pila</i>, <i>Unio</i>, <i>Sepia</i>, <i>Octopus</i>. (ix) Echinodermata: <i>Asterias</i>, <i>Ophiura</i>, <i>Echinus</i>, <i>Cucumaria</i>, <i>Antedon</i>. • Study of the sections: T.S. and L.S. of sponge; T.S. through pharynx, gizzard, and typhlosolar intestine of earthworm. • Mounting: Nerve ring and spermatheca of earthworm, salivary glands and mouthparts of cockroach. • Dissection: Alimentary system and nervous system of earthworm, digestive system and nervous system of cockroach. 	

Note: In case of unavailability of preserved specimens/slides, departments can use photographs for the study of museum specimens and permanent slides.

Evaluation Structure for end semester practical examination:

1. Identification with reason: 3 specimens/each 2 marks (Identification = $\frac{1}{2}$, Systematic position (as per theory syllabus)= $\frac{1}{2}$, Characters = 1), 1 section /each 2 marks
(Identification = $\frac{1}{2}$, Characters= $1\frac{1}{2}$)Total = 8 marks
2. Dissection & display, drawing and labelling (one system) ($4\frac{1}{2} + \frac{1}{2} + \frac{1}{2} + \frac{1}{2} = 6$ marks)
3. Mounting: Any one (2 marks)
4. Laboratory Note Book: 2 marks (Based on the neatness, inclusiveness, overall presentation and regularity)
5. Viva-Voce: 2 marks (Testing of Knowledge in the said Course)

Suggested Readings

1. Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2009). The Invertebrates: A Synthesis. III Edition, Jhon Willey & Sons.
2. Barrington, E.J.W. (2012). Invertebrate Structure and Functions. II Edition, EWP Publishers.
3. Brusca, R.C. and Brusca, G.J. (2003). Invertebrate. II Edition, Sinauer Associates Inc., Sunderland.
4. Levine, N. D., J. O. Corliss, F. E.G. Cox, G. Deroux, J. Grain, B. M. Honigberg, G. F. Leedale, et al. 1980. "A Newly Revised Classification of the Protozoa." *The Journal of Protozoology*. 27 (1): 37-58.
5. Parker, T.J. and Haswell, W.A. (1972). A text book of Zoology, Vol-I. VII Edition, Marshall and Williams (eds.), Mc Millan Press ltd.
6. Pechenik, J.A. (2015). Biology of the Invertebrates. VII Edition, McGraw-Hill Education.
7. Ruppert, E.E., Fox, R.S. and Barnes, R.D. (2003). Invertebrate Zoology: A Functional Evolutionary Approach. VII Edition, Cengage Learning, India.

SEC 1: Sericulture and Apiculture (Paper Code: UZOOSEC11001)
Paper Type: Theory + Practical Lab Based [TH+PLB]
Credit: 3 (Theory 2+ Practical 1)
Class Hours: 60 (Theory 30 hrs. + Practical 30 hrs.)
Full Marks: 75 (Theory 40 + Practical 20 + Continuous evaluation 10 + Attendance 05)
Duration of end semester examination: (Theory 2 hrs. + Practical 2 hrs.)

Syllabus:

Theory	Class Hour(s)
A. Sericulture	
Unit I: Introduction	01
<ul style="list-style-type: none"> • Types of silkworms, distribution and races. 	
Unit II: Biology of Silkworm	02
<ul style="list-style-type: none"> • Classification and lifecycle of <i>Bombyx mori</i>. • Structure of silk gland and secretion of silk. • Physical and chemical nature of silk fibre, uses of silk. 	
Unit III: Rearing of Silkworms	05
<ul style="list-style-type: none"> • Selection of mulberry variety and establishment of mulberry garden (Moriculture). • Rearing house and rearing appliances. • Disinfectants: Formalin, bleaching powder, RKO. • Silkworm rearing technology: Early age and late age rearing. • Types of mountages. • Spinning, harvesting and storage of cocoons. 	
Unit IV: Pests and Diseases	05
<ul style="list-style-type: none"> • Pests of silkworm: Uzi fly, dermestid beetles and vertebrates. • Control and preventive measures for pest infestation. • Causative agents, symptoms and remedies of silkworm diseases: Viral (Grasserie), bacterial (Flacherie), protozoan (Pebrine) and fungal (Muscardine). 	
Unit V: Entrepreneurship in Sericulture	02
<ul style="list-style-type: none"> • Prospects of Sericulture in India. • By-products of Sericulture and Seri-products for value addition. 	

B. Apiculture (Theory)	
Unit I: Biology of Bees	01
<ul style="list-style-type: none"> • Classification and biology of honey bees. 	
Unit II: Rearing of Bees	06
<ul style="list-style-type: none"> • Artificial bee rearing (Apiary), beehives: Newton and Langstroth, bee pasturage. • Selection of bee species for Apiculture. • Bee keeping equipment. • Methods of extraction of honey (indigenous and modern). 	
Unit III: Enemies and Diseases	04
<ul style="list-style-type: none"> • Enemies: Wasp and small hive beetle. • Causative agents, symptoms and remedies of bee diseases: Viral (Sac-brood disease), bacterial (American foul brood), protozoan (Nosema), Fungal (Chalk brood). 	
Unit IV: Bee Economy	02
<ul style="list-style-type: none"> • Products of Apiculture Industry and its uses (Honey, Bees wax, Propolis, Pollen, Royal Jelly, Bee Venom). 	
Unit V: Entrepreneurship in Apiculture	02
<ul style="list-style-type: none"> • Resource available, prospects and problems. • Bee keeping industry: Recent efforts and developments. • Modern methods in employing artificial beehives for crosspollination in horticultural gardens. 	

Practical	30 Hours
<ul style="list-style-type: none"> • Identification of different stages of life cycle of silk-moth. • Identification of worker, drone and queen of honeybee. • Identification of the pests of silkworm (as per theory syllabus). • Identification of the diseased silkworm (as per theory syllabus). • Identification of the diseased honey bee (as per theory syllabus). • Project report on a visit to a sericulture/apiculture farm. 	

Note: In case of unavailability of specimens, departments can use photographs for the study.

Evaluation Structure for end semester practical examination:

1. Identification: 5 specimens (any one stage of life cycle of silk-moth, any one caste of honeybee, any one pest of silkworm, any one diseased silkworm, any one diseased honeybee) /each 2 marks (Identification = ½, Characters= 1½). Total = 10 marks
2. Submission of project report. 6 marks
3. Laboratory Note Book: 2 marks (Based on the neatness, inclusiveness, overall presentation and regularity)
4. Viva-Voce: 2 marks (Testing of Knowledge in the said Course)

Suggested Readings

1. Appropriate Sericultural Techniques. M. S. Jolly (ed.), CSR&TI, Mysore.
2. Banerjee, T.K. (2016). Applied Zoology. New Central Book Agency (P) Ltd., Kolkata.
3. Bisht, D.S. Apiculture, ICAR Publication.
4. Chaudhuri, S. (2017). Economic Zoology. New Central Book Agency (P) Ltd., Kolkata.
5. Singh, S. Bee keeping in India. Indian council of Agricultural Research, New Delhi.
6. Tripathi, A.K., Pandey, B.N., Jaiswal, K. and Trivedi, S.P. (2009). Mulberry Sericulture: Problems and Prospects. Aph Publishing Corporation.
7. Ullal, S.R. and Narasimhanna, M.N. Handbook of Practical Sericulture, CSB, Bangalore.
8. Ganga, G. and Sulochana Chetty, J. (2014). Introduction To Sericulture. Oxford & Ibh Publishing Co. Pvt. Ltd.
9. Jaiswal, K., Trivedi, S.P., Pandey, B.N. and Pandey, P.N. (2009). Indian Sericulture: Past, Present and Future. Alfa Publication.
10. Sengupta, K. (1989). A Guide for Bivoltine Sericulture. CSR&TI, Mysore.
11. Narasimhanna, M.N. (1988). Manual of Silkworm Egg Production. CSB, Bangalore.
12. Wupang-Chun and Chen Da-Chung. (1988). Silkworm Rearing. FAO, Rome.
13. Krishnaswamy, S. (1986). Improved Method of Rearing Young age silkworm. CSB, Bangalore.
14. Prost, P.J. (1962). Apiculture. Oxford and IBH, New Delhi.
15. Hand book of Silkworm Rearing: Agriculture and Technical Manual-1. Fuzi Pub. Co. Ltd., Tokyo, Japan. (1972).

Semester II

MAJOR 2: Biology of Chordates (Paper Code: UZOOMAJ12002)

Paper Type: Theory + Practical Lab Based [TH+PLB]

Credit: 4 (Theory 3+ Practical 1)

Class Hours: 75 (Theory 45 hrs. + Practical 30 hrs.)

Full Marks: 75 (Theory 40 + Practical 20 + Continuous evaluation 10 + Attendance 05)

Duration of end semester examination: (Theory 2 hrs. + Practical 2 hrs.)

Syllabus:

Theory	Class Hour(s)
Unit I: Introduction to chordates	01
General characteristics and outline classification of Phylum Chordata up to classes.	
Unit II: Protochordata	04
<ul style="list-style-type: none">• General characteristics and classification of Sub-Phylum Urochordata and Cephalochordata up to classes.• Retrogressive metamorphosis in <i>Ascidia</i>.• General organization of <i>Branchiostoma</i>.	
Unit III: Origin of Chordata	02
<ul style="list-style-type: none">• Dipleurula concept and the Echinoderm theory of origin of chordates.	
Unit IV: Agnatha	02
<ul style="list-style-type: none">• General characteristics and classification of Cyclostomata up to orders.• Metamorphosis in <i>Petromyzon</i>.• Zoological importance of ammocoete larva.	
Unit V: Pisces	10
<ul style="list-style-type: none">• General characteristics and classification of Chondrichthyes and Osteichthyes up to sub-classes.• Swim bladder in fishes.• Accessory respiratory organs in fishes.• Migration of fishes.• Parental care in fishes.• Dipnoi: Distribution, morphology & affinities.	
Unit VI: Amphibia	04
<ul style="list-style-type: none">• General characteristics and classification up to extant orders.• Parental care in Amphibia.• Metamorphosis in <i>Bufo</i>.• Neoteny and paedogenesis.	
Unit VII: Reptilia	06
<ul style="list-style-type: none">• General characteristics and classification up to extant orders.• Poison apparatus and biting mechanism of snakes.• Types of snake venom & their mode of actions.	

Unit VIII: Aves	07
<ul style="list-style-type: none"> • General characteristics and classification up to sub-classes. • Exoskeleton (in relation to feathers). • Double respiration in birds. • Principles and aerodynamics of flight. • Migration of birds. 	
Unit IX: Mammals	06
<ul style="list-style-type: none"> • General characters and classification up to extant orders. • Exoskeletal derivatives of mammals. • Echolocation in Microchiroptera and Cetacea. 	
Unit X: Zoogeography	03
<ul style="list-style-type: none"> • Zoogeographical realms. • Plate tectonic and Continental drift theory. • Distribution of birds and mammals in different realms. 	

Note: Classification of Protochordata, Agnatha, Reptilia, Aves & Mammals to be followed from Young (1981), for Pisces to be followed from Romer (1959)/Berg (1940), for Amphibia to be followed from Duellman & Trueb (1986)/ Young (1981).

Practical	30 Hours
<ul style="list-style-type: none"> • Museum Study of <ul style="list-style-type: none"> (i) Protochordata: <i>Herdmania</i>, <i>Ascidia</i>, <i>Branchiostoma</i>. (ii) Agnatha: <i>Petromyzon</i>, <i>Myxine</i>, Ammocoete larva. (iii) Pisces: <i>Scoliodon</i>, <i>Sphyrna</i>, <i>Torpedo</i>, <i>Heteropneustes</i>, <i>Labeo</i>, <i>Exocoetus</i>, <i>Echeneis</i>, <i>Anguilla</i>, <i>Hippocampus</i>, <i>Tetrodon</i>, <i>Diodon</i>, <i>Anabas</i>, Flat fish. (iv) Amphibia: <i>Necturus</i>, <i>Axolotl</i>, <i>Tylototriton</i>, <i>Bufo</i>, <i>Hyla</i>. (v) Reptilia: <i>Chelone</i>, <i>Trionyx</i>, <i>Hemidactylus</i>, <i>Varanus</i>, <i>Uromastix</i>, <i>Chamaeleon</i>, <i>Draco</i>, <i>Bungarus</i>, <i>Vipera</i>, <i>Naja</i>, <i>Hydrophis</i>, <i>Crocodylus</i>. (vi) Aves: Oriental pied hornbill, Red breasted flycatcher, Great tit, Pelican. (vii) Mammalia: Bat (insectivorous and frugivorous), <i>Funambulus</i>, Red panda. • Key for identification of poisonous and non-poisonous snakes. • Mounting: Fish scales & pecten from fowl head. • Isolation of pituitary from fish head. 	

Note: In case of unavailability of preserved specimens/slides, departments can use photographs for the study of museum specimens and permanent slides.

Evaluation Structure for end semester practical examination:

1. Identification with reason: 4 specimen/each 2 marks (Identification = $\frac{1}{2}$, Systematic position (as per theory syllabus)= $\frac{1}{2}$, Characters = 1) Total = 8 marks
2. Key preparation: 2 marks
3. Isolation of pituitary gland from fish head: 4 marks
4. Mounting: Any one (2 marks)
5. Laboratory Note Book: 2 marks (Based on the neatness, inclusiveness, overall presentation and regularity)
6. Viva-Voce: 2 marks (Testing of Knowledge in the said Course)

Suggested Readings

1. Berg, L.S. (1940). Classification of fishes both recent and fossil. *Trudy Zoologicheskogo Instituta*. 5:85-517.
2. Darlington, P.J. *The Geographical Distribution of Animals*. R.E. Krieger Pub Co.
3. Duellman, W.E. and Trueb, L. (1986). *Biology of Amphibians*. Mc. Graw Hill Books Company.
4. Hall, B.K. and Hallgrimsson, B. (2008). *Strickberger's Evolution*. IV Edition, Jones and Bartlett Publishers Inc.
5. Jordan, E.L. and Verma, P.S. (2003). *Chordate Zoology*. S. Chand & Company Ltd., New Delhi.
6. Kardong, K.V. (2002). *Vertebrates: Comparative anatomy, function evolution*. Tata McGraw Hill.
7. Kent, G.C. and Carr, R.K. (2001). *Comparative anatomy of the Vertebrates*. IX Edition, McGraw Hill.
8. Nelson, J.S. (2006). *Fishes of the World*. IV Edition, Wiley.
9. Parker, T.J. and Haswell, W. (1972). *Text Book of Zoology, Volume II*. VII Edition, Marshall and Willam (eds.), Macmillan Press, London.
10. Pough, H. *Vertebrate life*. VIII Edition, Pearson International.
11. Romer, A.S. (1959). *The Vertebrate Story*. University of Chicago Press.
12. Romer, A.S. and Parsons, T.S. (1986). *The vertebrate body*. VI Edition, Saunders College Publishing.
13. Young, J. Z. (1981). *The Life of Vertebrates*. III Edition, ELBS, Oxford.
14. Young, J.Z. (2004). *The Life of Vertebrates*. III Edition (Indian Edition), Oxford University press.

SEC 2: Aquaculture & Fisheries and Poultry Farming (Paper Code: UZOOSEC12002)**Paper Type: Theory + Practical Lab Based [TH+PLB]****Credit: 3 (Theory 2+ Practical 1)****Class Hours: 60 (Theory 30 hrs. + Practical 30 hrs.)****Full Marks: 75 (Theory 40 + Practical 20 + Continuous evaluation 10 + Attendance 05)****Duration of end semester examination: (Theory 2 hrs. + Practical 2 hrs.)****Syllabus:**

Theory	Class Hour(s)
A. Aquaculture and Fisheries	
Unit I: Introduction to aquaculture and fisheries	01
<ul style="list-style-type: none">• Definition, scope and importance of aquaculture and fisheries.	
Unit II: Fish culture and Management	05
<ul style="list-style-type: none">• Management and types of fish culture, induced breeding; breeding pond, hatching pit, nursery pond, rearing pond and stocking pond; fish harvesting.• Polyculture or Composite fish culture, integrated fish farming, pen and cage culture, and raceway culture.• Causative agents, symptoms and remedies of fish diseases: Fungal (gill rot), bacterial (tail and fin rot, Dropsy), protozoan (ichthyophthiriasis) and parasitic (diptostomiasis and argulosis).	
Unit III: Fish Technology	02
<ul style="list-style-type: none">• Preservation and processing of fish.• Fish by-products and their economic importance.	
Unit IV: Prawn Farming and Pearl Culture	04
<ul style="list-style-type: none">• Species of commercial prawn; types of prawn farming; methods of prawn farming• Pearl producing molluscs, pearl formation, methods of pearl culture.	
Unit V: Aquarium fish management	03
<ul style="list-style-type: none">• Common characters and sexual dimorphism of fresh water and marine aquarium fish: Guppy, Molly, Sword tail, Gold fish, Angel fish, Blue morph, Anemone fish, Butterfly fish.• Live fish transportation: Fish handling, packing and forwarding techniques.• Aquarium maintenance.• Entrepreneurship in aquarium fish farming.	
B. Poultry Farming	
Unit I: Introduction to Poultry Farming	04
<ul style="list-style-type: none">• General introduction to poultry farming,• Characteristics of common fowl breeds: Indigenous (Aseel, Kadaknath, Ghagus, Harringhata Black) and exotic (Leghorn, Cornish, Rhode Island Red, Cochin).• Systems of poultry farming.	
Unit II: Farm Management	04
<ul style="list-style-type: none">• Nutrient requirements for different stages of layers and broilers.• Methods of feeding.• Management of chicks, growers, layers and broilers.	

Unit III: Poultry diseases	03
<ul style="list-style-type: none"> • Causative agents, symptoms and remedies of poultry diseases: Viral (Avian influenza), Bacterial (Pullorum disease), Protozoan (Coccidiosis) and Fungal (Aspergillosis). • Vaccination program. 	
Unit IV: Harvesting of Eggs	03
<ul style="list-style-type: none"> • Selection, care and handling of hatching eggs. • Egg testing. • Methods of hatching. • Brooding and rearing. • Sexing of chicks. 	
Unit V: Entrepreneurship in Poultry Farming	01
<ul style="list-style-type: none"> • Present and future scenario of poultry industry in India. 	

Practical	30 Hours
<p>Spot Identification:</p> <ul style="list-style-type: none"> ○ <i>Labeo rohita</i>, <i>Labeo calbasu</i>, <i>Catla catla</i>, <i>Cyprinus carpio</i>, <i>Hypophthalmichthys molitrix</i>, <i>Ctenopharyngodon idella</i>, <i>Cirrhinus mrigala</i>, <i>Clarias batrachus</i>, <i>Heteropneustes fossilis</i>, <i>Ophiocephalus punctatus</i>, <i>Ophiocephalus marulius</i>, <i>Anabas testudineus</i>. ○ Guppy, Molly, Sword tail, Gold fish, Angel fish, Blue morph, Anemone fish, Butterfly fish. ○ <i>Penaeus monodon</i>, <i>Metapenaeus affinis</i>, <i>Palaemon fluminicola</i>, <i>Macrobrachium rosenbergii</i>, <i>Pinctada</i> sp., <i>Mytilus</i> sp. • Identification of chicken breeds (as per theory syllabus). • Identification of diseased fish and chicken (as per theory syllabus). • Project report on a visit to a fish/prawn/pearl culture farm or aquarium fish farm or poultry farm. 	

Note: In case of unavailability of preserved specimens/slides, departments can use photographs for the study of museum specimens.

Evaluation Structure for end semester practical examination:

1. Identification: 5 specimens (any one species of fish, any species of prawn/bivalve, any one breed of chicken, any one diseased fish, any one diseased chicken) /each 2 marks (Identification = ½, Characters= 1½). Total = 10 marks
2. Submission of project report. 6 marks
3. Laboratory Note Book: 2 marks (Based on the neatness, inclusiveness, overall presentation and regularity)
4. Viva-Voce: 2 marks (Testing of Knowledge in the said Course)

Suggested Readings

1. Banerjee, T.K. (2016). Applied Zoology. New Central Book Agency (P) Ltd., Kolkata.
2. Chaudhuri, S. (2017). Economic Zoology. New Central Book Agency (P) Ltd., Kolkata.
3. Das, M.K. and Das, R.K. Fish and Prawn diseases in India – Diagnosis and Control. Inland Fisheries Society of India, Barrackpore, West Bengal.
4. Ghosh, N. (2015). Poultry Science and Practice. CBS Publishers & Distributors.
5. Govindan, T.K. Fish Processing Technology. Oxford & IBH Publishing Co. Pvt. Ltd., Kolkata.
6. Gupta, S.K. and Gupta, P.C. General and Applied Ichthyology (Fish & Fisheries). S. Chand & Co. Ltd., New Delhi.
7. Hiware, C.J., Pawar, R.T., Gaikward, J.M. and Sonawane, S.R. Classification and Identification of Freshwater fishes, Daya Publishing House, New Delhi.
8. Hurd, L.M. (2003). Modern Poultry Farming. I Edition, International Book Distributing Company, Lucknow.
9. Jhingran, V.G. Fish & Fisheries of India. Hindustan Publishing Corporation, Delhi.
10. Jull, M.A. (2007). Successful Poultry Management. II Edition, Biotech Books, New Delhi.
11. Khanna, S.S. and Singh, H.R. A textbook of fish biology and fisheries. III Edition, Narendra Publishing House, Delhi.
12. Pillay, T.V.R. Aquaculture; Principles & Practices. Fishing News Books, Oxford.
13. Prasad, J. (2015). Poultry Production and Management. Kalyani Publishers.
14. Rath, R.K. Freshwater Aquaculture. Scientific Publishers, Jodhpur.
15. Santhanam, R., Sukumaran N. and Natarajan, P. A Manual on Freshwater Aquaculture. Oxford IBH Publishing Co. Ltd., Kolkata.
16. Sreenivasaiah, P.V. (2015). Textbook of Poultry Science. I Edition, Write & Print Publications, New Delhi.

Semester III

MAJOR 3: Cell Biology (Paper Code: UZOOMAJ23003)

Paper Type: Theory + Practical Lab Based [TH+PLB]

Credit: 4 (Theory 3+ Practical 1)

Class Hours: 75 hrs (Theory 45 hrs. + Practical 30 hrs.)

Full Marks: 75 (Theory 40 + Practical 20 + Continuous evaluation 10 + Attendance 05)

Duration of end semester examination: (Theory 2 hrs. + Practical 2 hrs.)

Syllabus:

Theory	Class Hour(s)
Unit I: Overview of cells	02
<ul style="list-style-type: none">• Basic structure of prokaryotic cells (<i>E. coli</i>).• Major differences between prokaryotic and eukaryotic cells.	
Unit II: Plasma membrane	06
<ul style="list-style-type: none">• Structure of plasma membrane: Fluid mosaic model.• Passive transport: Facilitated diffusion of glucose.• Active transport: Transport via Na⁺/K⁺ pump.	
Unit III: Nucleus	05
<ul style="list-style-type: none">• Structure: Nuclear envelope and nucleolus.• Types of chromatins.• Packaging of chromatin fibre (Nucleosome model and Solenoid model).	
Unit IV: Cell organelles: Endomembrane system	09
<ul style="list-style-type: none">• Endoplasmic Reticulum: Structure and function of RER and SER.• Golgi Apparatus: Organization and function.• Lysosome: Types, function.• Overview of vesicular transport of proteins through GERL system.	
Unit V: Cell organelles: Mitochondria and Centrosome	06
<ul style="list-style-type: none">• Mitochondria: Structural organization and function.• Centrosome: Structure and function. Role in cell division.	
Unit VI: Cytoskeleton	05
<ul style="list-style-type: none">• Types and function.• Microfilament: Organization, motor protein (myosin).• Microtubule: Organization, motor proteins (kinesin and dynein).	
Unit VII: Cell Division	06
<ul style="list-style-type: none">• Cell cycle: Phases and regulation (various checkpoints and Cdks).• Mitosis: Process and significance.• Meiosis: Process and significance.	
Unit VIII: Cell Signaling	06
<ul style="list-style-type: none">• G-protein mediated cell signaling <i>via</i> glucagon• Receptor tyrosine kinase mediated cell signaling <i>via</i> insulin	

Practical	30 Hours
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- ❖ Study of the microscope: Simple and Compound.
- ❖ Study of Chromosomes: Polytene and Lampbrush chromosomes.
- ❖ Micrometry: Measurement of the microscopic object using a micrometer (Single cell).
- ❖ Study of cell: Preparation of temporary mount of human buccal epithelial cells.
- ❖ Temporary preparation of mitotic cells from onion root tips
- ❖ Temporary preparation of meiotic cells from short-horned grasshopper testes.

Evaluation Structure for end semester practical examination:

1. Measurement of the diameter of a cell using a micrometer (**6 marks**): Calibration of an ocular micrometer using a stage micrometer (3 marks) and measurement of the cell using an ocular micrometer (3 marks).
2. Temporary mount of the buccal epithelial cell (self) (**4 marks**): Preparation (3 marks), Mounting (1 mark).
3. Identification of polytene or lamp brush chromosome (any one) from permanent slide or photograph (**2 marks**): Identification ($\frac{1}{2}$ mark) and characters ($1\frac{1}{2}$ mark).
4. Identification of mitotic/meiotic cell divisional phase (**any two**) from onion root tip/grasshopper testes (from permanent slide or photograph) (**4 marks**): Identification ($\frac{1}{2}$ mark) and characters ($1\frac{1}{2}$ mark).
5. Laboratory Note Book: 2 marks (Based on neatness, inclusiveness, overall presentation, and regularity).
6. Viva-Voce: 2 marks (Testing of Knowledge in the said Course).

Suggested Readings

1. Karp, G. (2009). Cell and Molecular Biology: Concepts and Experiments. VI Edition John Wiley and Sons. Inc.
2. Iwasa J. and Marshall W. (2020). Karp's Cell and Molecular Biology: Concepts and Experiments. IX Edition John Wiley and Sons. Inc. K
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. Cooper, G.M. (2018). The Cell: A Molecular Approach. VIII Edition. Sinauer Associates: Oxford University Press, New York
5. 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.
6. 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
7. Lodish, H., D. Baltimore, A. Berk, L. Zipursky, M. Matsudaira and J. Darnell. (2010). Molecular Cell Biology, III Edition, Scientific American & W. H. Freeman. New York.
8. Powar C B. (2019): Cell Biology, III Edition, Himalaya Publication, Meerut

MAJOR-4: Biochemistry: Fundamentals (Paper Code: UZOOMAJ23004)**Paper Type: Theory + Practical Lab Based [TH+PLB]****Credit: 4 (Theory 3+ Practical 1)****Class Hours: 75 hrs (Theory 45 hrs. + Practical 30 hrs.)****Full Marks: 75 (Theory 40 + Practical 20 + Continuous evaluation 10 + Attendance 05)****Duration of end semester examination: (Theory 2 hrs. + Practical 2 hrs.)****Syllabus:**

Biochemistry: Fundamentals [3 Credits, 45 hrs]	
Theory	Class hour(s)
Unit I: Foundation of Biochemistry	06
Chemical basis of life:	
<ul style="list-style-type: none"> • Carbon in Biomolecules • Important functional Groups (Alcohol, Ketone, Aldehyde, Carboxylate, Ester, Ether, Amide, Amine) • Important chemical bonds (Covalent, Ionic, Hydrogen, Hydrophobic interaction and van der Waals force) 	
Unit II: Carbohydrates	08
Structure and significance:	
<ul style="list-style-type: none"> • Monosaccharides – structure of aldoses and ketoses sugars, ring structure of sugars, mutarotation, anomers, epimers and enantiomers • Disaccharides – reducing and non-reducing disaccharides, • Polysaccharides – homo- and heteropolysaccharides, structural and storage polysaccharides. 	
Unit III: Lipids	10
Structure and significance:	
<ul style="list-style-type: none"> • Building blocks of lipids - fatty acids. • Storage lipids - triacyl glycerol and waxes. • Structural lipids in membranes – glycerophospholipids, sphingolipids, glycolipids, and sterols, • Lipids as signals, cofactors and pigments 	
Unit IV: Proteins	09
Amino acids:	
<ul style="list-style-type: none"> • Basic structure • Classification of standard amino acids based on R groups. 	
Proteins:	
<ul style="list-style-type: none"> • Levels of organization: primary, secondary, tertiary and quaternary, Ramachandran plot. 	
Unit V: Nucleic Acids	08
Structure and significance:	
<ul style="list-style-type: none"> • Purines and pyrimidines, Nucleosides, Nucleotides, Nucleic acids. • Types of DNA and RNA, • Complementarity of DNA, 	

- Hypo- and Hyperchromaticity of DNA.

Unit VI: Enzymes

04

Types and functions:

- Classification of enzymes based on enzyme activity
- Coenzymes, Cofactors, Isozymes, Allosteric enzymes, Ribozyme,

PRACTICAL: Biochemistry-Fundamentals [1 Credits, 30 Hours]

- Qualitative tests of functional groups in carbohydrates (Molisch's Test, Iodine test, Fehling's Test/Benedict's Test, Barfoed's Test, Seliwanoff's Test)
- Qualitative tests of functional groups in proteins (Biuret test, Millon's test)
- Qualitative tests of functional groups in lipids (Saponification).
- Paper chromatography/TLC of amino acids.
- Demonstration of proteins separation by SDS-PAGE

Evaluation Structure for end semester practical examination:

1. Qualitative study of Carbohydrate/Protein/Lipid (**8 marks**): Table showing principle, procedure, observation and inference (3 marks), Workout (4 marks), Result and inference (1 mark).
2. Paper chromatography/ Thin Layer Chromatography (**8 marks**): Principle (2 marks), Workout (Sample charging, Placing the paper in the chamber, ninhydrin spraying, development of spot) (3 marks), Rf Calculation (2 marks), Identification of analyte (1 mark) [Amino acids to be given (mixture of any two) – Valine, Leucine, Arginine and Lysine]
3. Laboratory Note Book (**2 marks**): (Based on the neatness, inclusiveness, overall presentation and regularity).
4. Viva-voce (**2 marks**): (Testing of Knowledge in the said Course)

Suggested Readings:

1. Nelson, D.L., Cox, M.M. (2017). Lehninger: Principles of Biochemistry (7th ed.). New York, WH: Freeman Company.
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. Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R. (2008). Molecular Biology of the Gene, VI Edition, Cold Spring Harbor Lab. Press, Pearson Pub.

MAJOR 5: Ecology (Paper Code: UZOOMAJ23005)**Credit: 4 (Theory 3+ Practical 1)****Class Hours: 75 hrs. (Theory 45 hrs.+ Practical 30 hrs.)****Full Marks: 75 (Theory 40 + Practical 20 + Continuous evaluation 10 + Attendance 05)****Duration of end semester examination: (Theory 2 hrs. + Practical 2 hrs.)****Syllabus:**

Theory	Class Hour(s)
Unit 1: Introduction to Ecology	04
<ul style="list-style-type: none"> • Autecology and synecology. • Levels of organization. • Laws of limiting factors, Study of Physical factors (light, precipitation, temperature). 	
Unit II: Population	15
<ul style="list-style-type: none"> • Unique and group attributes of population: Demographic factors, life tables, fecundity tables (definitions), survivorship curves, dispersal, and dispersion. • Exponential and logistic growth, r and k strategies, Population regulation - density-dependent and independent factors. • Population Interactions: commensalism, ammensalism, mutualism, predation, competition, and parasitism. • Gause's Principle, Lotka-Volterra equation for competition. 	
Unit III: Community	09
<ul style="list-style-type: none"> • Community characteristics: species diversity, abundance, dominance, richness. • Vertical stratification, Ecotone, and edge effect. • Ecological succession (in reference to hydrosere). 	
Unit IV: Ecosystem	12
<ul style="list-style-type: none"> • Ecosystem structure and function: Types of Ecosystem (Pond, Grassland & Forest Ecosystem) • Food chain: Grazing and detritus food chains, Linear and Y-shaped food chains, Foodweb. • Energy flow through the ecosystem, Ecological pyramids • Nutrient and biogeochemical cycle with an example of Nitrogen cycle 	
Unit V: Biomes	05
<ul style="list-style-type: none"> • Factors that Make a Biome and Biomes classification • Types and characteristics of biomes (Tropical Rainforest, Temperate Forest, Taiga, Tundra, Savannah, Desert, Freshwater, Marine) • Significance of Biomes 	

Practical	30 Hours
<ul style="list-style-type: none"> ❖ Determination of population density in a natural/hypothetical community by quadrat method and calculation of Shannon-Weiner diversity index for the same community. ❖ Study of an aquatic ecosystem: <ul style="list-style-type: none"> • Population density of zooplankton (by Sedgewick Rafter scale) • Estimation of Dissolved Oxygen content (Winkler's method). • Estimation of Total Alkalinity. • Estimation of Free CO₂. 	

Evaluation Structure for end semester practical examination:

1. Calculation of the Shannon-Wiener Diversity Index from the provided data **(6 Marks)**: Principle (1Mark), Calculation (4 Marks), Inference (1 Mark).

OR

Calculation of population density of zooplankton **(6 Marks)**: Principle (1 Mark), Calculation (4 Marks), Inference (1 Mark).

2. Estimation of Dissolved Oxygen/Free CO₂/Alkalinity **(10 Marks)**: Principle (2 Marks), Workout (4 Marks), Calculation (3 Marks), Comment (1 Mark).
3. Laboratory Note Book **(2 marks)**: (Based on the neatness, inclusiveness, overall presentation and regularity).
4. Viva-voce **(2 marks)**: (Testing of knowledge in the said Course)

Suggested Reference Books

1. Stilling, P. (2001): Ecology: Theories & Application. 4th Edition
2. Odum, E.P. (2008): Fundamentals of Ecology. Indian Edition. Brooks/Cole
3. Smith, T. M., and Smith R. L. (2016): Elements of Ecology. 8th Ed. Pearson Education.
4. Begon, M., Harper J. L. and Townsend, C. R. (2006): Ecology: Individuals, Populations & communities. 4th Ed. Blackwell Publishing Ltd.
5. Ricklefs, R. E. and Miller, G. L. (2000): Ecology. 4th Ed. W. H. Freeman & Company.
6. Sinclair, A. R. E., Fryxell, J. M. and Caughley, G. (2006): Wildlife Ecology, Conservation, and Management. 2nd Edition. Blackwell Publishing Ltd
7. Krebs, C. J. (2016): Ecology: The Experimental Analysis of Distribution and Abundance. 6th Ed. Pearson India Education Ltd.
8. Sutherland, W. J. (2000): The Conservation Handbook: Research, Management & Policy. Blackwell Publishing Ltd.
9. Sodhi, N.S. and Ehlich, P. R. (2010): Conservation Biology for All. Oxford University Press.
10. Cunningham, W. P. and Cunningham, M. A. (2008): Environmental Science- A Global Concern. McGraw-Hill.
11. Darlington, Philip J Jr. (1966) Zoogeography: The geographical distribution of animals. John Wiley

SEC 3: Pest Management and Medical Diagnostics (Paper Code: UZ00SEC23003)**Paper Type: Theory + Practical Lab Based [TH+PLB]****Credit: 3 (Theory 2+ Practical 1)****Class Hours: 60 hrs. (Theory 30 hrs. + Practical 30 hrs.)****Full Marks: 75 (Theory 40 + Practical 20 + Continuous evaluation 10 + Attendance 05)****Duration of end semester examination: (Theory 2 hrs. + Practical 2 hrs.)****Syllabus**

Theory	Class Hour(s)
A. Pest Management	
Unit I: Introduction	02
<ul style="list-style-type: none"> Economic classification of different pests Nature of damages. 	
Unit II: Types of Common Pests	03
<ul style="list-style-type: none"> Structure-infesting pests: Identification and management. Invading pests: Identification and management. Rodents and other vertebrate pests: Identification and management. 	
Unit III: Pest infestation detection	02
<ul style="list-style-type: none"> Types of detection: Physical, Chemical, and Mechanical techniques. 	
Unit IV: Types and Basic Concept of Pest Control Techniques	03
<ul style="list-style-type: none"> Biological pest control. Mechanical pest control. Chemical pest control. 	
Unit V: Methods of Pest Control	05
<ul style="list-style-type: none"> Pesticides: Preparing formulations, application techniques, health and environmental concerns, and safety protocols. Common Techniques: Traps, Chemical repellents, Poisoned bait, Fumigation, Bio-pesticides, Electric fencing. Integrated Pest Management (IPM) 	
B. Medical Diagnostics	
Unit I: Introduction to Medical Diagnostics	01
<ul style="list-style-type: none"> Introduction to Medical Diagnostics and its importance. 	
Unit II: Blood - Composition and Function	03
<ul style="list-style-type: none"> Blood cell types and their functions Blood plasma Basic concept of blood grouping Types of Anaemia 	
Unit III: Urine - Composition and Function	03
<ul style="list-style-type: none"> Physical characteristics. Abnormal constituents in Urine. 	
Unit IV: Imaging Techniques	03
<ul style="list-style-type: none"> Medical imaging: Ultrasonography, X-ray of Bone fracture, PET, MRI, and CT scan (using reference photographs). 	
Unit V: Disorders	03
<ul style="list-style-type: none"> Diabetes (Type I and Type II): causes, symptoms, diagnosis and prevention. Thyroidism: types, causes, symptoms, diagnosis and prevention. Hypertension (Primary and secondary): Causes, symptoms, diagnosis and prevention. 	
Unit VI: Infectious Diseases	02
<ul style="list-style-type: none"> Tuberculosis: Causes, symptoms, diagnosis and prevention. Hepatitis: Causes, symptoms, diagnosis and prevention. 	

Practical	30 Hours
<ul style="list-style-type: none"> ❖ Preparation of blood smear and Differential Leucocyte Count (D.L.C) using Leishman's stain ❖ ABO Blood grouping and RH factor. ❖ Haematin crystal observation ❖ Estimation of Haemoglobin by Sahli's method. ❖ Pest study (either from museum specimens or photographs) <ul style="list-style-type: none"> • Structural pests: Termites, Cockroach, Ants, Beetles, Silverfish • Invading pests: Houseflies, Mosquito, Wasps, Spider, Ticks, Mites, Bedbugs, Lice • Vertebrate pests: Rats, House Mice, Birds ❖ Study of damage symptoms: Termites, Ants, Lice, Beetles, Rodents, Birds, ❖ Study of pest detection equipment: Inspection Mirror, LED Flashlight, Infrared Temperature Sensor, Night Vision Cameras, Rodent Traps, Aspirator, pitfall trap. 	

Evaluation Structure for end semester practical examination:

1. Identification of specimen (Four) – Diagnostic characters – 1½ Marks, Identification – ½. Total Marks = 8 (2×4) Marks
2. Estimation of Hb by Sahil's method (Principle – 2, Workout – 5, Comment – 1) Total Marks = 8 Marks

OR

Observation and identification of ABO blood group (Principle – 2, Workout – 5, Comment – 1)
Total Marks = 8 Marks

OR

Counting of different leucocytes using Leishman's stain (Principle – 1, Workout – 4, Calculation – 2, Comment – 1) Total Marks = 8 Marks

3. Laboratory Note Book: 2 marks (Based on neatness, inclusiveness, overall presentation, and regularity).
4. Viva-Voce: 2 marks (Testing of Knowledge in the said Course)

Suggested Readings:

1. Carolyn Randall (Ed). 1998. General Pest Management A Guide for Commercial Applicators. Michigan State University Extension
2. Thalya, P.R. and Chandra, R. 2022. Essentials of Pest Management: Key Information on Pest Identification and its Management. Wings Publication. pp. 263.
3. Evans, J. W. 2006. Insect Pests and Their Control. Asiatic Publishing House. pp. 178.
4. Sridhara, S. 2016. Vertebrate Pests in Agriculture. Scientific Publishers. pp. 513.
5. Fischbach, F.T. and Dunning, M.B. (2015) A Manual of Laboratory and Diagnostic Tests. Lippincott Williams & Wilkins, Philadelphia.
6. Cheesbrough M., J. McArthur (1976). A Laboratory Manual for Rural Tropical Hospitals, A Basis for Training Courses, Churchill Livingstone ISBN: 9780443011443
7. Godkar P.B. and Godkar D.P. (2014). Textbook of Medical Laboratory Technology, 3rd Edition, Bhalani Publishing House
8. Prakash, G. (2012), Lab Manual on Blood Analysis and Medical Diagnostics, S. Chand and Co. Ltd.

Semester IV

MAJOR 6: Genetics (Paper Code: UZOOMAJ24006)

Paper Type: Theory + Practical Lab Based [TH+PLB]

Credit: 4 (Theory 3+ Practical 1)

Class Hours: 75 (Theory 45 hrs. + Practical 30 hrs.)

Full Marks: 75 (Theory 40+ Practical 20 +Continuous Evaluation 10 + Attendance 05)

Duration of end semester examination: (Theory 2 hrs. + Practical 2 hrs.)

Syllabus:

Theory	Class Hour(s)
Unit I: Elements of heredity and variation	05
<ul style="list-style-type: none"> • Mendel and his experiments • Principles of segregation and independent assortment and their chromosomal basis • Test cross • Application of laws of probability to Mendelian inheritance 	
Unit II: Extension of Mendelism	08
<ul style="list-style-type: none"> • Dominance relationships (Complete dominance, Incomplete dominance and Co-dominance) • Multiple Allelism (with reference to human blood group) • Lethal alleles • Pleiotropy • Epistasis (Dominant and recessive epistasis) • Penetrance and expressivity • Phenocopy • Polygenic inheritance • Sex-linked, sex-influenced, and sex-limited inheritance 	
Unit III: Cytoplasmic and infective inheritance	04
<ul style="list-style-type: none"> • Criteria for extrachromosomal inheritance, • Kappa particle in <i>Paramecium</i> • Shell spiralling in snail 	
Unit IV: Linkage	08
<ul style="list-style-type: none"> • Linkage and Crossing Over • Molecular mechanism of crossing over (Holliday model), • Measuring Recombination Frequency and Linkage intensity using three-factor crosses, • Interference and Coincidence 	
Unit V: Mutations	08
<ul style="list-style-type: none"> • Types of gene mutations (Classification), • Types of chromosomal aberrations (Classification with one suitable example of each), • Non-disjunction and variation in chromosome number; • Molecular basis of mutations in relation to UV light and chemical mutagens 	
Unit VI: Sex chromosomes and sex determination	04
<ul style="list-style-type: none"> • Sex chromosome systems: XX/XO, XX/XY, ZZ/ZW, and haploidy/diploidy types • Mechanisms of sex determination in <i>Drosophila</i> • Sex Determination in Human • Dosage Compensation in <i>Drosophila</i> & Human 	
Unit VII: Human Genetics	04
<ul style="list-style-type: none"> • Karyotype, banding, nomenclature of chromosome subdivisions, and genetic map • Genetic disorders: <ul style="list-style-type: none"> ➤ Chromosomal aneuploidy (Down, Turner, Klinefelter syndromes) ➤ Chromosome translocation (chronic myeloid leukemia) and deletion ("Cri-du-chat syndrome) 	
Unit VIII: Recombination in Bacteria and Viruses	04
<ul style="list-style-type: none"> • Conjugation • Transformation • Transduction 	

Practical	30 Hours
<ul style="list-style-type: none"> ❖ Application of probability in the law of segregation with coin tossing. ❖ Study of mode of inheritance of the following traits by pedigree charts. ❖ Study of human karyotypes and numerical alterations (Down syndrome, Edward syndrome, Patau Syndrome, Klinefelter syndrome, Turner syndrome). ❖ Study of structural chromosome aberrations (dicentric, ring chromosome, and inversion in polytene chromosomes) from prepared slides/ photographs. ❖ Familiarization with techniques of handling <i>Drosophila</i>, identifying males and females: observing wild type and mutant (white eye, wingless, miniature wing, bristle-less, etc.) flies and setting up cultures. ❖ Linkage maps based on conjugation ❖ Chi-square analysis (goodness of fit) 	

Evaluation Structure for end semester practical examination:

1. Pedigree analysis (genotyping of the individuals in the pedigree chart (3 marks), analysis (3 marks) and inference (1 marks). Total: 07 marks
2. Identification (one structural aberration, one numerical alteration, and one mutation of *Drosophila*) 3 x 3 marks (characters: 2 marks and identification: 1 mark) = 09 marks
3. Laboratory Note Book: 2 marks (Based on neatness, inclusiveness, overall presentation and regularity).
4. Viva-Voce: 2 marks (Testing of Knowledge in the said Course)

Suggested Readings

1. Simons, M.J., Principles of Genetics (1981)
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., Palladino M.A., Killian D. Concepts of Genetics. 11th edition (2019) Pearson
4. Russell, P. J. (2009). Genetics- A Molecular Approach.III Edition. Benjamin Cummings
5. Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. 28.
6. Klug, W.S., Concept of Genetics (2013)
7. Brooker, R., Genetics-Analysis and Principles, 7th edition
8. Jorde. L.B., Medical Genetics, 6th Edition (2020)
9. Gardner, J.E., Principles of genetics, 8th Edition (2015)

MAJOR 7: Ethology and Chronobiology (Paper Code: UZOOMAJ24007)**Credit: 4 (Theory 3+ Practical 1)****Class Hours: 75 hrs (Theory 45 hrs. + Practical 30 hrs.)****Full Marks: 75 (Theory 40 + Practical 20 + Continuous evaluation 10 + Attendance 05)****Duration of end semester examination: (Theory 2 hrs. + Practical 2 hrs.)****Syllabus:**

Theory	Class Hour(s)
Unit I: Introduction to Animal Behaviour	05
<ul style="list-style-type: none">• Basic concept of Ethology,• Brief contributions of Karl von Frish, Konrad Lorenz, Niko Tinbergen• Proximate and ultimate causes of behaviour• Significance of animal behaviour study	
Unit II: Patterns of Behaviour	12
<ul style="list-style-type: none">• Stereotyped behaviours (Orientation, Reflexes)• Concepts of Fixed Action Pattern (FAP); Sign stimulus; Innate releasing mechanism (IRM) and Action Specific Energy (ASE)• Instinct vs. Learnt behaviour• Associative learning, Classical and Operant conditioning, Pavlov's Experiment, Habituation, Imprinting.	
Unit III: Social and Sexual Behaviour	10
<ul style="list-style-type: none">• Social organization in animals (Lions, Monkeys): Eusociality, Co-operation• Altruism (Hamilton's Theory): Reciprocal altruism and Kin selection• Communication: Auditory, Visual, Chemical (Pheromones) and Tactile communication, Bee Dance Language• Sexual Behaviour: Asymmetry of sex, Sexual dimorphism, Mate choice, Intra-sexual selection (malerivalry), Inter-sexual selection (female choice), Sexual conflict in parental care.	
Unit IV: Introduction to Chronobiology	08
<ul style="list-style-type: none">• Basic concept of chronobiology• Biological oscillation: the concept of average, amplitude, phase and period• Adaptive significance of biological clocks	
Unit V: Biological Rhythm	10
<ul style="list-style-type: none">• 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• Photoperiod and regulation of seasonal reproduction of vertebrates; Role of melatonin.	

Practical	30 Hours
<ul style="list-style-type: none"> • Study of geotaxis behaviour in soil arthropod. • Study of phototaxis behaviour in soil arthropod/insect larvae. • Study of aggressive behaviour of fish (Fighter fish / Lata fish). • Study of learning behaviour of rat (T-maze) • Study of any particular animal behaviour and prepare a report supported by geotagged photographs on that behaviour, in wild or in captivity, emphasizing on the importance of that particular behaviour. 	

Evaluation Structure for end semester practical examination:

1. Study of aggressive behaviour of fish (**8 marks**): Principle (2 marks), Observation and recording of behaviour (4 marks), Inference (2 marks)

OR

Study of learning behaviour of rat (**8 marks**): Principle (2 marks), Observation and recording of behaviour (4 marks), Inference (2 marks)

2. Study of geotaxis/phototaxis behaviour in soil arthropod/insect larvae (**4 marks**): Principle (2 marks), Notes on Observation (2 marks)
3. Submission of field report (**4 marks**)
4. Laboratory Note Book (**2 marks**): (Based on neatness, inclusiveness, overall presentation, and regularity).
5. Viva-voce (**2 marks**): (Testing of Knowledge in the said Course)

Suggested Reference Books
1. Alcock, J. (2009): Animal Behaviour: An evolutionary approach. 9 th Ed. Sinauer Associate Inc., USA
2. Drickamer, L.C., Vessey, S.H. and Jacob, E. (2002): Animal Behaviour. 5th ed. McGraw Hill
3. Sherman, P. W. and Alcock, J. Exploring Animal Behaviour, Sinauer Associate Inc., Massachusetts, USA.
4. Mathur, R. (2023). Animal Behaviour. 6 th Ed. Rastogi Publications.
5. Manning & Dawkins (1998): An Introduction to Animal Behaviour .5th ed. Cambridge.
6. Dunlap, J.C., Loros, J.J. DeCoursey , P. J.(eds). (2004): Chronobiology Biological Timekeeping. Sinauer Associates, Inc. Publishers, Sunderland, MA, USA
7. Saunders, D.S.(2002). Insect Clocks. C.G.H. Stee, X.,Vafopoulou, R.D. Lewis (eds.). 3 rd Ed. Baren and Noble Inc. New York, USA
8. Kumar, V. (2002) Biological Rhythms: Narosa Publishing House, Delhi/ Springer-Verlag,Germany.

MAJOR 8: Environment and Public Health (Paper Code: UZOOMAJ24008)

Paper Type: Theory + Practical Lab Based [TH+PLB]

Credit: 4 (Theory 3+ Practical 1)

Class Hours: 75 hrs (Theory 45 hrs. + Practical 30 hrs.)

Full Marks: 75 (Theory 40 + Practical 20 + Continuous evaluation 10 + Attendance 05)

Duration of end semester examination: (Theory 2 hrs. + Practical 2 hrs.)

Syllabus:

Environment and Public Health [3 Credits, 45 hrs]	
Theory	Class hour(s)
Unit I: Introduction	03
<ul style="list-style-type: none">• Sources of Environmental hazards,• Hazard identification and accounting,• Fate of toxic and persistent substances in the environment,• Biomagnification.	
Unit II: Climate Change	08
<ul style="list-style-type: none">• Greenhouse gases and global warming,• Acid rain,• Ozone layer destruction,• Effect of climate change on public health	
Unit III: Pollution	10
<ul style="list-style-type: none">• Sources, effects and control of air, water, noise pollution	
Unit IV: Waste Management Technologies	12
<ul style="list-style-type: none">• Sources, types and characteristics of waste,• Sewage disposal and its management,• Solid waste disposal,• Biomedical waste handling and disposal,• Nuclear waste handling and disposal,• Waste from thermal power plant	
Unit V: Diseases	12
<ul style="list-style-type: none">• Causes, symptoms and control of tuberculosis, Asthma, Cholera, Minamata disease, typhoid, filariasis	

PRACTICAL: Environment and Public Health [1 Credits, 30 Hours]

- Determination of pH in water and soil
- Determination of turbidity of water body
- Estimation of Cl, Hardness in water samples from different locations
- Counting of dust particle in ambient air medium.
- Visit to Auto/vehicle (Emission) pollution testing centre and submission of a report.

Evaluation Structure for end semester practical examination:

1. Determine the pH of water / soil **(4 marks)**: Principle (1 Mark), Workout (2 marks), comment (1 mark).

Or

Determine the turbidity of water body **(4 marks)**: Principle (1 Mark), Workout (2 marks), comment (1 mark).

Or

Calculate the dust particle in the ambient air and write its significance **(4 marks)**: Workout (3 marks), comment (1 mark).

2. Estimation of Cl/Hardness **(8 Marks)**: Principle (1 Marks), Workout (4 Marks), Calculation (2 Marks), Comment (1 Mark).

3. Submission of report **(4 marks)**

4. Laboratory Note Book **(2 marks)**: (Based on the neatness, inclusiveness, overall presentation and regularity).

5. Viva-voce **(2 marks)**: (Testing of knowledge in the said Course)

Suggested Readings:

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.

UNIVERSITY OF NORTH BENGAL

Accredited by NAAC with grade "B++"

B.Sc. Zoology FOUR YEAR UNDERGRADUATE PROGRAM
(FYUGP)
w.e.f. 2023-2024

Course Curriculum for B.Sc. Zoology (Minor)

Under
THE NEW CURRICULUM AND CREDIT FRAMEWORK, 2022



समानो मन्त्रः समितिः समानी

B.Sc. Zoology Minor

UNIVERSITY OF NORTH BENGAL
RAJA RAMMOHANPUR, DARJEELING
WEST BENGAL
PIN-734013

FYUGP COURSE STRUCTURE OF ZOOLOGY (MINOR)

Semester	Major Courses (Credit)	Skill Enhancement Courses (Credit)	Minor Courses (Credit) #	Inter-disciplinary Courses (Credit)	Ability Enhancement Compulsory Courses (Credit)	Value Added Courses (Credit)	Semester-wise Credit
I	MAJ-1 (4)	SEC-1 Sericulture and Apiculture (3)	MIN-(A)-1 Animal Diversity (4)	MDC-1 (3) (Any-one from the list provided by the college)	AECC- MIL/ ALT. ENG.-1 (2)	VAC- Understanding India/Digital Marketing (4)	20
II	MAJ-2 (4)	SEC-2 Aquaculture & Fisheries and Poultry Farming (3)	MIN-(B)-1 Animal Diversity (4)	MDC-2 (3) (Any-one from the list provided by the college)	AECC-ENG.-1(2)	VAC- Environmental Education (4)	20
III	MAJ-3 (4)	SEC-3 Pest Management and Medical Diagnostics (3)	MIN-A-2 Cell Biology and Genetics(4)		AECC- MIL/ ALT. ENG.-2 (2)		21
	MAJ-4 (4)						
	MAJ-5 (4)						
IV	MAJ-6 (4)		MIN-B-2 Cell Biology and Genetics (4)	MDC-3 (3) (Any-one from the list provided by the college)	AECC-ENG.-2(2)		21
	MAJ-7 (4)						
	MAJ-8 (4)						
V	MAJ-9 (4)	Internship (2)	MIN-A-3 Molecular Biology and Physiology (4)				22
	MAJ-10 (4)						
	MAJ-11 (4)						
	MAJ-12 (4)						
VI	MAJ-13 (4)		MIN-B-3 Molecular Biology and Physiology (4)				20
	MAJ-14 (4)						
	MAJ-15 (4)						
	MAJ-16 (4)						
VII	MAJ-17 (4)		MIN-A-4 Economic Zoology(4)				16
	MAJ-18 (4)						
	MAJ-19 (4)						
VIII	MAJ-20 (4)		MIN-B-4 Economic Zoology(4)				20
	MAJ-21 (4)						
	MAJ- 22 (4)						
	MAJ-23 (4)						
	Research Project/Dissertation (12)						

Students have to opt for any two minor subjects as Minor A and Minor B, hence in a particular academic year students will complete a course offered in Zoology minor either in the even or the odd semester.

Semester I / Semester II

MINOR (A/B) 1: Animal Diversity (Paper Code: UZOOMIN11001 / UZOOMIN12001)
Paper Type: Theory + Practical Lab Based [TH+PLB] Credit: 4 (Theory 3+ Practical 1)

Class Hours: 75 (Theory 45 hrs. + Practical 30 hrs.)

Full Marks: 75 (Theory 40 + Practical 20 + Continuous evaluation 10 + Attendance 05)

Duration of end semester examination: (Theory 2 hrs. + Practical 2 hrs.)

Syllabus:

Theory	Class Hour(s)
A. Non-Chordates	
Unit I: Protista	04
<ul style="list-style-type: none">• General characters and classification up to phyla.• Locomotory organelles in Protozoa (structure only).• Life cycle of <i>Plasmodium vivax</i>.	
Unit II: Porifera	02
<ul style="list-style-type: none">• General characters and classification up to classes.• Canal system in <i>Sycon</i>.	
Unit III: Cnidaria and Ctenophora	03
<ul style="list-style-type: none">• General characters and classification up to classes of Phylum Cnidaria.• General characters of Phylum Ctenophora.• Polymorphism in <i>Obelia</i>.	
Unit IV: Platyhelminthes and Nematoda	05
<ul style="list-style-type: none">• General characters and classification up to classes.• Life cycle of <i>Taenia solium</i>.• Life cycle of <i>Ascaris lumbricoides</i>.	
Unit V: Annelida	03
<ul style="list-style-type: none">• General characters and classification up to classes.• Coelom and metamerism in Annelida.	
Unit VI: Arthropoda	04
<ul style="list-style-type: none">• General characters and classification up to classes.• Metamorphosis in lepidopteran insects.	
Unit VII: Mollusca	03
<ul style="list-style-type: none">• General characters and classification up to classes.• Pearl culture.	
Unit VIII: Echinodermata	03
<ul style="list-style-type: none">• General characters and classification up to classes.• Water vascular system in <i>Asterias</i>.	
Unit IX: Hemichordata	01
<ul style="list-style-type: none">• Salient features.	

B. Chordates	
Unit I: Protochordata	01
<ul style="list-style-type: none"> • Salient features of Urochordata and Cephalochordata. 	
Unit II: Chordata	01
<ul style="list-style-type: none"> • Salient features. 	
Unit III: Pisces	03
<ul style="list-style-type: none"> • General characters and classification up to classes. • Migration of fish. 	
Unit IV: Amphibia	03
<ul style="list-style-type: none"> • General characters and classification up to extant orders. • Parental care in Amphibia. 	
Unit V: Reptilia	03
<ul style="list-style-type: none"> • General characters and classification up to extant orders. • Differences between poisonous and non-poisonous snakes. 	
Unit VI: Aves	03
<ul style="list-style-type: none"> • General characters and classification up to sub-classes. • Flight adaptation in birds. 	
Unit VII: Mammals	03
<ul style="list-style-type: none"> • General characters and classification up to infra-classes. • Adaptive radiation in mammals. 	

Note: Outline classification of the Kingdom Protista up to Phyla to be followed from Levine et al. (1980) and that of other non-chordate Phyla up to classes to be followed from "Ruppert, Fox and Barnes (2003). Invertebrate Zoology: A Functional Evolutionary Approach". VII Edition or from Brusca, R.C and Brusca, G. J (2003): Invertebrate (2nd ed.) Sinauer Associates Inc., Publishers Sunderland. Classification of Pisces to be followed from Romer (1959)/ Berg (1940), for Amphibia to be followed from Duellman & Trueb (1986)/ Young (1981), for Reptilia, Aves & Mammals to be followed from Young (1981).

Practical	30 Hours
<ul style="list-style-type: none"> ❖ Spot identification: <ul style="list-style-type: none"> • Non-Chordates: <i>Euglena</i>, <i>Paramecium</i>, <i>Sycon</i>, <i>Physalia</i>, <i>Metridium</i>, <i>Taenia</i>, <i>Ascaris</i>, <i>Nereis</i>, leech, <i>Peripatus</i>, <i>Limulus</i>, hermit crab, <i>Daphnia</i>, millipede, centipede, cockroach, <i>Chiton</i>, <i>Octopus</i>, starfish and <i>Balanoglossus</i>. • Chordates: <i>Ascidia</i>, <i>Herdmania</i>, <i>Branchiostoma</i>, <i>Scoliodon</i>, <i>Labeo</i>, <i>Hippocampus</i>, <i>Tylotriton</i>, <i>Draco</i>, <i>Naja</i>, <i>Viper</i>, any three common birds (crow, duck, owl), squirrel and bat. ❖ Temporary mounts of: <ul style="list-style-type: none"> • <i>Cyclops</i>, <i>Daphnia</i>, <i>Mysis</i>. • Unstained mounts of cycloid and ctenoid scales. ❖ Submission of a report on the prevalence of insect or avian fauna in the college campus/your locality. 	

Note: In case of unavailability of preserved specimens/slides, departments can use photographs for the study of museum specimens and permanent slides.

Evaluation Structure for end semester practical examination:

1. Spot identification: 4 specimens (2 non chordates and 2 chordates)/each 2 marks
(Identification = ½, Systematic position (as per theory syllabus)= ½, Characters = 1) Total = 8 marks
2. Mounting: Any one (2 marks)
3. Submission of project: 6 marks
4. Laboratory Note Book: 2 marks (Based on the neatness, inclusiveness, overall presentation and regularity)
5. Viva-Voce: 2 marks (Testing of Knowledge in the said Course)

Suggested Readings

1. Barnes, R.S.K., Calow, P.P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2009). The Invertebrates: A Synthesis. III Edition, John Wiley & Sons.
2. Berg, L.S. (1940). Classification of fishes both recent and fossil. Trudy Zoologicheskogo Instituta. 5:85-517.
3. Brusca, R.C. and Brusca, G.J. (2003). Invertebrate. II Edition, Sinauer Associates Inc., Sunderland.
4. Duellman, W.E. and Trueb, L. (1986). Biology of Amphibians. Mc. Graw Hill Books Company.
5. Kardong, K.V. (2002). Vertebrates: Comparative Anatomy, Function, Evolution. III Edition, McGraw-Hill.
6. Levine, N. D., J. O. Corliss, F. E.G. Cox, G. Deroux, J. Grain, B. M. Honigberg, G. F. Leedale, et al. 1980. "A Newly Revised Classification of the Protozoa." *The Journal of Protozoology*. 27 (1): 37-58.
7. Parker, T.J. and Haswell, W.A. (1972). A text book of Zoology, Vol-I & II. VII edition, Marshall and Williams (eds.), Mcmillan Press ltd.
8. Pechenik, J.A. (2015). Biology of the Invertebrates. VII Edition, McGraw-Hill Education.
9. Romer, A.S. (1959). The Vertebrate Story. University of Chicago Press.
10. Ruppert, E.E., Fox, R.S., Barnes, R.D. (2003). Invertebrate Zoology: A Functional Evolutionary Approach. VII Edition, Cengage Learning, India.
11. Young, J. Z. (1981). The Life of Vertebrates. III Edition, ELBS, Oxford.
12. Young, J.Z. (2004). The Life of Vertebrates. III Edition (Indian Edition), Oxford University press.

Semester III / Semester IV

MINOR-(A/B) 2: Cell Biology and Genetics (Paper Code: UZOOMIN23002 / UZOOMIN24002)

Paper Type: Theory + Practical Lab Based [TH+PLB]

Credit: 4 (Theory 3+ Practical 1)

Class Hours: 75 hrs. (Theory 45 hrs. + Practical 30 hrs.)

Full Marks: 75 (Theory 40 + Practical 20 + Continuous evaluation 10 + Attendance 05)

Duration of end semester examination: (Theory 2 hrs. + Practical 2 hrs.)

Syllabus:

Theory	Class Hour(s)
A. Cell Biology	
Unit I: Plasma membrane	02
<ul style="list-style-type: none"> • Structure of plasma membrane: Fluid mosaic model. • Transport across the membrane: Active and Passive transport (Brief idea with examples). 	
Unit II: Nucleus	03
<ul style="list-style-type: none"> • Structure and function. • Types of chromatins. 	
Unit III: Cell organelles	08
<ul style="list-style-type: none"> • Mitochondria: Structural organization and function. • Endoplasmic Reticulum: Structure and function of RER and SER. • Golgi Apparatus: Organization and function. • Centrosome: Organization and function. 	
Unit IV: Cell Division	05
<ul style="list-style-type: none"> • Cell cycle: Phases. • Mitosis: Process and significance. • Meiosis: Process and significance. 	
Unit V: Cell Signaling	05
<ul style="list-style-type: none"> • Basic concept of cell signaling • G-protein cell signaling mediated by glucagon 	
B. Genetics	
Unit I: Elements of heredity and variation	03
<ul style="list-style-type: none"> • Mendel and his experiments • Principles of segregation and independent assortment • Test cross 	
Unit II: Extension of Mendelism:	05
<ul style="list-style-type: none"> • Incomplete dominance and Co-dominance • Multiple Allelism (with reference to human blood group) • Sex-linked, sex-influenced and sex-limited inheritance 	
Unit III: Cytoplasmic inheritance	03
<ul style="list-style-type: none"> • Criteria for extra chromosomal inheritance, • Kappa particle in <i>Paramecium</i> 	
Unit IV: Linkage	03
<ul style="list-style-type: none"> • Linkage and Crossing Over • Molecular mechanism of crossing over (Holliday model), 	
Unit V: Mutation	05
<ul style="list-style-type: none"> • Types of gene mutations (Classification) • Types of chromosomal aberrations (Classification with one suitable example of each) 	
Unit VI: Sex determination	03
<ul style="list-style-type: none"> • Mechanisms of sex determination in <i>Drosophila</i> (Genic Balance Theory) • Sex determination in Human 	

Practical	30 Hours
<ul style="list-style-type: none"> • Study of microscope: Simple and Compound. • Study of cell: Preparation of temporary mount of human buccal epithelial cells. • Study of different stages of meiosis by permanent slide • Identification of chromosomal aberration of humans using prepared karyotype (Down Syndrome, Edward Syndrome, Patau Syndrome, Cri-du-chat syndrome, Turner syndrome, Klinefelter syndrome) • Chi-square test (Goodness of fit) 	

Evaluation Structure for end semester practical examination:

1. Spot identification: 3 stages of meiosis (3 x 2 = 6 marks)
2. Identification of one chromosomal aberration with reason using prepared karyotype (photograph): 3 marks
3. Problem on chi-square test: 7 marks
4. Laboratory Note Book: 2 marks (Based on neatness, inclusiveness, overall presentation, and regularity)
5. Viva-Voce: 2 marks (Testing of Knowledge in the said Course)

Suggested Readings
<ol style="list-style-type: none"> 1. Karp, G. (2009). Cell and Molecular Biology: Concepts and Experiments. VI Edition John Wiley and Sons. Inc. 2. 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. 3. Powar C B. (2019): Cell Biology, III Edition, Himalaya Publication, Meerut 4. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons, Inc. 5. Klug, W.S., Cummings, M.R., Spencer, C.A., Palladino M.A., Killian D. Concepts of Genetics. 11th edition (2019) Pearson 6. Russell, P. J. (2009). Genetics- A Molecular Approach. III Edition. Benjamin Cummings 7. Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. 28. 8. Gardner, J.E., Principles of genetics, 8th Edition (2015)