RAJA NARENDRALAL KHAN WOMEN'S COLLEGE (AUTONOMOUS)

MIDNAPORE-721102, WEST BENGAL, INDIA

Faculty of Science

Department of Zoology

The Syllabus for the UNDERGRADUATE Programme

in

Zoology

Under NEP 2020

w.e.f. 2023-2024

PROGRMME OUTCOME

Upon completion of B.Sc. Zoology Honours or Honours with Research Programme, the graduates will be able to -

1. Know the fundamental principles in Zoology. Recognize the relationships between structure and functions of biological organization in animals.
2. Analyse the principles, classification, form, and function of animal evolution, and to compare the structure of Prokaryotes and Eukaryotes.
3. Understand the animal diversity which includes animal classification with taxonomy and their diagnostic characteristics.
4. Apply knowledge and understanding the protection and restoration of biological diversity, ecological integrity, and health. Understand a range of conservation management.
5. Understand the evolutionary history and main characteristics of the animal groups.
6. Comprehend and critical analysis of population processes, dynamics and interactions, and associated models.
7. Comprehension of the structure, biogeography, and diversity of ecosystems in relation to climate, geology, soils, paleo-historical and evolutionary factors.
8. Understand the applied biological sciences such as Sericulture, Aquaculture and Apiculture.
9. Collect, record, and analyze data using appropriate ecological, genetic, and physiological techniques in the field and laboratory.
10. Use information technology systems effectively to analyze and interpret data, and the evidence for research.
11. Develop the writing skills required in the programme which includes publishing research articles, oral and poster presentations at conferences.
12. Explain the molecular and cellular basis of physiological functions in animals.
13. Provide innovative skills which will enable to develop the knowledge and skills required for employment such as biochemistry, microbiology, aquaculture, apiculture, and biotechnology on the level of the gene, genome, and their functions.
14. Perform practical skills in the areas of developmental biology, biochemistry, cell and molecular biology, genetics, immunology, and microbiology.

UG ZOOLOGY (MAJOR) SYLLABUS

Sem	Code	Title of the Paper	Credit	Allot. Class		Marks
				Th.	Prc.	
	ZOOMJ101	NON-CHORDATES	4	3	1	75
I	ZOOSEC101	APICULTURE	3	2	1	50
	ZOOMJ201	ECOLOGY	4	3	1	75
II	ZOOSEC201	SERICULTURE	3	2	1	50
	ZOOMJ301	SYSTEMATICS & TAXONOMY	4	3	1	75
	ZOOMJ302	CHORDATES	4	3	1	75
III	ZOOSEC301	AQUARIUM FISH MANAGEMENT	3	2	1	50
	ZOOMJ401	COMPARATIVE ANATOMY	4	3	1	75
	ZOOMJ402	ANIMAL PHYSIOLOGY	4	3	1	75
IV	ZOOMJ403	PARASITOLOGY **OR** APPLIED ENTOMOLOGY AND NEMATOLOGY	4	3	1	75
	ZOOMJ501	CELL BIOLOGY	4	3	1	75
	ZOOMJ502	MOLECULAR BIOLOGY	4	3	1	75
	ZOOMJ503	BIOCHEMISTRY	4	3	1	75
V	ZOOMJ504	ENDOCRINOLOGY	4	3	1	75
	ZOOMJ601	GENETICS	4	3	1	75
	ZOOMJ602	IMMUNOLOGY	4	3	1	75
	ZOOMJ603	DEVELOPMENTAL BIOLOGY	4	3	1	75
VI	ZOOMJ604	EVOLUTION	4	3	1	75
	ZOOMJ701	ANIMAL BEHAVIOUR	4	3	1	75
	ZOOMJ702	**C**OMPUTATIONAL BIOLOGY	4	3	1	75
	ZOOMJ703	BIOPHYSICS	4	3	1	75
VII	ZOOMJ704	MICROBIOLOGY	4	3	1	75
	ZOOMJ801	METHODS IN BIOLOGY	4	3	1	75
	ZOOMJ802	BIOTECHNOLOGY	4	3	1	75
VIII		**RESEARCH PROJECT** **Or** **DSE-I** **DSE-II** **DSE-III**	12 or (4×3)			225 or 75×3

UG ZOOLOGY (SEC) SYLLABUS

Sem	Code	Title of the Paper	Credit	Allot. Class		Marks
				Th.	Prc.	
I	ZOOSEC101	SEC01T: APICULTURE	3	2	1	50
II	ZOOSEC201	SEC02T: SERICULTURE	3	2	1	50
III	ZOOSEC301	SEC03T: AQUARIUM FISH MANAGEMENT	3	2	1	50

UG ZOOLOGY MINOR SYLLABUS

Sem	Code	Title of the Paper	Credit	Allot. Class		Marks
				Th.	Prc.	
I	ZOOMI101 (1A)	NON-CHORDATE	4	3	1	75
II	ZOOMI201 (2A)	NON-CHORDATE	4	3	1	75
III	ZOOMI301 (1B)	ECOLOGY	4	3	1	75
IV	ZOOMI401 (2B)	ECOLOGY	4	3	1	75
V	ZOOMI501 (1C)	PARASITOLOGY	4	3	1	75
VI	ZOOMI601 (2C)	PARASITOLOGY	4	3	1	75
VII	ZOOMI701 (1D)	ANIMAL BEHAVIOUR	4	3	1	75
VIII	ZOOMI801 (2D)	ANIMAL BEHAVIOUR	4	3	1	75

UG ZOOLOGY IDC/MDC

Sem	Code	Title of the Paper	Credit	Marks
I	IDC-I	ENVIRONMENTAL STUDIES (ENVS)	3	50
II	IDC-II	CLIMATE CHANGE & DIASTER MANAGEMENT (CCDM)	3	50
III	IDC-III	DIGITAL FLUENCY AND ARTIFICIAL INTELLIGENCE (DF & AI)	3	50

UG ZOOLOGY VAC

Sem	Code	Title of the Paper	Credit	Marks
I	VAC-III	UNDERSTANDING INDIA	2	50
	VAC-IV	INDIAN CONSTITUTION & ETHICS	2	50
II	VAC-I	PHYSICAL FITNESS & SOCIAL AWARENESS	2	50
	VAC-II	MENTAL HEALTH & WELLBEING	2	50

UG ZOOLOGY AEC

Sem	Code	Title of the Paper	Credit	Marks
I	AEC-I	ENG-I	2	50
II	AEC-II	BNG/HIN-I	2	50
III	AEC-III	BNG/HIN-II	2	50
IV	AEC-IV	ENG-II	2	50

RAJA NARENDRALAL KHAN WOMEN'S COLLEGE (AUTONOMOUS)

Semester-I
Course Structure

Sl. No.	Name of the Courses	No. of Papers	Credits	Full Marks
1	Major	01	04	75
2	Minor	01	04	75
3	IDC/MDC	01	03	50
4	AEC ENGLISH	01	02	50
5	SEC	01	03	50
6	VAC (Group-C)	02	04(02+02)	100(50+50)
Total		***07***	***20***	***400***

Raja N. L. Khan Women's College (Autonomous)

Curriculum for Undergraduate in Zoology

[NEP 2020]

Semester-I

Paper Code	Name of the Subject	Nature	Teaching Scheme in hour per week			Credit	Marks
			L	T	P		
ZOOMJ101	**MJ101T:** Non-Chordates-I	Major Course	3	0	0	4	75
	MJ101P: Non-Chordates-I (Practical)	Major Course	0	0	1		
ZOOMI101	**MI101T:** Non-Chordates	Minor Course	3	0	0	4	75
	M101P: Non-Chordates (Practical)	Minor Course [Practical]	0	0	1		
ZOOSEC101	SEC101T: Apiculture	SEC	2	0	0	3	50
	SEC101P: Apiculture (Practical)	SEC (Practical)	0	0	1		

L=Lecture, T=Tutorial, P=Practical

Major 101: Non-Chordates **Credits 04**
Major 101T-Non-Chordates **Credits 03**

Course objectives and expected outcome

This course provides an introduction to the basics of animal classification. It covers various phylum (major and minor) under non-chordates as per the hierarchy. The students will learn about their properties, identifying characters, specialized organ-systems, diversity and the basic scheme of classification. Therefore, this fundamental course of classical Zoology will be helpful for the students to be inclined more into the beauty Animal Kingdom.

Course Contents:

Sl. No.	TOPICS	Allotted Lecture
1.	**Unit1: Basics of Animal Classification** • Definitions: Classification, Systematics and Taxonomy; Taxonomic Hierarchy, Taxonomic types; • Codes of Zoological Nomenclature; Principle of priority; Synonymy and Homonymy • Concept of classification, Six kingdom classification (Carl Woese)	4
2.	**Unit2: Protista** • Protozoa • General characteristics and Classification up to phylum (according to Levineet.al.,1981) Locomotion In *Euglena*, *Paramoecium and* Amoeba • Conjugation in *Paramoecium* • Life cycle and pathogenicity of Plasmodium *vivax* and Entamoeba *histolytica*	10
3.	**Unit 3: Metazoa** • Evolution of symmetry and segmentation of Metazoa	2
4.	**Unit4: Porifera** • General characteristics and Classification up to classes (Ruppert & Barnes, 1994); • Canal system and spicules in sponges	5
5.	**Unit5: Cnidaria** • General characteristics and Classification up to classes. (Ruppert & Barnes, 1994) • Polymorphism in Cnidaria	4
6.	**Unit6: Ctenophora** • General characteristics, Classification up to Classes. (Ruppert & Barnes, 1994)	2

7.	**Unit7: Platyhelminthes** • General characteristics and Classification up to classes. (Ruppert & Barnes, 1994) • Life cycle: pathogenicity and control measures of *Fasciola hepatica*	6
8.	**Unit8: Nematoda** • General characteristics and Classification up to classes. (Ruppert & Barnes, 1994) • Life cycle: pathogenicity and control measures of *Wuchereria bancrofti* • Parasitic adaptations in helminthes	4
9.	**Unit8: Annelida** • General characteristics and Classification up to classes. (Ruppert & Barnes, 1994) • Excretion in Annelida through nephridia.	5
10.	**Unit 10**: **Arthropoda** • General characteristics and Classification up to classes. (Ruppert & Barnes, 1994). • Respiration in Arthropoda (Gills in prawn and trachea in cockroach). • Metamorphosis in Insects. • Social life in termite	6
11.	**Unit 11: Onychophora** • General characteristics and Evolutionary significance	2
12.	**Unit12: Mollusca** • General characteristics and Classification up to classes. (Ruppert & Barnes, 1994) • Nervous system and torsion in Gastropoda	5
13.	**Unit 13: Echinodermata** General characteristics and Classification upto classes. (Ruppert & Barnes, 1994) Water-vascular system in Asteroidea. Larval forms in Echinodermata Affinities with Chordates	5
14.	**Unit14: Hemichordata** General characteristics of phylum Hemichordata. Relationship with non-chordates and chordates	4

❖ Classification for metazoans to be followed from: Rupert and Barnes, 1994, 6thEdition.

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Suggested Readings:

➢ Ruppert and Barnes, R.D. (2006). Invertebrate Zoology, VIII Edition. Holt Saunders International Edition.

➢ Invertebrates by Brusca & Brusca. Second edition, 2002.

➢ The Invertebrates: A New Synthesis, III Edition, Blackwell Science

Major 101 P Non-Chordates **Credits 01**

Course Contents:

1. Identification of Amoeba, Euglena, Entamoeba, Opalina, Paramecium

2. Identification of Sycon, Neptune's Cup, Obelia, Physalia, Millepora, Aurelia, Tubipora, Gorgonia, Metridium.

3. Identification and significance of adult Fasciola hepatica, Ascaris lumbricoides.

4. Staining/ mounting of any protozoa/helminth isolated from the gut of cockroach.

5. Study of following specimens:

a. Annelids-Aphrodite, Nereis, Heteronereis, Sabella, Serpula, Chaetopterus,

Pheretima, Hirudinaria

b. Arthropods - Limulus, Palamnaeus, Palaemon, Daphnia, Balanus, Sacculina, Cancer, Eupagurus, Scolopendra, Julus, Bombyx, Periplaneta, termites and honey bees Onychophora - Peripatus

c. Molluscs-Chiton, Dentalium, Pila, Doris, Helix, Unio, Ostrea ,Pinctada, Sepia,

Octopus, Nautilus

d. Echinoderms-Pentaceros/Asterias, Ophiura, Clypeaster, Echinus, Cucumaria and Antedon

6. Study of digestive system, septal nephridia and pharyngeal nephridia of earthworm

7. Mounting of mouth parts and dissection of digestive system and nervous system of

Periplaneta

SEC 101: Apiculture **Credits: 03**

SEC 101T: Apiculture **Credits: 02**

Course objectives and expected outcome

The student will be able to understand the basics of beekeeping tools, equipment, and managing beehives; understand the primary life cycle of the honeybees; learn and manage beehives for honey production and pollination; understand the marketing of various bee products. The course will be useful for providing self-employment to the learner.

Course Contents:

Sl. No.	TOPICS	Allotted Lecture
1.	**Unit 1: Biology of Bees** History, Classification and Biology of Honey Bees Social Organization of Bee Colony	3
2.	**Unit 2: Rearing of Bees** 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)	5
3.	**Unit 3: Diseases and Enemies** Bee Diseases and Enemies Control and Preventive measures	2
4.	**Unit 4: Bee Economy** Products of Apiculture Industry and its Uses (Honey, Bees Wax, Propolis), Pollen propagation	4
5.	**Unit 5: Entrepreneurship in Apiculture** Bee Keeping Industry – Recent Efforts, Modern Methods in employing artificial Beehives for cross pollination in horticultural gardens	6

Suggested Readings:

- Prost, P. J. (1962). Apiculture. Oxford and IBH, New Delhi.
- Bisht D.S., Apiculture, ICAR Publication.
- Singh S., Beekeeping in India, Indian council of Agricultural Research, New Delhi.
- Economic Zoology by G. S. Shukla & V. B. Upadhyay

SEC 1P: Apiculture **Credits: 01**

Course Contents:

1. Studies of Bee hives
   a. Construction of bee hives
   b. Identification of Bee caste
   c. Extraction of honey
2. Visit to an Apiculture farm.

Minor 101: Non-Chordates **Credits 04**
Minor 101T-Non-Chordates **Credits 03**

Course objectives and expected outcome

This course provides an introduction to the basics of animal classification. It covers various phylum (major and minor) under non-chordates as per the hierarchy. The students will learn about their properties, identifying characters, specialized organ-systems, diversity and the basic scheme of classification. Therefore, this fundamental course of classical Zoology will be helpful for the students to be inclined more into the beauty Animal Kingdom.

Course Contents:

Sl. No.	TOPICS	Allotted Lecture
1.	**Unit1: Basics of Animal Classification** • Definitions: Classification, Systematics and Taxonomy; Taxonomic Hierarchy, Taxonomic types; • Codes of Zoological Nomenclature; Principle of priority; Synonymy and Homonymy • Concept of classification, Six kingdom classification (Carl Woese)	4
2.	**Unit2: Protista** • Protozoa • General characteristics and Classification up to phylum (according to Levineet.al.,1981) Locomotion In *Euglena*, *Paramoecium and* Amoeba • Conjugation in *Paramoecium* • Life cycle and pathogenicity of Plasmodium *vivax* and Entamoeba *histolytica*	10
3.	**Unit 3: Metazoa** • Evolution of symmetry and segmentation of Metazoa	2
4.	**Unit4: Porifera** • General characteristics and Classification up to classes (Ruppert & Barnes, 1994); • Canal system and spicules in sponges	5
5.	**Unit5: Cnidaria** • General characteristics and Classification up to classes. (Ruppert & Barnes, 1994) • Polymorphism in Cnidaria	4
6.	**Unit6: Ctenophora** • General characteristics, Classification up to Classes. (Ruppert & Barnes, 1994)	2

7.	**Unit7: Platyhelminthes** • General characteristics and Classification up to classes. (Ruppert & Barnes, 1994) • Life cycle: pathogenicity and control measures of *Fasciola hepatica*	6
8.	**Unit8: Nematoda** • General characteristics and Classification up to classes. (Ruppert & Barnes, 1994) • Life cycle: pathogenicity and control measures of *Wuchereria bancrofti* • Parasitic adaptations in helminthes	4
9.	**Unit8: Annelida** • General characteristics and Classification up to classes. (Ruppert & Barnes, 1994) • Excretion in Annelida through nephridia.	5
10.	**Unit 10**: **Arthropoda** • General characteristics and Classification up to classes. (Ruppert & Barnes, 1994). • Respiration in Arthropoda (Gills in prawn and trachea in cockroach). • Metamorphosis in Insects. • Social life in termite	6
11.	**Unit 11: Onychophora** • General characteristics and Evolutionary significance	2
12.	**Unit12: Mollusca** • General characteristics and Classification up to classes. (Ruppert & Barnes, 1994) • Nervous system and torsion in Gastropoda	5
13.	**Unit 13: Echinodermata** General characteristics and Classification upto classes. (Ruppert & Barnes, 1994) Water-vascular system in Asteroidea. Larval forms in Echinodermata Affinities with Chordates	5
14.	**Unit14: Hemichordata** General characteristics of phylum Hemichordata. Relationship with non-chordates and chordates	4

❖ Classification for metazoans to be followed from: Rupert and Barnes, 1994, 6thEdition.

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Suggested Readings:

➢ Ruppert and Barnes, R.D. (2006). Invertebrate Zoology, VIII Edition. Holt Saunders International Edition.

➢ Invertebrates by Brusca & Brusca. Second edition, 2002.

➢ The Invertebrates: A New Synthesis, III Edition, Blackwell Science

Minor 101 P Non-Chordates **Credits 01**

Course Contents:

1. Identification of Amoeba, Euglena, Entamoeba, Opalina, Paramecium

2. Identification of Sycon, Neptune's Cup, Obelia, Physalia, Millepora, Aurelia, Tubipora, Gorgonia, Metridium.

3. Identification and significance of adult Fasciola hepatica, Ascaris lumbricoides.

4. Staining/ mounting of any protozoa/helminth isolated from the gut of cockroach.

5. Study of following specimens:

a. Annelids-Aphrodite, Nereis, Heteronereis, Sabella, Serpula, Chaetopterus,

Pheretima, Hirudinaria

b. Arthropods - Limulus, Palamnaeus, Palaemon, Daphnia, Balanus, Sacculina, Cancer, Eupagurus, Scolopendra, Julus, Bombyx, Periplaneta, termites and honey bees Onychophora - Peripatus

c. Molluscs-Chiton, Dentalium, Pila, Doris, Helix, Unio, Ostrea ,Pinctada, Sepia,

Octopus, Nautilus

d. Echinoderms-Pentaceros/Asterias, Ophiura, Clypeaster, Echinus, Cucumaria and Antedon

6. Study of digestive system, septal nephridia and pharyngeal nephridia of earthworm

7. Mounting of mouth parts and dissection of digestive system and nervous system of

Periplaneta

RAJA NARENDRALAL KHAN WOMEN'S COLLEGE (AUTONOMOUS)

Semester-II
Course Structure

Sl. No.	Name of the Courses	No. of Papers	Credits	Full Marks
1	Major	01	04	75
2	Minor	01	04	75
3	IDC/MDC	01	03	50
4	AEC MIL (Beng./ Hindi)	01	02	50
5	SEC	01	03	50
6	VAC (Group-C)	02	04(2+2)	100(50+50)
7	CESR	01	02	50
Total		***08***	***22***	***450***

Raja N. L. Khan Women's College (Autonomous)

Curriculum for Undergraduate in Zoology

[NEP 2020]

Semester-II

Paper Code	Name of the Subject	Nature	Teaching Scheme in hour per week			Credit	Marks
			L	T	P		
ZOOMJ201	**MJ201:** Ecology	Major Course- 1	3	0	0	4	75
	MJ102P: Ecology (Practical)	Major Course1 [Practical]	0	0	1		
ZOOMI201	**M201T:** Non-Chordates	Minor Course-1	3	0	0	4	75
	M201P: Non-Chordates (Practical)	Minor Course-1 [Practical]	0	0	1		
ZOOSEC201	SEC201T: Sericulture	SEC	2	0	0	3	50
	SEC201P: Sericulture (Practical)	SEC (Practical)	0	0	1		

L=Lecture,T=Tutorial,P=Practical

Major 201: Ecology **Credits 04**

Major 201T Ecology **Credits 03**

Course objectives and expected outcome

This course introduces the basics of ecosystem structure, composition, and significance. This study provides information about factors affecting the population and community. Developed environmental monitoring skills, including conduct of experiments and data analysis. It also teaches about the significance of wildlife, the threatened category, and the conservation strategy of wildlife animals in an ecosystem.

Course Contents:

Sl. No.	TOPICS	Allotted Lecture
1.	**Unit 1: Introduction to Ecology** • History of ecology, Autoecology and synecology, Levels of organization, Laws of limiting factors, Study of physical factors, Atmosphere, Hydrosphere and Biosphere	4
2	**Unit 2: Population** • Unitary and Modular populations • Unique and group attributes of population: Demographic factors, lifetable, fecundity table, • Survivorship curves, dispersal and dispersion. • Geometric, exponential and logistic growth, equation and patterns, r and k strategy, Populations • Population regulation-density-dependent and independent factors • Population Interactions, Gause's Principle with laboratory and field examples, Lotka-Volterra equation for competition and elimination.	20
3	**Unit 3: Community** • Community characteristics: species diversity, abundance, dominance, richness, • Vertical stratification, Ecotone and edge effect, Ecological succession with one example	11
4	**Unit 4: Ecosystem** • Definition and types of ecosystems with example, Foodchain: Detritus and grazing food chains, • Linear and Y-shaped food chains, Food web, Energy flow through theecosystem, Ecological pyramids and Ecological efficiencies. • Nutrient and biogeochemical cycle, Nitrogen cycle • Human modified ecosystem	10

5	**Unit 5: Applied Ecology** • Wildlife conservation (in-situ and ex-situ conservation) • Management strategies for tiger conservation; Wildlife protection act (1972)	5

Suggested Readings:

- Krebs,C.J.(2001).Ecology.VI Edition. Benjamin Cummings.
- Odum,E.P.,(2008).Fundamentals of Ecology. Indian Edition.
- Brooks/ColeRobert Leo Smith Ecology and field biology.Harper and Row publisher.
- Ecology: Theories & Application (2001).4th Edition by Peter Stilling.
- Ecology by Cain,Bowman & Hacker. 3rd edition.Sinauer associates

Major 201P Ecology **Credits 01**

Course contents:

1. Study of life tables and plotting of survivorship curves of different types from the hypothetical/real data provided
2. Determination of population density in a natural/hypothetical community by Quadrate method and calculation of Shannon-Weiner diversity index for the same community
3. Study of an aquatic ecosystem: Phytoplankton and zooplankton, Measurement of area, temperature, turbidity/penetration of light, Determination of pH, and Dissolved Oxygen content (Winkler'smethod), Chemical Oxygen Demand and free CO2.
4. Project report on costal ecosystem

SEC 201: Sericulture **Credits: 03**

SEC 201T: Sericulture **Credits: 02**

Course objectives and expected outcome

Understand concepts of sericulture industry and demonstrate interdisciplinary skills acquired in mulberry plant cultivation, silkworm rearing, diagnosis of diseases and pest of mulberry and silkworm and their prevention. The course will be useful for providing self-employment to the learner.

Course Contents:

Sl. No.	TOPICS	Allotted Lecture
1.	**Unit 1: Introduction** Sericulture: Definition, Types of silkworms, Distribution and Races, Exotic and indigenous races. Mulberry and non-mulberry Sericulture	2
2.	**Unit 2: Biology of Silkworm** Life cycle of Bombyx mori Structure of silk gland and secretion of silk	4
3.	**Unit 3: Rearing of Silkworms** Selection of mulberry variety and establishment of mulberry garden 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	10
4.	**Unit 4: Pests and Diseases** Pests of silkworm: Uzi fly, dermestid beetles and vertebrates Pathogenesis of silkworm diseases: Protozoan, viral, fungal	3

	and bacterial Control and prevention of pests and diseases	
5.	**Unit 5: Entrepreneurship in Sericulture** Prospectus of Sericulture in India: Sericulture industry in different states, employment, potential in mulberry and non-mulberry sericulture.	**4**
Suggested Readings: ➢ Economic Zoology by G. S. Shukla & V. B. Upadhyay		

SEC 201P: Sericulture **Credits: 01**

Course Contents:

1. Visit to a sericulture farm and prepare a report.
2. Identification of life cycle stages of *Bombyx mori*.

Minor 201: Non-Chordates **Credits 04**
Minor 201T-Non-Chordates **Credits 03**

Course objectives and expected outcome

This course provides an introduction to the basics of animal classification. It covers various phylum (major and minor) under non-chordates as per the hierarchy. The students will learn about their properties, identifying characters, specialized organ-systems, diversity and the basic scheme of classification. Therefore, this fundamental course of classical Zoology will be helpful for the students to be inclined more into the beauty Animal Kingdom.

Course Contents:

Sl. No.	TOPICS	Allotted Lecture
1.	**Unit1: Basics of Animal Classification** • Definitions: Classification, Systematics and Taxonomy; Taxonomic Hierarchy, Taxonomic types; • Codes of Zoological Nomenclature; Principle of priority; Synonymy and Homonymy • Concept of classification, Six kingdom classification (Carl Woese)	4
2.	**Unit2: Protista** • Protozoa • General characteristics and Classification up to phylum (according to Levineet.al.,1981) Locomotion In *Euglena*, *Paramoecium and* Amoeba • Conjugation in *Paramoecium* • Life cycle and pathogenicity of Plasmodium *vivax* and Entamoeba *histolytica*	10
3.	**Unit 3: Metazoa** • Evolution of symmetry and segmentation of Metazoa	2
4.	**Unit4: Porifera** • General characteristics and Classification up to classes (Ruppert & Barnes, 1994); • Canal system and spicules in sponges	5
5.	**Unit5: Cnidaria** • General characteristics and Classification up to classes. (Ruppert & Barnes, 1994) • Polymorphism in Cnidaria	4
6.	**Unit6: Ctenophora** • General characteristics, Classification up to Classes. (Ruppert & Barnes, 1994)	2

7.	**Unit7: Platyhelminthes** • General characteristics and Classification up to classes. (Ruppert & Barnes, 1994) • Life cycle: pathogenicity and control measures of *Fasciola hepatica*	6
8.	**Unit8: Nematoda** • General characteristics and Classification up to classes. (Ruppert & Barnes, 1994) • Life cycle: pathogenicity and control measures of *Wuchereria bancrofti* • Parasitic adaptations in helminthes	4
9.	**Unit8: Annelida** • General characteristics and Classification up to classes. (Ruppert & Barnes, 1994) • Excretion in Annelida through nephridia.	5
10.	**Unit 10**: **Arthropoda** • General characteristics and Classification up to classes. (Ruppert & Barnes, 1994). • Respiration in Arthropoda (Gills in prawn and trachea in cockroach). • Metamorphosis in Insects. • Social life in termite	6
11.	**Unit 11: Onychophora** • General characteristics and Evolutionary significance	2
12.	**Unit12: Mollusca** • General characteristics and Classification up to classes. (Ruppert & Barnes, 1994) • Nervous system and torsion in Gastropoda	5
13.	**Unit 13: Echinodermata** General characteristics and Classification upto classes. (Ruppert & Barnes, 1994) Water-vascular system in Asteroidea. Larval forms in Echinodermata Affinities with Chordates	5
14.	**Unit14: Hemichordata** General characteristics of phylum Hemichordata. Relationship with non-chordates and chordates	4

❖ Classification for metazoans to be followed from: Rupert and Barnes, 1994, 6thEdition.

❖ Classification to be followed from Rupert and Barnes, 1994, 6thEdition

Suggested Readings:

➢ Ruppert and Barnes, R.D. (2006). Invertebrate Zoology, VIII Edition. Holt Saunders International Edition.

➢ Invertebrates by Brusca & Brusca. Second edition, 2002.

➢ The Invertebrates: A New Synthesis, III Edition, Blackwell Science

Minor 201 P Non-Chordates **Credits 01**

Course Contents:

1. Identification of Amoeba, Euglena, Entamoeba, Opalina, Paramecium

2. Identification of Sycon, Neptune's Cup, Obelia, Physalia, Millepora, Aurelia, Tubipora, Gorgonia, Metridium.

3. Identification and significance of adult Fasciola hepatica, Ascaris lumbricoides.

4. Staining/ mounting of any protozoa/helminth isolated from the gut of cockroach.

5. Study of following specimens:

a. Annelids-Aphrodite, Nereis, Heteronereis, Sabella, Serpula, Chaetopterus,

Pheretima, Hirudinaria

b. Arthropods - Limulus, Palamnaeus, Palaemon, Daphnia, Balanus, Sacculina, Cancer, Eupagurus, Scolopendra, Julus, Bombyx, Periplaneta, termites and honey bees Onychophora - Peripatus

c. Molluscs-Chiton, Dentalium, Pila, Doris, Helix, Unio, Ostrea ,Pinctada, Sepia,

Octopus, Nautilus

d. Echinoderms-Pentaceros/Asterias, Ophiura, Clypeaster, Echinus, Cucumaria and Antedon

6. Study of digestive system, septal nephridia and pharyngeal nephridia of earthworm

7. Mounting of mouth parts and dissection of digestive system and nervous system of

Periplaneta

RAJA NARENDRALAL KHAN WOMEN'S COLLEGE (AUTONOMOUS)

Semester-III
Course Structure

Sl. No.	Name of the Courses	No. of Papers	Credits	Full Marks
1	Major	02	08(4+4)	150(75x2)
2	Minor	01	04	75
3	IDC/MDC	01	03	50
4	AEC MIL (Beng./ Hindi)	01	02	50
5	SEC	01	03	50
Total		***06***	***20***	***375***

Raja N. L. Khan Women's College (Autonomous)

Curriculum for Undergraduatein Zoology

[NEP 2020]

Semester-III

Paper Code	Name of the Subject	Nature	Teaching Scheme in hour per week			Credit	Marks
			L	T	P		
ZOOMJ301	**MJ301T:** Systematics & Taxonomy	Major Course	3	0	0	4	75
	MJ301P: Systematics & Taxonomy (Practical)	Major Cource	0	0	1		
ZOOMJ302	**MJ302T:** Chordates	Major Cource	3	0	0	4	75
	MJ302P: Chordates (Practical)	Major Cource	0	0	1		
ZOOMI301	**MI301T:** Ecology	Minor Course	3	0	0	4	75
	MI301T: Ecology (Practical)	Minor Course [Practical]	0	0	1		
ZOOSEC301	SEC301T: Aquarium fish management	SEC	2	0	0	3	50
	SEC301P: Aquarium fish management (Practical)	SEC (Practical)	0	0	1		

L=Lecture, T=Tutorial, P=Practical

Major 301 : Systematics & Taxonomy **Credits: 04**

Major 301 T: Systematics & Taxonomy **Credits: 03**

Course objectives and expected outcome

This course introduces the science of taxonomy and systematics, exploring the methods and principles used to classify and naming organisms. It covers the history, principles, and methodologies of systematics, including morphological and molecular techniques, and phylogenetic analysis. The course will also discuss the importance of taxonomy and systematics in understanding biodiversity, evolution, and conservation.

Sl. No.	TOPICS	Allotted Lecture
1.	**Unit 1: Introduction to Taxonomy and Systematics** • Overview of taxonomy & systematics • Historical perspective and the significance of taxonomy in biological sciences.	4
2.	**Unit 2: The Species Concept** • Different species concepts (biological, morphological, phylogenetic). • Challenges and debates in defining species. Cryptic species, ring species concept.	7
3.	**Unit 3: Taxonomic Hierarchy and Nomenclature** • Rules and conventions (ICZN, ICBN). • Binomial nomenclature, typification, and the role of herbaria and museums.	6
4.	**Unit 4: Morphological Techniques in Taxonomy** • Traditional morphological methods for classification. • Importance of morphological traits in different groups	8
5.	**Unit 5: Molecular Systematics** • Application of DNA sequencing in taxonomy. • Molecular markers and their applications in systematics.	8
6.	**Unit 6: Phylogenetics: Principles and Methods** • Phylogenetic trees: types, UPGMA & Maximum Parsimony • Methods of phylogenetic analysis (cladistics, phenetics).	8
7.	**Unit 7: Conservation and Taxonomy** • Role of taxonomy in conservation biology. • Conservation priorities and the identification of keystone species, Umbrella species, Flagship species & Indicator Species.	4

Suggested Readings:

- "Systematics and the Origin of Species" by Ernst Mayr.
- "Principles of Systematic Zoology" by Eldredge and Cracraft, and "Molecular Systematics" edited by Hillis, Moritz, and Mable.
- "Principle of Taxonomy" – V. C. Kapor

Major 301 P: Systematics & Taxonomy **Credits: 01**

Course Contents:

1. Type study and identification: Typification and identifying different organisms.
2. Preparation of Dichotomous Keys
3. Construction of phylogenetic tree: UPGMA
4. Phylogenetic analysis software: Practical use of various computational tools. Case studies using tools/software like CLUSTALW, MEGA.

Major 302: Chordates **Credits: 04**

Major 302T: Chordates **Credits: 03**

Course objectives and expected outcome

Identify the chordates and classify them. Develop understanding on the diversity of life regarding chordates. Describe general taxonomic rules on animal classification of chordates. Classify Protochordate to Mammalia with taxonomic keys. Understand Mammals with specific structural adaptations. Understand the origin and evolutionary relationship of different phyla from Protochordate to Mammalia. To identify chordates based on special identifying characters Define the main characteristics of chordates. Recall the classification of Phylum Chordata. Describe the different chordate animals (in lab). Apply the relationship between structure and function of organ-systems, and their adaptation with environment List each class in its taxonomic position according to the modifications of structures of different organs in each taxon. Gain knowledge about zoogeographical realms and distribution of chordates in world

Course Contents:

Sl. No.	Topics	Lectures
1.	**Unit 1: Introduction to Chordates** • General characteristics and outline classification of Phylum Chordata.	4
2.	**Unit 2: Protochordata** • General characteristics and classification of sub-phylum Urochordata and Cephalochordata up to Classes. Retrogressive metamorphosis in Ascidia. Chordate Features and Feeding in Branchiostoma.	5
3.	**Unit 3: Origin of Chordata** • Dipleurula concept and the Echinoderm theory of origin of chordates. • Advanced features of vertebrates over Protochordata.	3
4.	**Unit 4: Agnatha** • General characteristics and classification of Cyclostomes up to order.	2
5.	**Unit 5: Pisces** • General characteristics and classification of Chondrichthyes and Osteichthyes up to Subclasses. Accessory respiratory organ, migration and parental care in fishes • Swim bladder in fishes. Classification up to Sub-Classes. • Lung fishes: Characteristics and their distribution.	4

6.	**Unit 6: Amphibia** • General characteristics and classification up to living Orders. • Metamorphosis and parental care in Amphibia. • Defence mechanism in Amphibia.	**4**
7.	**Unit 7: Reptilia** • General characteristics and classification up to living Orders. • Poison apparatus and Biting mechanism in Snake.	**4**
8.	**Unit 8: Aves** • General characteristics and classification up to Sub-Classes • Exoskeleton and migration in Birds. • Principles and aerodynamics of flight.	**6**
9.	**Unit 9: Mammals** • General characters and classification up to living orders. Affinities of Prototheria. • Exoskeleton derivatives of mammals. Adaptive radiation in mammals with reference to locomotory appendages. Echolocation in Micro chiropterans and Cetaceans.	**6**
10.	**Unit 10: Zoogeography** • Zoogeographical realms, Plate tectonic and Continental drift theory, distribution of animals in different realms	**4**

Note: Classification from Protochordata, Agnatha, Reptilia, Aves and Mammalian to be Followed from Young (1981), for Pisces to be followed from Nelson, 2016, for Amphibia to be followed from Duellman and Trueb (1986)

Suggested Readings:

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. Parker, T. J. &Haswell, W. (1972). Text Book of Zoology, Volume II: Marshall and Willam (Eds.) 7th Ed. Macmillan Press, London.
6. Kardong, K. V. (2002). Vertebrates: Comparative anatomy, function evolution. Tata McGraw Hill.
7. Kent, G. C. & Carr, R. K. (2001). Comparative anatomy of the Vertebrates. 9th Ed. McGraw Hill.
8. Nelson, J.S., (2006) : Fishes of the World, 4th Edn., Wiley.

Major 302P: Chordates **Credits: 01**

List of Practical:

1. Identification of the following animals

- **Protochordata**
  Balanoglossus, Herdmania, Branchiostoma
- **Agnatha**
  Petromyzon, Myxine
- **Fishes**
  Scoliodon, Sphyrna, Pristis, Torpedo, Chimaera, Mystus, Heteropneustes, Labeo rohita, Labeo bata, Labeo calbasu, Puntius, Amblyopharyngodon, Catla, Cirhinus, Exocoetus, Echeneis, Anguilla, Hippocampus, Tetrodon/ Diodon, Anabas, Flat fish
- **Amphibia**
  Necturus, Bufo, Hyla, Alytes, Axolotl, Tylototriton
- **Reptilia**
  Chelone, Trionyx, Hemidactylus, Varanus, Uromastix, Chamaeleon, Ophiosaurus, Draco, Bungarus, Vipera, Naja, Hydrophis, Zamenis, Crocodylus.
- **Mammalia**: Megachiroptera & Microchiroptera
- **Aves**: Passer, Pycnonotus, Alcedo, Dinopium

2. Dissection of brain and pituitary of *Tilapia sp.*
3. Dissection of Urinogenital system of *Tilapia sp*
4. Pecten from Fowl head
5. IX^{th} and X^{th} cranial nerve of *Chana* sp.
6. Afferent and Efferent arterial system of *Chana* sp.

SEC 301: Aquarium fish Management **Credits: 03**

SEC 301T: Aquarium fish Management **Credits: 02**

Course objectives and expected outcome

To understand the present state and future potential of Aquarium fish industry, student will gain knowledge on the aquarium construction and aquarium managements. Aquarium fish behavior and biology, which is important to maintain the aquarium fish handling and transportation. This course helpful to student to identify the fishes and study their characteristics. This portion also helps our students to study the feeding habit, breeding habit and behavior. This knowledge is very much helpful to aquarium fish culture related different aspects and their budget analysis.

Sl. No.	Topics	Allotted Lectures
1.	**Unit 1: Introduction to Aquarium fish keeping:** Overview of Aquaculture, Potential scope of aquarium fish industry as a cottage industry, exotic and indigenous species of aquarium fishes.	6
2.	**Unit 2: Biology of aquarium fishes:** Common characters and sexual dimorphism of fresh water and marine aquarium fishes such as Guppy, Molly, Sword tail, Goldfish, Angel fish, Blue morph, Anemone fish and butterfly fish etc.	8
3.	**Unit 3: Food and feeding of aquarium fishes:** Use of live fish feed organisms. Preparation and composition of formulated fish feed, Aquarium fish as larval predator.	6
4.	**Unit 4: Fish transportation:** Live fish transport- fish handling, packing and forward techniques.	5
5.	**Unit 5: Maintenance of aquarium:** General aquarium maintenance-budget for setting up an aquarium fish farm as a cottage industry.	5
Suggested Readings: 1. Fisheries Science by C. B. L. Srivastava 2. Ornamental fish Culture by Chanda, Chakravorty, Dasgupta & Das		

SEC 301P: Aquarium fish Management **Credits: 01**

1. Aquarium construction and decoration
2. Aquarium fish collection, handling and management
3. Identification of aquarium fishes.
4. Visit to aquarium farm and submission a report.

Minor 301: Ecology **Credits 04**

Minor 301T Ecology **Credits 03**

Course objectives and expected outcome

This course introduces the basics of ecosystem structure, composition, and significance. This study provides information about factors affecting the population and community. Developed environmental monitoring skills, including conduct of experiments and data analysis.It also teaches about the significance of wildlife, the threatened category, and the conservation strategy of wildlife animals in an ecosystem.

Course Contents:

Sl. No.	TOPICS	Allotted Lecture
1.	**Unit 1: Introduction to Ecology** • History of ecology, Autoecology and synecology, Levels of organization, Laws of limiting factors, Study of physical factors, Atmosphere, Hydrosphere and Biosphere	4
2.	**Unit 2: Population** • Unitary and Modular populations • Unique and group attributes of population: Demographic factors, lifetable, fecundity table, • Survivorship curves, dispersal and dispersion. • Geometric, exponential and logistic growth, equation and patterns, r and k strategy, Populations • Population regulation-density-dependent and independent factors • Population Interactions, Gause's Principle with laboratory and field examples, Lotka-Volterra equation for competition and elimination.	20
3.	**Unit 3: Community** • Community characteristics: species diversity, abundance, dominance, richness, • Vertical stratification, Ecotone and edge effect, Ecological succession with one example	11
4.	**Unit 4: Ecosystem** • Definition and types of ecosystems with example, Food chain: Detritus and grazing food chains, • Linear and Y-shaped food chains, Food web, Energy flow through the ecosystem, Ecological pyramids and Ecological efficiencies. • Nutrient and biogeochemical cycle, Nitrogen cycle • Human modified ecosystem	10

5.	**Unit 5: Applied Ecology** • Wildlife conservation (in-situ and ex-situ conservation) • Management strategies for tiger conservation; Wildlife protection act (1972)	5

Suggested Readings:

- Krebs,C.J.(2001).Ecology.VI Edition. Benjamin Cummings.
- Odum,E.P.,(2008).Fundamentals of Ecology. Indian Edition.
- Brooks/ColeRobert Leo Smith Ecology and field biology.Harper and Row publisher.
- Ecology: Theories & Application (2001).4th Edition by Peter Stilling.
- Ecology by Cain,Bowman & Hacker. 3rd edition.Sinauer associates

Minor 301P Ecology **Credits 01**

Course contents:

1. Determination of population density in a natural/hypothetical community by Quadrate method and calculation of Shannon-Weiner diversity index for the same community
2. Study of an aquatic ecosystem: Phytoplankton and zooplankton, Determination of pH, and Dissolved Oxygen content (Winkler's method) and free CO2.
3. Project report on costal ecosystem

RAJA NARENDRALAL KHAN WOMEN'S COLLEGE (AUTONOMOUS)

Semester-IV
Course Structure

Sl. No.	Name of the Courses	No. of Papers	Credits	Full Marks
1	Major	03	12(4x3)	225(75x3)
2	Minor	01	04	75
3	AEC ENGLISH	01	02	50
4	Professional Course	01	02	50
Total		***06***	***20***	***400***

Raja N. L. Khan Women's College (Autonomous)

Curriculum for Undergraduate in Zoology

[NEP 2020]

Semester-IV

Paper code	Name of the Subject	Nature	Teaching Scheme in hour per week			Credit	Marks
			L	T	P		
ZOOMJ401	**MJ401T:** Comparative anatomy	Major Course	3	0	0	4	75
	MJ401P: Comparative anatomy (Practical)	Major Course	0	0	1		
ZOOMJ402	**MJ402T:** Animal Physiology	Major Course	3	0	0	4	75
	MJ402P: Animal Physiology (Practical)	Major Course	0	0	1		
ZOOMJ403	**MJ403T:** Parasitology **Or** Applied Entomology and Nematology	Major Course	3	0	0	4	75
	MJ403P: Parasitology **Or** Applied Entomology and Nematology (Practical)	Major Course	0	0	1		
ZOOMI401	**MI401 T:** Ecology	Minor Course	3	0	0	4	75
	M401 P: Ecology (Practical)	Minor Course [Practical]	0	0	1		

L=Lecture, T=Tutorial, P=Practical

Major 401: Comparative anatomy **Credits: 04**

Major 401T: Comparative anatomy **Credits: 03**

Course objectives and expected outcome

The students will be able to understand the basic structure, organization of anatomical systems like digestive systems, respiratory system, urinogenital system, central nervous system, olfactory system etc., and their modification in the major transitions in vertebrate's evolution.

Sl. No.	Topics	Allotted Lectures
1.	**Unit 1: Integumentary System** Structure, function and derivatives of integument in amphibian, birds and mammals.	5
2.	**Unit 2: Skeletal System** Overview of axial and appendicular skeleton: Jaw suspension; Visceral arches	5
3.	**Unit 3: Digestive System** Comparative anatomy of stomach: dentition in mammals.	6
4.	**Unit 4: Respiratory System** Respiratory organs of fish, amphibian, birds and mammals.	6
5.	**Unit 5: Circulatory System** General plan of circulation, Comparative account of heart and aortic arches.	7
6.	**Unit 6: Urinogenital System** Succession of kidney, Evolution of urinogenital ducts, Types of mammalian uteri.	7
7.	**Unit 7: Nervous System** Comparative account of brain. Cranial nerves in mammals.	6
8.	**Unit 8: Sense Organs** Classification of receptors, Brief account of olfactory and	6

	auditory receptors in vertebrate.	

Suggested Readings:

- Kardong, K.V. (2005). *Vertebrates' Comparative Anatomy, Function and Evolution*. IV Edition. McGraw-Hill Higher Education.
- Kent, G.C. and Carr R.K. (2000). *Comparative Anatomy of the Vertebrates*. IX Edition. The McGraw-Hill Companies
- Hilderbrand, M (1988) . *Analysis of Vertebrate Structure*. 3rd Edition, John Wiley and Sons.
- Saxena, R.K. & Saxena, S.C. (2008): *Comparative Anatomy of Vertebrates*, Viva Books Pvt. Ltd.

Major 401P: Comparative anatomy **Credits: 01**

(1) Study of placoid, cycloid and ctenoid scales through permanent slides/photographs.

(2) Study of disarticulated skeleton of Toad, Pigeon and Guineapig

(3) Demonstration of Carapace and plastron of turtle.

(4) Identification of mammalian skulls: One herbivorous (Guineapig) and one carnivorous(Dog) animal

(5) Dissection of Tilapia: Circulatory system, Brain, pituitary, urinogenital system.

Major 402: Animal Physiology **Credits: 04**

Major 402T: Animal Physiology **Credits: 03**

Course objectives and expected outcome

The course will give students in-depth knowledge of the numerous physiological organ systems as well as the significance of the human body's integrative activities. To get a deeper understanding of and respect for mammalian physiology; to be able to explain how critical physiological systems—such as the digestive, respiratory, cardiac, neurological, muscular, reproductive, and renal systems—work; to be aware of the body's signaling system and various physiological disease.

Course Contents:

Sl. No.	Contents	Allotted Lecture
1.	**Unit1: Physiology of Digestion:** Structural organisation and functions of Gastrointestinal tract and Associated glands; Mechanical and chemical digestion of food, absorption of Carbohydrates, Lipids, Proteins; Disease related to digesion, PCM	5
2.	**Unit 2: Physiology of Respiration:** Resipratory organs, Mechanism of Respiration, Respiratory volumes and capacities, transport of Oxygen and Carbon dioxide in blood, Dissociation curves and the factors influencing it, respiratory pigments; Carbon monoxide poisoning	5
3.	**Unit 3: Physiology of Circulation:** Components of Blood and their functions; Structure and functions of haemoglobin, Haemostasis; Blood clotting system, Fibrinolytic system Haemopoiesis; Basic steps and its regulation Blood groups; ABO and Rh factor, Circulation related disease	6
4.	**Unit 4: Physiology of Heart:** Structure of mammalian heart, Coronary Circulation, Structure and working of conducting myocardial fibres, Origin and conduction of cardiac impulses Cardiac Cycle and cardiac output Blood pressure and its regulation, Heart related disease	6
5.	**Unit 5: Physiology of Nervous System:** Structural organization of nervous system, 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, Receptors	8
6.	**Unit 6: Muscular Physiology:** Ultra structure of skeletal muscle, Muscle properties, Types of muscle, Physical and chemical basis of muscle contraction	5
7.	**Unit 7: Renal Physiology:** Structure of Kidney and its functional	5

	unit, Mechanism of urine formation, Regulation of acid- base balance	
8.	**Unit 8: Reproductive physiology:** Structure of Primary and Secondary sex organ of Human, Menstrual Cycle, Physiological changes during pregnancy, Parturition, Amniocentesis, MTP, Lactation, STD	5

Suggested Readings:

- Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Hercourt
- Eckert Animal Physiology: Mechanisms and adaptations Randall, Burggren and French Vander A, Sherman J. and Luciano D. (2014). Vander's Human Physiology: The Mechanism of Body Function. XIII Edition, McGraw Hills
- Victor P. Eroschenko. (2008). Di Fiore's Atlas of Histology with Functional correlations. XII Edition. Lippincott W. & Wilkins.
- Vander A, Sherman J. and Luciano D. (2014). Vander's Human Physiology: The Mechanism of Body Function. XIII Edition, McGraw Hills

Major 402P: Animal Physiology **Credits: 01**

Course Contents:

1. Determination of ABO Blood group
2. Enumeration of red blood cells and white blood cells using haemocytometer
3. Estimation of haemoglobin using Sahli's haemoglobinometer
4. Preparation of haemin and haemochromogen crystals
5. Recording of blood pressure using as phygmomanometer

Major 403: Parasitology **Credits: 04**

Major 403T: Parasitology **Credits: 03**

Course objectives and expected outcome:

The course will provide an understanding of the diversity and biology of parasites, besides the epidemiological aspects of different parasitic diseases will be explored and students will be able to gain knowledge regarding the mode of transmission of parasitic diseases and its preventive measures.

Course Contents:

Sl. No.	Topics	Allotted Lecture
1)	**Unit 1: Introduction to Parasitology** Types of parasites and hosts. The basic concept of Parasitism: Commensalism, Symbiosis, Phoresis, Mutualism, Predation, Carrier and Vectors. Host parasitic interactions	10
2)	**Unit 2: Parasitic Protists** -Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of *Plasmodium vivax, Trypanosoma gambiense, Leishmania donovani*	6
3)	**Unit 3: Parasitic Platyhelminthes** -Study of Morphology, Life Cycle, Prevalence, Epidemology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of, *Diphyllobothrium latum, Taenia solium*	5
4)	**Unit 4: Parasitic Nematodes** Study of Morphology, Life Cycle, Prevalence, Epidemology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of *Ascaris lumbricoides, Brugia malayi* and *Loa loa*; Nematode Plant interaction; Gall formation.	7
5)	**Unit 5: Parasitic Arthropods** Biology, importance and control of ticks (Soft tick *Ornithodoros*, Hard tick *Ixodes*), mites (*Sarcoptes*), Lice(*Pediculus*), Flea(*Xenopsylla*) and Bug (*Cimex*)	10
6)	**Unit 6: Zoonotic disease (with special reference to)** *Wuchereria bancrofti , Schistosoma haematobium, Paragonimus westermani. Giardia intestinalis*	**7**

Suggested Readings:

- Arora, D. R and Arora,B.(2001) Medical Parasitology.II Edition. CBS Publications and Distributors
- E.R Noble and G.A. Noble(1982) Parasitology: The biology of animal parasites, V Edition, Lea & Febiger
- Ahmed, N.,Dawson,M.,Smith,C. and Wood, Ed,(2007) Biology of Disease
- Taylor and Francis Group

- Parija, S. C. Textbook of medical parasitology, protozoology & helminthology(Text and colour Atlas), II Edition, All India Publishers & Distributers,Medical Books Publishers, Chennai,Delhi
- Rattan Lal Ichhpujani and Rajesh Bhatia. Medical Parasitology,III Edition ,Jaypee Brothers Medical Publishers(P) Ltd.,New Delhi.
- Page66Meyer, Olsen & Schmidt's Essestials of Parasitology, Murray, D.Dailey, W.C. Brown Publishers.
- K. D . Chatterjee(2009). Parasitology:Protozoology and Helminthology. XIII Edition, CBS Publishers & Distributors (P) Ltd.

Major 403P: Parasitology **Credits: 01**

Course Contents:

1. Study of life stages of *Giardia intestinalis, Trypanosoma gambiense, Leishmania donovani, Plasmodium* sp. through permanent slides / photographic plate.
2. Study of plant parasitic root knot nematode, Meloidogyne from the soil sample.
3. Identification: *Pediculous sp., Xenopsylla sp., Cimex sp., Taenia sp.*
4. Study of nematode/cestode parasites from the intestines of Poultry bird/Cockroach (Intestine can be procured from poultry/market as a by-product.

OR

Major 403 Applied Entomology and Nematology **Credits 04**

Major 403T Applied Entomology and Nematology **Credits 03**

Course objectives and expected outcome:

Applied Entomology and Nematology focuses on the practical application of knowledge about insects and nematodes to solve problems in agriculture, horticulture, forestry, and public health. This field integrates scientific research with real-world applications to manage pest populations, promote beneficial insects, and ensure sustainable practices.

Course Contents:

Sl. No.	Topics	Allotted Lecture
1.	**Unit 1Basics of Entomology** Insect diversity and adaptation: Morphological adaptation of insects: Head and antenna; Mouthparts of honey bee and cockroach; Thorax and thoracic appendages- legs and wings [General concept]. Physiological adaptation in cockroach: Digestive system: Alimentary canal and digestive glands, digestion; Respiratory organs and mechanism of gaseous exchange; Sense organs compound eyes, chemoreceptors. General Characteristics of Class Insecta and living orders with examples:Orthoptera, Dictyoptera, Hemiptera, Coleoptera, Lepidoptera, Diptera, Hymenoptera, Anoplura, Siphonaptera(Imms, A.D., 1938); Ticks and Mites: General features; difference between ticks and mites; Soft ticks and Hard ticks.	7
2.	**Unit 2 Medical Entomology** Concept of Vectors: Mechanical and biological vectors, modes of transmission; Biological vector and disease cycle. Biology of Anopheles, Culex and Aedes:Study of mosquito borne diseases- Malaria, Dengue, and Filariasis; control of mosquitoes. Biology of Musca domestica:Disease relationship; control of house fly. Biology and systematicsof Bed bug Cimex lectularius; disease relationship; Control of Bed Bug. Ticks as Causative agents and Vectors: Rickettsiosis, Tick-borne encephalitis. Forensic Entomology: General perceptions and status of Forensic entomology; Insects and other arthropods of forensic importance; Pattern of insect succession on carcass; Postmortem Interval (PMI) and its estimation process; Applications and limitations of Forensic Entomology	10
3.	**Unit 3 Agricultural Entomoloy** Concept of insect pest; Economic Injury Level (EIL), Economic Threshold Level (ETL), Dynamics of EIL; Pests of major crops (Life cycle, Nature of damage and control measures): Pests of Paddy, *Scirpophaga incertulus*; Pests of Jute, *Anomis sabulifera*; Pests of brinjal, *Leucinodes orbonalis*; Stored grain pest: *Sitophilus oryzae*; Invasive insect pests of India and their consequences. Insect Pest control: Chemical, Mechanical, Cultural and Biological control	7

	measures; Integrated Pest Management (IPM) Study of appliances used in pest control: Dusters; Sprayers- categories of sprayers, agricultural Aircrafts; Granule applicator; soil injectors.	
4.	**Unit 4 General awareness in Agriculture and related branches of life sciences** History and economic importance of plant-parasitic nematodes; Nematode parasitism; Fundamentals of nematode morphology, taxonomy, biology and ecology; Nematode interactions with micro-organisms; Entomopathogenic nematodes; Symptoms and disease cycle of important nematode diseases caused by Meloidogyne, Heterodera, Pratylenchus, Ditylenchus, Radopholus, Aphelenchoides, Anguina, Bursaphelenchus, Rotylenchulus, Xiphinema etc. Basic principles of nematode management - regulatory and quarantine, cultural, host resistance, biological and chemical methods; Isolation of nematode from soil and plant materials, and other basic nematological techniques.	9
5.	**Unit 5 Symptoms caused by nematodes with examples** Interaction between plant parasitic nematodes and disease causing fungi, bacteria and viruses . Different methods of nematode management. Cultural methods (Crop rotation, fallowing, soil amendments, other land management techniques). Physical methods (Soil solarization, hot water treatment). Biological methods, Chemical methods (fumigants, non fumigants).Resistant varieties.	10

403 P Applied Entomology and Nematology **Credits 01**

Course Contents:

1. Dissection and temporary mounting of: - Antennae and mouth parts of Cockroach, and Mosquito
2. Methods of collection, preservation, and identification of economically important insects.
3. Identification of following insect pests (Order, family and specimen characters only): *Scirpophaga incertulus; Sitophilus oryzae; Callosobruchus chinensis, Leucinodes orbonalis; Anomis sabulifera; Pyrilla perpusilla*.
4. Identification and medical significance of following insects (adults) through permanent slides/photographs: *Aedes sp., Culex sp., Anopheles sp.* [for mosquito, larvae and both sexes of adults],
5. Visits to any one place of applied entomological significance (submission of a field report): a. Agricultural field/ forest for on spot study of pests and damage caused.
6. Extraction of nematodes from soil and plant tissues following combined Cobb's sieving technique and Baermann funnel technique
7. Counting and estimation of plant parasitic nematodes
8. Experimental techniques used in pathogenicity studies with root-knot nematode

Minor 401: Ecology **Credits 04**

Minor 401T Ecology **Credits 03**

Course objectives and expected outcome

This course introduces the basics of ecosystem structure, composition, and significance. This study provides information about factors affecting the population and community. Developed environmental monitoring skills, including conduct of experiments and data analysis. It also teaches about the significance of wildlife, the threatened category, and the conservation strategy of wildlife animals in an ecosystem.

Course Contents:

Sl. No.	TOPICS	Allotted Lecture
1.	**Unit 1: Introduction to Ecology** • History of ecology, Autoecology and synecology, Levels of organization, Laws of limiting factors, Study of physical factors, Atmosphere, Hydrosphere and Biosphere	4
2.	**Unit 2: Population** • Unitary and Modular populations • Unique and group attributes of population: Demographic factors, lifetable, fecundity table, • Survivorship curves, dispersal and dispersion. • Geometric, exponential and logistic growth, equation and patterns, r and k strategy, Populations • Population regulation-density-dependent and independent factors • Population Interactions, Gause's Principle with laboratory and field examples, Lotka-Volterra equation for competition and elimination.	20
3.	**Unit 3: Community** • Community characteristics: species diversity, abundance, dominance, richness, • Vertical stratification, Ecotone and edge effect,	11

	Ecological succession with one example	
4.	**Unit 4: Ecosystem** • Definition and types of ecosystems with example, Foodchain: Detritus and grazing food chains, • Linear and Y-shaped food chains, Food web, Energy flow through theecosystem, Ecological pyramids and Ecological efficiencies. • Nutrient and biogeochemical cycle, Nitrogen cycle • Human modified ecosystem	10
5.	**Unit 5: Applied Ecology** • Wildlife conservation (in-situ and ex-situ conservation) • Management strategies for tiger conservation; Wildlife protection act (1972)	5

Suggested Readings:

- Krebs,C.J.(2001).Ecology.VI Edition. Benjamin Cummings.
- Odum,E.P.,(2008).Fundamentals of Ecology. Indian Edition.
- Brooks/ColeRobert Leo Smith Ecology and field biology.Harper and Row publisher.
- Ecology: Theories & Application (2001).4th Edition by Peter Stilling.
- Ecology by Cain,Bowman & Hacker. 3rd edition.Sinauer associates

Minor 401P Ecology **Credits 01**

Course contents:

4. Determination of population density in a natural/hypothetical community by Quadrate method and calculation of Shannon-Weiner diversity index for the same community
5. Study of an aquatic ecosystem: Phytoplankton and zooplankton, Determination of pH, and Dissolved Oxygen content (Winkler'smethod) and free CO2.
6. Project report on costal ecosystem

RAJA NARENDRALAL KHAN WOMEN'S COLLEGE (AUTONOMOUS)

Semester-V
Course Structure

Sl. No.	Name of the Courses	No. of Papers	Credits	Full marks
1	Major	04	16(4x4)	300(75x4)
2	Minor	01	04	75
Total		***05***	***20***	***375***

Raja N. L. Khan Women's College (Autonomous)

Curriculum for Undergraduate in Zoology

[NEP 2020]

Semester-V

Sl. No.	Name of the Subject	Nature	Code	Teaching Scheme in hour per week			Credit	Marks
				L	T	P		
ZOOMJ501	**MJ501T:** Cell Biology	Major Course		3	0	0	4	75
	MJ501P: Cell Biology (Practical)	Major Cource		0	0	1		
ZOOMJ502	**MJ502T:** Molecular Biology	Major Cource		3	0	0	4	75
	MJ502P: Molecular Biology (Practical)	Major Cource		0	0	1		
ZOOMJ503	**MJ503T:** Biochemistry	Major Cource		3	0	0	4	75
	MJ503P: Biochemistry (Practical)	Major Cource		0	0	1		
ZOOMJ504	**MJ504T:** Endocrinology	Major Cource		3	0	0	4	75
	MJ504P: Endocrinology (Practical)	Major Cource		0	0	1		
ZOOMI501	**MI501 T:** Parasitology	Minor Course		3	0	0	4	75
	MI501 P: Parasitology (Practical)	Minor Course [Practical]		0	0	1		

L=Lecture, T=Tutorial, P=Practical

Major 501: Cell Biology **Credits: 04**

Major 501T: Cell Biology **Credits: 03**

Course objectives and expected outcome

Students will acquire comprehensive knowledge of membrane structure and composition, protein transport and trafficking, the cytoskeleton, cell movement, and the extracellular matrix. They will gain a thorough understanding of the mechanisms of cell division and its regulation through different checkpoints. The cell cycle, apoptosis, signal transduction, and cancer biology will be integral components of the course.

Course Contents:

Sl. No.	Topics	Allotted Lecture
1.	**Unit1: Overview of Cells** Basic structure of Prokaryotic and Eukaryotic cells, Cell wall, nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes,Viruses,Viroid, Prion and Mycoplasma.	5
2.	**Unit 2: Plasma Membrane** Structure of model membrane, lipid bilayer and membrane protein diffusion, osmosis, ion channels, active transport, membrane pumps, mechanism of sorting and regulation of intracellular transport, electrical properties of membranes, Ultra structure and composition of Plasma membrane: Fluid mosaic model, Transport across membrane: Active and Passive transport, Facilitated transport, Cell junctions: Tight junctions, Gap junctions, Desmosomes.	8
3.	**Unit3: Cytoplasmic micorganelles I** Structure and Functions: Endoplasmic Reticulum, Golgi Apparatus, Lysosomes, Protein sorting and mechanisms of vesicular transport	5
4.	**Unit4: Cytoplasmic micorganelles II** Mitochondria: Structure, Semi-autonomous nature, Endosymbiotic hypothesis, Mitochondrial Respiratory Chain, Chemi-osmotic hypothesis, Peroxisomes: Structure and Functions, Centrosome: Structure and Functions	5
5.	**Unit 5: Cytoskeleton** Type, structure and functions of cytoskeleton, Accessory proteins of microfilament &microtubule, A brief idea about molecular motors.	5
6.	**Unit 6: Nucleus** Structure of Nucleus: Nuclear envelope, Nuclear pore complex, Nucleolus, Chromatin: Euchromatin and Hetrochromatin and packaging (nucleosome).	5
7.	**Unit 7: Cell cycle and Cancer** Cell cycle and its regulation, Cancer (Concept of oncogenes and tumor suppressor genes with special reference to p53, Retinoblastoma and Ras and APC). Therapeutic interventions of uncontrolled cell growth, apoptosis. Mitosis and Meiosis: Basic process and their significance.	7
8.	**Unit 8: Cell Signaling**	5

	Hormones and their receptors, cell surface receptor, signaling through G-protein coupled receptors, signal transduction pathways, second messengers, regulation of signaling pathways, bacterial chemotaxis and quorum sensing.	

Suggested Readings:

- Lewin'sCells–3rd Edition– Cassimeris/Lingappa/Plopper–Johns&BartlettPublishers
- Biologyof Cancer byRobert.A.Weinberg.2ndedition.
- Cooper, G.M. and Hausman, R.E. (2009). The Cell: A Molecular Approach. VEdition. ASM Press and Sunderland, Washington, D.C.; Sinauer Associates, MA.
- Bruce Albert, Bray Dennis, Levis Julian, Raff Martin, Roberts Keith and WatsonJames (2008). Molecular Biology of the Cell, V Edition, Garland publishing Inc., NewYork and London.

Major 501P: Cell Biology **Credits: 01**

Course Contents:

1. Cytological preparation of Meiotic stages from short horned Grasshopper Testis.
2. Preparation of permanent slide to show the presence of Barr body in human female blood cells/cheek cells.
3. Mitochondria identification through vital staining

Major 502: Molecular Biology **Credits: 04**

Major 502T: Molecular Biology **Credits: 03**

Course objectives and expected outcome

The course will elucidate the fundamentals of genetics and Mendelian laws, the concept of alleles, and the idea of linkage and crossing over of genes. It will provide an avenue for becoming familiar with various types of genetic data (genotyping, expression, and sequence data), chromosomal mapping, the genetic composition of biological populations, and evolutionary factors that elucidate variation. In-depth knowledge of chemical and molecular processes between cells, including the central dogma, will be ensured by the end of this course.

Course Contents:

Sl. No.	Topics	Allotted Lecture
1.	**Unit1: Nucleic Acids** Salient features of DNA and RNA. Watson and Crick Model of DNA	4
2.	**Unit2: DNA Replication** Mechanism of DNA Replication in Prokaryotes and eukaryotes, Semi-conservative, bidirectional and discontinuous Replication, RNA priming, Replication of telomeres, Unit of replication, enzymes involved, replication origin and replication fork, fidelity of replication, extrachromosomal replicons, DNA damage and repair mechanisms, homologous and site-specific recombination.	9
3.	**Unit3: Transcription** Mechanism of Transcription in prokaryotes and eukaryotes, Transcription factors, formation of initiation complex, transcription activator and repressor, RNA polymerases, capping, elongation, and termination, RNA processing, RNA editing, splicing, and polyadenylation, structure and function of different types of RNA, RNA transport, Difference between prokaryotic and eukaryotic transcription.	9
4.	**Unit4: Translation** Mechanism of protein synthesis in prokaryotes, Ribosome structure and assembly in prokaryotes, Ribosome, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase, and translational proof-reading, translational inhibitors, Post- translational modification of proteins fidelity of protein synthesis, charging of tRNA; genetic code, Degeneracy of the genetic code and Wobble Hypothesis; Inhibitors of protein synthesis; Difference between prokaryotic and eukaryotic translation	10
5.	**Unit5: Post Transcriptional Modifications and Processing of Eukaryotic RNA** Capping and PolyA tail formation in mRNA; Split genes: concept of introns and exons, splicing mechanism, alternative splicing, exon	5

	shuffling, and RNA editing, Processing of tRNA	
6.	**Unit6: Gene Regulation** Regulation of Transcription in prokaryotes: *lac* operon and *trp* operon; Regulation of Transcription in eukaryotes: Activators, enhancers, silencer, repressors, miRNA mediated gene silencing, Genetic imprinting	4
7.	**Unit7: DNA Repair Mechanisms** Types of DNA repair mechanisms, RecBCD model in prokaryotes, nucleotide and base excision repair, SOS repair	4

Suggested Readings:

- Molecular Cell Biology by Harvey Lodish. 7th Edition. W.H.Freeman.
- Molecular Biology of the Gene by Watson.7th Edition.Pearson.
- iGenetics: A Molecular Approach by Peter. J. Russell.3rd edition.Pearson Benjamin Cummings.

Major 502P: Molecular Biology **Credits: 01**

Course Contents:

1. Preparation of Salivary gland polytene chromosome from *Drosophila melanogaster*
2. Isolation & purification of DNA from tissue.
3. Principle & method of Agarose Gel Electrophoresis.

Major 503: Biochemistry **Credits: 04**

Major 503T: Biochemistry **Credits: 03**

Course objectives and expected outcome

The course aims to provide students with a basic understanding of molecular architecture of eukaryotic cells and organelles, including membrane structure and dynamics, principles of bioenergetics and enzyme catalysis, chemical nature of biological macromolecules, their three-dimensional construction, and the principles of molecular recognition, metabolism of dietary and endogenous carbohydrate, lipid, and protein; how inherited genetic errors can cause both single gene and multifactorial diseases and the consequences of this inheritance for individuals and populations.

Course Contents:

Sl. No.	Topics	Allotted Lecture
1.	**Unit 1: Carbohydrates** • Structure and Biological importance: Monosaccharides, Disaccharides, Polysaccharides; Derivatives of Monosaccharides • Carbohydrate metabolism: Glycolysis, Citric acid cycle, Pentose phosphate pathway, Gluconeogenesis	10
2.	**Unit 2: Lipids** • Structure and Significance: Physiologically important saturated and unsaturated fatty acids, Tri-acylglycerols, Phospholipids, Sphingolipid, Glycolipids, Steroids, Eicosanoids and terpinoids. • Lipid metabolism: β-oxidation of fatty acids; Fatty acid biosynthesis	8
3.	**Unit 3: Proteins** • Amino acid: Structure, Classification, General and Electro chemical properties of α-amino acids; Physiological importance of essential and non-essential amino acids • Proteins: Bonds stabilizing protein structure; Levels of organization • Protein metabolism: Transamination, Deamination, Urea cycle, Fate of C-skeleton of Glucogenic and Ketogenic amino acids	10
4.	**Unit 4: Nucleic Acids** • Structure: Purines and pyrimidines, Nucleosides, Nucleotides, Nucleic acids • Types of DNA and RNA, Complementarity of DNA, Hpyo- Hyperchromaticity of DNA • Basic concept of nucleotide metabolism	6
5.	**Unit 5: Enzymes**	8

	Nomenclature and classification; Cofactors; Specificity of enzyme action; Isozymes; Mechanism of enzyme action; Enzyme kinetics; Derivation of Michaelis-Menten equation, Lineweaver-Burk plot; Factors affecting rate of enzyme-catalyzed reactions; Enzyme inhibition; Allosteric enzymes and their kinetics; Strategy of enzyme action- Catalytic and Regulatory (Basic concept with one example each)	
6.	**Unit 5: Oxidative Phosphorylation** Redox systems; Review of mitochondrial respiratory chain, Inhibitors and un-couplers of Electron Transport System	5

Suggested Readings:

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.
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 503P: Biochemistry **Credits: 01**

1. Qualitative tests of functional groups in carbohydrates, proteins and lipids.
2. Quantitative estimation of Lowry Methods.
3. Demonstration of proteins separation by SDS-PAGE.
4. To study the enzymatic activity of Trypsin and Lipase.
5. To perform the Acid and Alkaline phosphatase assay from serum/ tissue.

Major 504: Endocrinology **Credits: 04**

Major 504T: Endocrinology **Credits: 03**

Course objectives and expected outcome

Students should be able to demonstrate/illustrate how the homeostatic model applies to every endocrine system in normal physiology and disease, how every aspect of our physiology and behavior is directly controlled or modified by hormones using reproduction, growth, development, stress, and metabolism as examples, how endocrine systems can be disrupted with respect to synthesis, knowing about chemical communication process in our body

Course Contents:

Sl. No.	Topics	Allotted Lecture
1.	**Unit-1: Introduction to Endocrinology** General idea of Endocrine systems, types of gland, Classification, Characteristic and Transport of Hormones, Neurosecretions and Neurohormones	10
2.	**Unit-2: Epiphysis, Hypothalamo-hypophysial Axis** Structure of pineal gland, Secretions and their functions in biological rhythms and reproduction. Structure and functions of hypothalamus and Hypothalamic nuclei, Regulation of neuroendocrine glands, Feedback mechanisms Structure of pituitary gland, Hormones and their functions, Hypothalamo-hypophysial portal system, Disorders of pituitary gland.	10
3.	**Unit-3: Peripheral Endocrine Glands** Structure, Hormones, Functions and Regulation of Thyroid gland, Parathyroid, Thymus, Adrenal, Pancreas, Ovary and Testis. Hormones in homeostasis, Disorders of endocrine glands	10
4.	**Unit-4: Regulation of Hormone Action** Mechanism of action of steroidal, non-steroidal hormones with receptors. Bioassays of hormones using RIA & ELISA.	10

	Estrous cycle in rat and menstrual cycle in human. Multifaceted role of Vasopressin & Oxytocin. Hormonal regulation of parturition.	

Suggested Readings:

1. Guyton and Hall. Textbook of Medical Physiology. 13th Edition
2. Histology: A Text and Atlas. Sixth Edition. Ross & Pawlina. Lippincott Williams & Wilkins.
3. Vertebrate Endocrinology by David O. Norris,

Major 504P: Endocrinology **Credits: 01**

Course contents:

1. Dissect and display of pituitary gland of fish.
2. Study of the permanent slides of all the endocrine glands
3. Tissue fixation, embedding in paraffin, microtomy and slide preparation of any endocrine gland
4. Estimation of plasma level of any hormone using ELISA.
5. Designing of primers of any hormone.

Minor 501: Parasitology **Credits: 04**

Minor 501 T: Parasitology **Credits: 03**

Course objectives and expected outcome:

The course will provide an understanding of the diversity and biology of parasites, besides the epidemiological aspects of different parasitic diseases will be explored and students will be able to gain knowledge regarding the mode of transmission of parasitic diseases and its preventive measures.

Course Contents:

Sl. No.	Topics	Allotted Lecture
1.	**Unit 1: Introduction to Parasitology** Types of parasites and hosts. The basic concept of Parasitism: Commensalism, Symbiosis, Phoresis, Mutualism, Predation, Carrier and Vectors. Host parasitic interactions	10
2.	**Unit 2: Parasitic Protists** -Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of *Plasmodium vivax, Trypanosoma gambiense, Leishmania donovani*	6
3.	**Unit 3: Parasitic Platyhelminthes** -Study of Morphology, Life Cycle, Prevalence, Epidemology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of, *Diphyllobothrium latum, Taenia solium*	5
4.	**Unit 4: Parasitic Nematodes** Study of Morphology, Life Cycle, Prevalence, Epidemology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of *Ascaris lumbricoides, Brugia malayi* and *Loa loa*; Nematode Plant interaction; Gall formation.	7
5.	**Unit 5: Parasitic Arthropods** Biology, importance and control of ticks (Soft tick *Ornithodoros*, Hard tick *Ixodes*), mites (*Sarcoptes*), Lice(*Pediculus*), Flea(*Xenopsylla*) and Bug (*Cimex*)	10
6.	**Unit 6: Zoonotic disease (with special reference to)** *Wuchereria bancrofti , Schistosoma haematobium, Paragonimus westermani. Giardia intestinalis*	**7**

Suggested Readings:

- Arora, D. R and Arora,B.(2001) Medical Parasitology.II Edition. CBS Publications and Distributors
- E.R Noble and G.A. Noble(1982) Parasitology: The biology of animal parasites, V Edition, Lea & Febiger
- Ahmed, N.,Dawson,M.,Smith,C. and Wood, Ed,(2007) Biology of Disease

- Taylor and Francis Group
- Parija, S. C. Textbook of medical parasitology, protozoology & helminthology(Text and colour Atlas), II Edition, All India Publishers & Distributers,Medical Books Publishers, Chennai,Delhi
- Rattan Lal Ichhpujani and Rajesh Bhatia. Medical Parasitology,III Edition ,Jaypee Brothers Medical Publishers(P) Ltd.,New Delhi.
- Page66Meyer, Olsen & Schmidt's Essestials of Parasitology, Murray, D.Dailey, W.C. Brown Publishers.
- K. D . Chatterjee(2009). Parasitology:Protozoology and Helminthology. XIII Edition, CBS Publishers & Distributors (P) Ltd.

Minor 501 P: Parasitology **Credits: 01**

Course Contents:

1. Study of life stages of *Giardia intestinalis, Trypanosoma gambiense, Leishmania donovani, Plasmodium* sp. through permanent slides / photographic plate.

2. Study of adult and life stages of *Schistosoma haematobium,* through permanent slides/ photographic plate.

5. Identification: *Pediculous sp., Xenopsylla sp., Cimex sp*. *Ascaris sp.,Taenia sp.*

6. Study of nematode/cestode parasites from the intestines of Cockroach

RAJA NARENDRALAL KHAN WOMEN'S COLLEGE (AUTONOMOUS)

Semester-VI
Course Structure

Sl. No.	Name of the Courses	No. of Papers	Credits	Full Marks
1	Major	04	16(4x4)	300(75x4)
2	Minor	01	04	75
3	Summer Internship	01	02	50
Total		***06***	***22***	**425**

Raja N. L. Khan Women's College (Autonomous)

Curriculum for Undergraduate in Zoology

[NEP 2020]

Semester-VI

Paper Code	Name of the Subject	Nature	Teaching Scheme in hour per week			Credit	Marks
			L	T	P		
ZOOMJ601	**MJ601T:** Genetics	Major Course	3	0	0	4	75
	MJ601P: Genetics (Practical)	Major Cource	0	0	1		
ZOOMJ602	**MJ602T:** Immunology	Major Cource	3	0	0	4	75
	MJ602P: Immunology (Practical)	Major Cource	0	0	1		
ZOOMJ603	**MJ603T:** Developmental Biology	Major Cource	3	0	0	4	75
	MJ603P: Developmental Biology (Practical)	Major Cource	0	0	1		
ZOOMJ604	**MJ604T:** Evolution	Major Cource	3	0	0	4	75
	MJ604P: Evolution (Practical)	Major Cource	0	0	1		
ZOOMI601	**MI601T:** Parasitology	Minor Course	3	0	0	4	75
	MI601P: Parasitology (Practical)	Minor Course [Practical]	0	0	1		

L=Lecture, T=Tutorial, P=Practical

Major 601: Genetics **Credits: 04**

Major 601T: Genetics **Credits: 03**

Course objectives and expected outcome

This course aims to offer an overview of genetics starting from inheritance biology to the current understanding of various phenomena like crossing over, recombination, sex determination, mutations and transposition. In addition, fathoming the microbial genetics has been prioritized in this syllabus. So, the course infiltrated with dynamic areas will assist in developing sound fundamental knowledge of the principles of genetics, to be used as a steppingstone for higher studies and research in this field.

Course Contents:

Genetics

Sl. No.	Topics	Allotted Lecture
1.	**Unit 1: Mendelism and its Extension** Basic principles of heredity: Mendel's laws, monohybrid and dihybrid crosses; Incomplete dominance and co-dominance; Epistasis; Multiple alleles, Isoallele, Pseudoallele, Lethal alleles; Pleiotropy; Penetrance & Expressivity; Sex-linked, sex-influenced and sex-limited inheritance; Polygenic inheritance.	8
2.	**Unit 2: Linkage, Crossing Over and Chromosomal Mapping** Linkage: Complete & incomplete Linkage; Crossing over: molecular basis; Measuring Recombination frequency and linkage map construction using three factor crosses; Interference and Coincidence.	8
3.	**Unit 3: Sex Determination** Genetic basis of sex-determining Systems; Mechanism sex determination in *Drosophila melanogaster*; Sex determination in human; Dosage compensation in Drosophila and Human.	6
4.	**Unit 4: Mutations** Types of gene mutations; Categories of chromosomal aberrations; Non-disjunction and variation in chromosome number; Different chromosomal disorders in human: Turner's syndrome, Klinefelter's syndrome, Down syndrome, Cri-du-Chat syndrome; Molecular basis of mutations in relation to UV light and chemical mutagens.	8

5	**Unit 5: Extra-chromosomal inheritance** Criteria for extra-chromosomal inheritance; Maternal effects: coiling in snail shells; Infective heredity: kappa particles in Paramecium.	**4**
6	**Unit 6: Transposable Genetic Elements** Transposons in bacteria; Ac-Ds elements in maize; P elements in Drosophila; Retrotransposons; LINE, SINE and Alu elements in human.	**4**
7	**Unit 7: Microbial Genetics** Bacterial genetic elements: types and structural organization; Recombination in bacteria and gene mapping; Transformation; Conjugation; Transduction (Generalized and Specialized); Complementation tests; General principles and genetics of bacteriophage (T4 and Lambda phage): structure, genome organization and life cycle (lytic and lysogenic).	**5**

Suggested Readings:

- Snustad, D.P. and Simmons, M.J. (2009). Principles of Genetics, 5th Edition. John Wiley and Sons Inc.
- Russel, P.J. (2010). iGenetics: A Molecular Approach. Pearson Benjamin.
- Watson, J.D. (2014). Molecular Biology of the gene, 7th Edition, Pearson.
- Klug, W.S., Cummings, M.R. and Spencer, C.A. (2012). Concepts of Genetics, 10th Edition. Benjamin Cummings
- Krebs, J.E., Goldstein E.S. and Kilpatrick S.T. (2009). Lewins's Genes X, 10th Edition. Jones and Bartlett.
- Gupta, P.K. (2007). Genetics: Classical To Modern. Rastogi Publications, Meerut.

Major 601P: Genetics **Credits: 01**

Course Contents:

1. Verification of Mendelian Ratio using Chi square analyses.
2. Preparation of Linkage Maps based on conjugation.
3. Pedigree analysis of some human inherited traits.
4. Preparation of human karyotype and study the chromosomal aberrations with respect to number, translocation, deletion etc. from the pictures provided.
5. Study of mutant phenotypes of Drosophila from photograph.

Major 602: Immunology **Credits: 04**

Major 602T: Immunology **Credits: 03**

Course objectives and expected outcome

At the end of this course students will be able to know about our defense system, which are working throughout the clock and trying to make us healthy and free from the infections of pathogens. At the same time, they will be able to understand how disease occurs in an organism and its curing process or its preventive measures with the help of vaccination for better tomorrow.

Course Contents:

Sl. No.	Topics	Allotted Lecture
1.	**Unit 1: Overview of Immune System:** Basic concepts of health and diseases, Historical perspective of Immunology, Cells and organs of the Immune system	5
2.	**Unit2: Innate and Adaptive Immunity:** Anatomical barriers, Inflammation, Cell and molecules involved in innate immunity, Adaptive immunity (Cell mediated and Humoral).	5
3.	**Unit 3: Antigens:** Antigenicity and immunogenicity, Immunogens, Adjuvants and Haptens, Factors influencing immunogenicity, B and T-Cell epitopes	5
4.	**Unit 4: Immunoglobulins:** Structure and functions of different classes of immunoglobulins, Antigen-antibody interactions, Immunoassays (ELISA and RIA), Hybridoma technology, Monoclonal antibody production	8
5.	**Unit 5: Major Histocompatibility Complex:** Structure, Types and functions of MHC molecules. Structure of T cell Receptor and its signalling, Tcell development & selection, Autoimmune disease	5
6.	**Unit 6: Cytokines:** Types, properties and functions of cytokines.	2

7.	**Unit7: Complement System:** Components and pathways of complement activation.	4
8.	**Unit 8: Hypersensitivity** Gelland Coombs'classification and brief description of various types of hypersensitivities.	3
9.	**Unit 9: Immunology of diseases** Malaria, Filariasis, Dengue and Tuberculosis	5
10.	**Unit 10: Vaccines** Various types of vaccines. Active& passive immunization (Artificial and natural).	3

Suggested Readings:

- Kindt, T. J.,Goldsby,R.A.,Osborne, B.A.and Kuby,J(2006).Immunology, VI Edition. W.H. Freeman and Company.
- Abbas, K. Abul and Lechtman H. Andrew(2003.) Cellular and Molecular Immunology. V Edition. Saunders Publication.

Major 602P: Immunology **Credits: 01**

Course contents:

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. Study the macrophage from Rat/Pigeon
5. ABO blood group determination.
6. Demonstration of ELISA

Major 603: Developmental Biology **Credits: 04**

Major 603T: Developmental Biology **Credits: 03**

Course objectives and expected outcome

The goal of this course is to provide a thorough understanding of the ideas of early animal development. This course requires students to gain critical awareness for approaches used to research embryonic development in animals. Different aspects of animal development will be explored in one model system or another. After teaching the topics, students will learn about several techniques to studying them. Topics to be covered include stem cell regeneration, disease development, and evolutionary change mechanisms.

Course Contents:

Sl. No.	Topics	Allotted Lecture
1.	**Unit 1: Introduction to Developmental Biology** Basic concepts: Phases of Development, Cell-cell interaction, Differentiation and growth, Cytoplasmic Determinants and gene expression, Biogenetic law/ Recapitulation theory	5
2.	**Unit 2: Early Embryonic Development** Outline knowledge of gametogenesis; ultrastructure of sperm and ovum; Types of eggs, Egg membranes; physical and molecular events of Fertilization in sea urchin and mammals.	10
3.	**Unit 3: Early Embryonic Development** Cleavage- types, role of yolk in cleavage. Formation of blastula in chick. Fate map, morphogenetic movement and process of gastrulation in chick. Embryonic induction and organizer concept.	10
4.	**Unit 3: Late Embryonic Development** Fate of Germ Layers; Formation and functions of Extra-embryonic membranes in Chick; Implantation of embryo in humans, Placenta (Structure, types and functions of placenta), Implantation abnormalities	6
5.	**Unit 4: Post Embryonic Development** Development of brain and Eye in Chick. Regeneration: Modes of regeneration, epimorphosis, morphallaxis and compensatory regeneration	7
6.	**Unit 5: Implications of Developmental Biology** Teratogenesis: Teratogenic agents and their effects on embryonic development, In vitro fertilization (IVF) and embryo transfer, Stem cell: Concept of potency, types, markers and applications of stem cell therapy, Amniocentesis	7

Suggested Readings:

- Gilbert S.F. 2010. Developmental Biology, IX Edition, Sinauer Associates, Inc.,
- Publishers
- Verma PS, Agarwal VK. 2014. Chordate Embryology: Developmental Biology. S. Chand Pub.

- Chaki K C; Kundu G & Sarkar S. - Introduction to General Zoology; Vol. 1, NCBA, Kolkata
- Slack JMW. 2012. Essential Developmental Biology. Wiley-Blackwell

Major 603P: Developmental Biology **Credits: 01**

1. Study of whole mounts of developmental stages of chick embryo through permanent slides: 24, 48, 72 and 96 hours of incubation

2. Identification of slide of placenta.

3. Study the developmental stages of Drosophila.

Major 604: Evolution **Credits: 04**

Major 604T: Evolution **Credits: 03**

Course objectives and expected outcome

The curriculum in evolution includes modern aspects of evolution and molecular phylogenetic trees. DNA and amino acid sequences are studied by genomics and proteomics data analysis and find out the similarities and dissimilarities between different species of the same or diverse group. By nearest neighbor analysis and by the principle of parsimony, a gene tree could be made. Students benefit from the study of genome analysis and by finding the sequences; they may be able to find out the molecular systematic position.

Course Contents:

SI. No	Topics	Allotted Lecture
1.	**Unit-1:** Life's Beginnings: Chemogeny, RNA world, Biogeny, Origin of photosynthesis, volution of eukaryotes.	4
2.	**Unit-2:** History of evolutionary concept, Lamarkism, Darwinism and Neo Darwinism.	5
3.	**Unit-3:** Geological time scale, Fossil records of Hominids (from *Australopithacus* to *Homo sapiens*), evolution of horse. Neutral theory of molecular evolution, Molecular clock.	6
4.	**Unit-4:** Sources of variations: Heritable variations and their role in evolution.	4
5.	**Unit-5:** Population genetics: Hardy-Weinberg Law (statement and derivation of equation, application of law to biallelic Population); Evolutionary forces upsetting H-W equilibrium; Natural selection (concept of fitness, types of selection, selection coefficient, mode of selection heterozygous superiority). Genetic Drift mechanism (founder's effect, bottleneck phenomenon). Role of Migration and Mutation in changing allele frequencies.	9
6.	**Unit-6:** Species concept, Isolating mechanisms, modes of speciation. Adaptive radiation /Macroevolution (exemplified by Galapagos finches).	4
7.	**Unit-7:** Extinctions, Background, and mass extinctions (causes and effects), detailed example of K-T extinction.	4
8.	**Unit-8:** Phylogenetic trees, Construction & interpretation of Phylogenetic tree using parsimony, Convergent & Divergent evolution.	4
9.	**Unit-9:** Origin and Evolution of Man, Unique Hominin characteristics contrasted with primate characteristic Molecular analysis of human origin.	5
Suggested Readings: ➢ Campbell, N. A. and Reece J. B (2011). Biology. IXE dition. Pearson, Benjamin, Cummings.		

- Douglas, J. Futuyma (1997). Evolutionary Biology. Sinauer Associates.
- Geneics: A Molecular Approach. 3rd edition. Peter. J. Russell.

Major 604P: Evolution **Credits: 01**

Course Contents:

1. Study of fossils from models/pictures
2. Study of homology and analogy from suitable specimens
3. Study of Hardy-Weinberg Law by chi square analysis.
4. Studies of Phylogenetic tree to show the relationship between different phyla
5. Field visit to any National Park to study the adaptive modification of animal.

Minor 601: Parasitology **Credits: 04**

Minor 601 T: Parasitology **Credits: 03**

Course objectives and expected outcome:

The course will provide an understanding of the diversity and biology of parasites, besides the epidemiological aspects of different parasitic diseases will be explored and students will be able to gain knowledge regarding the mode of transmission of parasitic diseases and its preventive measures.

Course Contents:

Sl. No.	Topics	Allotted Lecture
1.	**Unit 1: Introduction to Parasitology** Types of parasites and hosts. The basic concept of Parasitism: Commensalism, Symbiosis, Phoresis, Mutualism, Predation, Carrier and Vectors. Host parasitic interactions	10
2.	**Unit 2: Parasitic Protists** -Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of *Plasmodium vivax, Trypanosoma gambiense, Leishmania donovani*	6
3.	**Unit 3: Parasitic Platyhelminthes** -Study of Morphology, Life Cycle, Prevalence, Epidemology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of, *Diphyllobothrium latum, Taenia solium*	5
4.	**Unit 4: Parasitic Nematodes** Study of Morphology, Life Cycle, Prevalence, Epidemology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of *Ascaris lumbricoides, Brugia malayi* and *Loa loa*; Nematode Plant interaction; Gall formation.	7
5.	**Unit 5: Parasitic Arthropods** Biology, importance and control of ticks (Soft tick *Ornithodoros*, Hard tick *Ixodes*), mites (*Sarcoptes*), Lice(*Pediculus*), Flea(*Xenopsylla*) and Bug (*Cimex*)	10
6.	**Unit 6: Zoonotic disease (with special reference to)** *Wuchereria bancrofti , Schistosoma haematobium, Paragonimus westermani. Giardia intestinalis*	**7**

Suggested Readings:

- Arora, D. R and Arora,B.(2001) Medical Parasitology.II Edition. CBS Publications and Distributors
- E.R Noble and G.A. Noble(1982) Parasitology: The biology of animal parasites, V Edition, Lea & Febiger
- Ahmed, N.,Dawson,M.,Smith,C. and Wood, Ed,(2007) Biology of Disease
- Taylor and Francis Group

- Parija, S. C. Textbook of medical parasitology, protozoology & helminthology(Text and colour Atlas), II Edition, All India Publishers & Distributers,Medical Books Publishers, Chennai,Delhi
- Rattan Lal Ichhpujani and Rajesh Bhatia. Medical Parasitology,III Edition ,Jaypee Brothers Medical Publishers(P) Ltd.,New Delhi.
- Page66Meyer, Olsen & Schmidt's Essestials of Parasitology, Murray, D.Dailey, W.C. Brown Publishers.
- K. D . Chatterjee(2009). Parasitology:Protozoology and Helminthology. XIII Edition, CBS Publishers & Distributors (P) Ltd.

Minor 601 P: Parasitology **Credits: 01**

Course Contents:

1. Study of life stages of *Giardia intestinalis, Trypanosoma gambiense, Leishmania donovani, Plasmodium* sp. through permanent slides / photographic plate.

2. Study of adult and life stages of *Schistosoma haematobium,* through permanent slides/ photographic plate.

5. Identification: *Pediculous sp., Xenopsylla sp., Cimex sp*. *Ascaris sp.,Taenia sp.*

6. Study of nematode/cestode parasites from the intestines of Cockroach

RAJA NARENDRALAL KHAN WOMEN'S COLLEGE (AUTONOMOUS)

Semester-VII
Course Structure

Sl. No.	Name of the Courses	No. of Papers	Credits	Full Marks
1	Major	04	16(4x4)	300(75x4)
2	Minor	01	04	75
Total		***05***	***20***	***375***

Raja N. L. Khan Women's College (Autonomous)

Curriculum for Undergraduate in Zoology

[NEP 2020]

Semester-VII

Paper Code	Name of the Subject	Nature	Teaching Scheme in hour per week			Credit	Marks
			L	T	P		
ZOOMJ701	**MJ701T:** Animal Behavior	Major Course	3	0	0	4	75
	MJ701P: Animal Behavior (Practical)	Major Cource	0	0	1		
ZOOMJ702	**MJ702T:** Computational Biology	Major Cource	3	0	0	4	75
	MJ702P: Computational Biology (Practical)	Major Cource	0	0	1		
ZOOMJ703	**MJ703T:** Biophysics	Major Cource	3	0	0	4	75
	MJ703P: Biophysics (Practical)	Major Cource	0	0	1		
ZOOMJ704	**MJ704T:** Microbiology	Major Cource	3	0	0	4	75
	MJ704P: Microbiology (Practical)	Major Cource	0	0	1		
ZOOMI701	**MI701T:** Animal Behaviour	Minor Course	3	0	0	4	75
	MI701T: Animal Behaviour (Practical)	Minor Course [Practical]	0	0	1		

Major 701: Animal Behaviour **Credits: 04**

Major 701T: Animal Behaviour **Credits: 03**

Course objectives and expected outcome

This course will introduce you to animal behaviour research and its (very recent) history. We shall investigate the origins (ultimate cause) of behaviour, its role in an animal's survival and reproduction, and how behaviours evolve across evolutionary time. We will explore the evolution of benevolence, reproductive behaviour and communication. We will also discuss how animals choose foraging strategies, avoid predators, find suitable territories, and decide to migrate. The topic of behavioural research in zoos and its importance in species conservation will be examined. The course also covers the proximate reasons of behaviour, what drives behaviour, and the importance of ontogeny (organismal development). Although the basis of conduct lies in neurobiology and the brain, these will not be explored in length in this course. We will talk about the role of memory and learning in animal behaviour.

Course Contents:

Sl. No.	Topics	Allotted Lecture
1.	**Unit I-Concept of Ethology** • Introduction - Origin & history of Ethology • Brief profiles of Karl von Frish, Ivan Pavlov, Konard Lorenz, Niko Tinbergen. • Mechanism of Behaviour. Proximate & ultimate causes of behaviour. Stimulus, Releaser & Sign Stimulus.	7
2.	**Unit 2 - Classification of behavioural Patterns** • Behavioural Patterns: Stereotyped Behaviours, FAP, acquired behaviour, Instinct vs Learnt Behaviour, Associative learning, classical and operant Conditioning, Habituation, Imprinting, Conflict behaviours.	13
3.	**Unit 3. Social behaviour obstacles solving ecological behaviour, reproductive behaviour** • Social behaviour, Concept of society. • Communication and the senses. Ritualization, Signals, Altruism, Insect society with honey bee as example, Foraging in honey bee and advantages of the waggle dance. • Foraging behaviour -(Finding food, selecting food, capturing food, consuming food) Territorial behaviours, Antipredatory behaviours, Aggressive behaviours, Play behaviours. • Reproductive behaviour - Asymmetry of sex Sexual dimorphism, Male Choice, Inter sexual selection (male rivalry), Intra sexual selection (female choice), Diversity in mating system. Courtship behaviour, Parental care, Problems of offspring recognition, ethogram.	14

4.	**Unit 4 - Introduction to Chronobiology** • Historical developments in Chronobiology Biological oscillation: the concept of Average, amplitude, phase and period, adaptive significance of biological clocks.	5
5.	**Unit 5: 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, Photo period and regulation of seasonal reproduction of vertebrates, Role of melatonin, many behaviours in animals are rhythmic in nature.	6

Suggested Readings:

- Animal Behaviour by Drickamar.
- John Alcock, Animal Behaviour, Sinauer Associate Inc., USA.
- Paul W. Sherman and John Alcock, Exploring Animal Behaviour, Sinauer
- Associate Inc., Massachusetts, USA.
- Chronobiology Biological Timekeeping: Jay. C. Dunlap, Jennifer. J. Loros Patricia J. De Coursey (ed). 2004, Sinauer Associates, Inc. Publishers, Sunderland, MA, USA
- Insect Clocks D.S. Saunders, C.G.H. Steel, X., Afopoulou (ed.) R.D. Lewis. (3rdEd) 2002 Barens and Noble Inc. New York, USA
- Biological Rhythms: Vinod Kumar (2002) Narosa Publishing House, Delhi/ Springer-Verlag, Germany.

Major 701 P: Animal Behaviour **Credits: 01**

Course Contents:

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.
4. To study the phototaxis behaviour in insect larvae.

Major 702: Computational Biology **Credits: 04**

Major 702T: Computational Biology **Credits: 03**

Course objectives and expected outcome

By the end of this course, students will have gained a profound understanding of how statistical principles are employed in analyzing biological data. Through an intensive exploration of bioinformatics, genomics, and proteomics, students will develop the ability to apply their knowledge to practical scenarios. Furthermore, they will learn how to validate biological data using statistical methodologies, ensuring the reliability and accuracy of research outcomes.

Course Contents:

SI. No	Topics	Allotted Lecture
1.	**Unit 1: Introduction to Bioinformatics** Importance, Goal, Scope; Genomics, Transcriptions, System Biology, Functional Genomics, Metabolomics; Application and Limitation of Bioinformatics.	7
2.	**Unit 2: Biological Databases** Introduction to biological databases; Classification: Primary, secondary and composite databases; Nucleic acid databases (GenBank, DDBJ, EMBL); Protein databases (PIR,SWISS-PROT, TrEMBL, PDB); Metabolic pathway database (KEGG, EcoCyc, and MetaCyc).	7
3.	**Unit 3: Data Generation and Data Retrieval** Generation of data (DNA sequence, Protein sequencing, Mass spectrometry, Microarray), Sequence submission tools (e.g. BankIt, Sequin, Webin); Sequence file format (e.g, FASTA, Clustal, Swiss-Prot); Sequence annotation; Data retrieval system (SRS, Entrez).	7
4.	**Unit 4: Basic Concepts of Sequence Alignment** Scoring Matrices (PAM, BLOSUM), Methods of Alignment (BLAST); Local and global alignment, pair wise and multiple sequence alignments; Similarity, Identity and homology of sequences.	7
5.	**Unit 5: Applications of Bioinformatics** Structural Bioinformatics (3-D protein, PDB), Functional genomics (genome-wide and high throughput approaches to gene and protein function), Drug discovery method (Basic concept)	7
6.	**Unit 6: Biostatistics** • Introduction: Sample and population, Variables: Classification; Sampling techniques • Measurement of central tendencies: mean, mode, median • Measurement of dispersion: types, calculation of standard deviation, standard error, Co-efficient of Variance, Kurtosis and skewness. • Probability and Probability distribution: Laws of probability, normal distribution, Binomial and Poison distribution • Parametric and non-parametric tests:Chi-square test, Z-test,	10

	t-test • Correlation and regression: correlation coefficient and types/ models of regression • ANOVA: overview, models	

Suggested Readings:

- Daniel (1999). Biostatistics (3rd edition) Panima Publishing Corporation.
- Khan (1999). Fundamentals of Biostatistics, Panima Publishing Corporation
- Swardlaw, A.C. (1985). Practical Statistics for Experimental Biologists, Joh
- Bazin, M.J. (1983). Mathematics in microbiology Academic press
- Campbell, R.C. (1974). Statistics for Biologists, Cambridge Univ. Press, Cambridge
- Bliss, C.I.K. (1967). Statistics in Biology, Vol.1 Mc Graw Hill, New York.
- Dhananjaya (2002). Introduction to Bioinformatics, www.sd-bio.com series 2. Jan (2001). Nucleic acid research, Genome Database issue
- Higgins & Taylor (2000). Bioinformatics, OUP.
- Baxavanis (1998). Bioinformatics.
- Fry, J.C. (1993). Biological Data Analysis. A practical Approach. IRL Press, Oxford.

Major 702P: Computational Biology Credits: 01

Course Contents:

1. Operation Microsoft word, Microsoft excel, Microsoft Power Point and Internet.
2. Preparation of graph of experimental data using MS Excel/software.
3. Computation of mean, median, mode, SD, SE, correlation coefficient, regression and ANOVA using available software.
4. Database searching, pairwise alignment – global and local, multiple sequence alignment, construction of phylogenetic tree, evaluation of secondary structure of protein, homology modelling

Major 703: Biophysics **Credits: 04**

Major 703T: Biophysics **Credits: 03**

Course objectives and expected outcome

The goal of this course is to provide a deep and broad physicochemical basis of common biological phenomena and laboratory methods. After teaching the topics, students will learn about several biophysical properties and techniques to study biophysics. Topics to be covered include properties of matter and solutions, thermodynamics and chemical kinetics, colloidal system, biophysical basis of separation, radioactivity, microscopy, biophysics of membrane and cellular energy currency.

Course Contents:

SI. No	Topics	Allotted Lecture
1.	**Unit 1: Properties of matter and solutions** Diffusion: Definition, factors, biological applications. Solution: solvent, solute. Osmosis: Definition, van't Hoff laws, Gibbs-Donnan effect, plasmolysis-deplasmolysis, factors, biological applications. pH: definition, biological significance.	5
2.	**Unit 2: Thermodynamics and chemical kinetics** Laws of thermodynamics, enthalpy, entropy, Gibbs free energy. Enzymes: properties, Michaelis-Menten equation, enzyme inhibition curves. Ribozymes.	6
3.	**Unit 3: Colloidal system** Definition, classification, properties, colloidal solution and true solution, lyophilic and lyophobic sol, adsorption.	5
4.	**Unit 4: Biophysical basis of separation / Instrumentation based on biophysical separation** Ultrafiltration and its biological application. Dialysis and its biological applications. Sedimentation: erythrocyte sedimentation rate. Ultracentrifugation. Chromatography and its types. Electrophoresis: gel electrophoresis and SDS-PAGE. Southern blotting, northern blotting and western blotting. RIA, ELISA and types. Flow cytometry.	10
5.	**Unit 5: Radioactivity** Radioisotopes, radioactive decays, effects of radioactivity on human bodies**.**	4
6.	**Unit 6: Microscopy** Properties of light and Beer-Lambert law. Bright field light microscopy. Dark-ground microscopy/ultramicroscopy. Phase-contrast microscopy. Fluorescence microscopy.	5
7.	**Unit 7: Biophysics of membrane** Micelle and liposome. SEM and TEM. Membrane transport: non-	6

	mediated transport of solutes, gases and water and carrier mediated transport. Membrane potential.	
8.	**Unit 8: Cellular energy currency** ATP as energy transducer, substrate level phosphorylation and oxidative phosphorylation.	4

Suggested Readings:

- Biophysics and Biophysical Chemistry by Debajyoti Das, Academic Publishers, Kolkata
- Tools of Biochemistry by Cooper, Terrance G; (Publisher)- New York: Wiley-Interscience
- "Biophysics: Tools and Techniques" by J. N. Agarwal
- "Biological Physics: Energy, Information, Life" by Philip Nelson
- "Biophysics: A Physiological Approach" by Patrick F. Dillon

Major 703P: Biophysics Credits: 01

Course Contents:

1. Estimation of pH of solution by pH meter.
2. Demonstration of Chromatographic techniques
3. Microscopic study of hypotonic and hypertonic treatment of mammalian erythrocytes.
4. Demonstration of phase-contrast and fluorescence microscopy (Live and virtual)

Major 704: Microbiology **Credits: 04**

Major 704T: Microbiology **Credits: 03**

Course objectives and expected outcome

The curriculum in microbiology includes historical perspective of microbiology, types of micro-organism, their morphological structures and distribution of normal flora in the body with their beneficial effects. Students will gain knowledge about different microbial pathogenicity, their mode of infection and different microbial disease. Students also know about different staining procedures and bacterial genetics.

Course Contents:

SL. No.	Topics	Allotted Lecture
1.	**Unit1: Introduction to Microbiology** Historical perspective of Microbiology, Prokaryotic pathogens, Eukaryotic pathogens.	4
2.	**Unit2**: **Bacterial taxonomy** Principles and modern approaches of bacterial taxonomy. Basic idea up to eight kingdom concept and domain concept of Carl Woose.	8
3.	**Unit3: Morphology of Bacteria and Virus** Cell wall (Structure of peptidoglycan), Cell envelope (Cell membrane, Differences between gram- positive and gram-negative species, External capsule and glycocalyx, Plasmids and episomes. Nuclear material, Bacterial Chromosome (Fundamental differences with eukaryotic chromosome). Reserve materials (carbon and phosphate reserve, cyanophycin), Cytoplasmic inclusions (Chlorosome, magnetosome, carboxysome, gasvesicles, ribosome). Structural organization of viruses, Prions and viroids.	8
4.	**Unit5: Pathogenicity of Microorganisms** Bacterial pathogenesis: Entry to the host, Adherence to host cells, Invasiveness, Bacterial toxins: Exotoxins, Endotoxins, Antigenic switching. Viral Pathogenesis: Cellular level (Cell death, Transformation, Cell fusion, Cytopathic effect). Initial infections: Routes of entry and dissemination to secondary sites, Typical secondary sites of localization, Virus shedding and mode of transmission; Factors involved intermination of acute infection.	8
5.	**Unit6: Infection of pathogens to human populations** Communicable, Non-communicable, Endemic, Epidemic, Pandemic and Sporadic.	2

6.	**Unit7: Diagnostic Microbiology and Bacteria culture** Koch's postulates, Sensitivity and specificity of test results, Principles and applications: Simple staining, Gram-staining, Acid-fast staining, Collection of specimens, Growth requirements and Growth factors, Oxygen requirement. Culture Media: Simple media, Complex media, Selective media and Enriched media.	4
7.	**Unit8: Genetic recombination in bacteria** Transformation, Conjugation-F+, F-, Hfr & F' strain, Transduction, Generalized &specialized types.	3
8.	**Unit9: Microbial Diseases** Name of pathogen, symptoms, pathogenesis, mode of action &preventive measures of following diseases: Bacterial (Polio, Typhoid, Staphylococcal Food Poisoning), Viral(Dengue, AIDS).	4

Suggested Readings:

- Cummings. Black, J. G. (2011).Microbiology:PrinciplesandExplorations.8th ed. John Wiley and Sons, New York.
- Campbell, R. (1983).MicrobialEcology.2nded.Oxford, Blackwell.
- Pinehuk, G. (2003). Schaum's outline Series: Theory and Problems of Immunology. McGraw-Hill.
- Presscott, L.M., Harley, J. P. and Klein, D.A. (2011).Microbiology, 8th ed. McGraw Hill, New York.
- Schlegel, H.G. (1993).GeneralMicrobiology.7thed. Cambridge University Press.
- Slonczeweski, J.L. and Foster, J.W. (2009).Microbiology-An Evolving Science. Norton.
- Talaro, K. and Talaro, A. (1999).Foundations in Microbiology.3rd ed. Dubuque, McGraw- Hill.
- Tortora, G.J., Funke, B. R., and Case. C.L. (2008).Microbiology. An Introduction.9th ed. Benjamin /Cummings Publishing. Menlo ParkCalif.
- Voyleys, B.A. (2002). The Biology of Viruses. 2nd Edn. McGraw Hill.

Major 704 P: Microbiology Credits: 01

Course Contents:

1. Simple staining and Gram's staining of bacteria.
2. Preparation of liquid media (broth) and solid media for routine cultivation of bacteria.
3. Preparation of slant and stab.
4. Pure culture techniques: Spread plate, Pour plate and Streak plate
5. Biochemical test for characterization: Catalase, Nitrate-reduction, Indole production, Methyl Red and Voges-Proskauer Test.
6. Microbiological examination of milk (Methylene blue reductase test).
7. Sugar fermentation test.

Minor 701: Animal Behaviour **Credits: 04**

Minor 701T: Animal Behaviour **Credits: 03**

Course objectives and expected outcome

This course will introduce you to animal behavior research and its (very recent) history. We shall investigate the origins (ultimate cause) of behaviour, its role in an animal's survival and reproduction, and how behaviours evolve across evolutionary time. We will explore the evolution of benevolence, reproductive behaviour and communication. We will also discuss how animals choose foraging strategies, avoid predators, find suitable territories, and decide to migrate. The topic of behavioral research in zoos and its importance in species conservation will be examined. The course also covers the proximate reasons of behaviour, what drives behaviour, and the importance of ontogeny (organismal development). Although the basis of conduct lies in neurobiology and the brain, these will not be explored in length in this course. We will talk about the role of memory and learning in animal behaviour.

Course Contents:

Sl. No.	Topics	Allotted Lecture
1.	**Unit I-Concept of Ethology** • Introduction - Origin & history of Ethology • Brief profiles of Karl von Frish, Ivan Pavlov, Konard Lorenz, Niko Tinbergen. • Mechanism of Behaviour. Proximate & ultimate causes of behaviour. Stimulus, Releaser & Sign Stimulus.	7
2.	**Unit 2 - Classification of behavioural Patterns** • Behavioural Patterns: Stereotyped Behaviours, FAP, acquired behaviour, Instinct vs Learnt Behaviour, Associative learning, classical and operant Conditioning, Habituation, Imprinting, Conflict behaviours.	13
3.	**Unit 3. Social behaviour obstacles solving ecological behaviour, reproductive behaviour** • Social behaviour, Concept of society. • Communication and the senses. Ritualization, Signals, Altruism, Insect society with honey bee as example, Foraging in honey bee and advantages of the waggle dance. • Foraging behaviour -(Finding food, selecting food, capturing food, consuming food) Territorial behaviours, Antipredatory behaviours, Aggressive behaviours, Play behaviours. • Reproductive behaviour - Asymmetry of sex Sexual dimorphism, Male Choice, Inter sexual selection (male rivalry), Intra sexual selection (female choice), Diversity in mating system. Courtship behaviour, Parental care, Problems of offspring recognition, ethogram.	14

4.	**Unit 4 - Introduction to Chronobiology** • Historical developments in Chronobiology Biological oscillation: the concept of Average, amplitude, phase and period, adaptive significance of biological clocks.	5
5.	**Unit 5: 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, Photo period and regulation of seasonal reproduction of vertebrates, Role of melatonin, many behaviours in animals are rhythmic in nature.	6

Suggested Readings:

- Animal Behaviour by Drickamar.
- John Alcock, Animal Behaviour, Sinauer Associate Inc., USA.
- Paul W. Sherman and John Alcock, Exploring Animal Behaviour, Sinauer
- Associate Inc., Massachusetts, USA.
- Chronobiology Biological Timekeeping: Jay. C. Dunlap, Jennifer. J. Loros Patricia J. De Coursey (ed). 2004, Sinauer Associates, Inc. Publishers, Sunderland, MA, USA
- Insect Clocks D.S. Saunders, C.G.H. Steel, X., Afopoulou (ed.) R.D. Lewis. (3rdEd) 2002 Barens and Noble Inc. New York, USA
- Biological Rhythms: Vinod Kumar (2002) Narosa Publishing House, Delhi/ Springer-Verlag, Germany.

Minor 701 P: Animal Behaviour **Credits: 01**

Course Contents:

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.
4. To study the phototaxis behaviour in insect larvae.

RAJA NARENDRALAL KHAN WOMEN'S COLLEGE (AUTONOMOUS)

Semester-VIII
Course Structure

Sl. No.	Name of the Courses	No. of Papers	Credits	Full Marks
1	Major	02	08(4x2)	150(75x2)
2	Minor	01	04	75
3	Research Project Or DSE-I, DSE-II, DSE-III	01	12 Or 4×3	225
Total		***06***	***24***	***450***

Raja N. L. Khan Women's College (Autonomous)

Curriculum for Undergraduate in Zoology

[NEP 2020]

Semester-VIII

Paper Code	Name of the Subject	Nature	Teaching Scheme in hour per week			Credit	Marks
			L	T	P		
ZOOMJ801	**MJ801T:** Methods in Biology	Major Course	3	0	0	4	75
	MJ801P: Methods in Biology (Practical)	Major Cource	0	0	1		
ZOOMJ802	**MJ802T:** Biotechnology	Major Cource	3	0	0	4	75
	MJ802P: Biotechnology (Practical)	Major Cource	0	0	1		
RESEARCH PROJECT **Or** **ZOODSE801** **ZOODSE802** **ZOODSE803**						12 Or 4×3=12	225
ZOOM108A	**MI801 T:** Animal Behaviour	Minor Course	3	0	0	4	75
	MI801 P: Animal Behaviour (Practical)	Minor Course [Practical]	0	0	1		

L=Lecture, T=Tutorial, P=Practical

Major 801: Methods in Biology **Credits: 04**

Major 801T: Methods in Biology **Credits: 03**

Course objectives and expected outcome

This course is designed to offer knowledge on various domains of biology with a concrete understanding of advanced molecular biology techniques, instrumentations, biochemical methods and their applications. The implication of this learning will be effective in various research fields, biomedical and clinical laboratories and in industries. The budding minds will be more inclined to cutting edge research through generation of innovative ideas and troubleshooting of current research problems with the application of these techniques for the betterment of environment and society.

Course Contents:

Sl. No.	Contents	Allotted Lecture
1.	**Unit 1: Methods in Molecular Biology** **a)** Isolation and purification of DNA (Plasmid and Genomic), RNA and proteins; Separation of nucleic acids and protein: Agarose gel electrophoresis and sodium dodecyl sulphate-polyacrylamide gel electrophoresis; amplification of DNA by polymerase chain reaction; RT-PCR. **b)** Introduction to Recombinant DNA Technology; General strategy of gene cloning: genomic libraries; cDNA libraries; single gene cloning; Expression of recombinant proteins using bacterial, animal and plant vectors. **c)** Northern Blotting, Southern Blotting and FISH.	**15**
2.	**Unit 2: Biophysical and Biochemical methods** **a) Microscopic techniques** Microscopy: general principle; Resolving power; Image processing methods and applications; Optical microscope; Fluorescence microscope; Confocal microscope and Electron microscope. **b) Spectrophotometry** UV-visible light spectroscopy; Fluorescence Spectroscopy; Infrared and Raman spectroscopy; Nuclear magnetic resonance spectroscopy and their applications in Biology.	**15**

	c) Centrifugation General Principle, types and applications. **d) Chromatographic techniques** Chromatography: General Principle and Emerging Trends, Partition Chromatography, Adsorption Chromatography, Thin Layer Chromatography, Gel Filtration Chromatography, Ion-Exchange Chromatography, Affinity Chromatography, HPLC and FPLC. **e) Immunological Techniques** ELISA; Western blotting; Immunofluorescence and Flow Cytometry.	
3.	**Unit 4: Methods in Environmental Biotechnology** **a)** Bioremediation; *In situ* and *Ex situ* Bioremediation. **b)** Bioremediation of Xenobiotic components and hydrocarbons. **c)** Phytoremediation. **d)** Cryopreservation; Integration of different rural biotechnological tools.	**10**
4.	**Unit 4: Electrophysiological methods** Patch-clamp recording; ECG; PET; MRI; fMRI; CAT.	**5**

Suggested Readings:

- Wilson, K. and Walker, J. (2009). Principle and techniques of biochemistry and Molecular Biology, 7th Edition. Cambridge University Press.
- Sheehan, D. (2009). Physical biochemistry: Principles and Applications, 2nd Edition. Wiley.
- Ramesh, V. (2019). Biomolecular and Bioanalytical Techniques: Theory, Methodology and Applications. Wiley.
- Kumar, P. (2021). Biophysics and Molecular Biology, 4th edition. Pathfinder Publication, India.

Major 801P: Methods in Biology **Credits: 01**

Course Contents:

1. Extraction of protein from biological sample and demonstration of SDS-PAGE.
2. Demonstration of various chromatographic techniques used in analytical research.
3. Institutional visit for learning about various sophisticated instruments used in biomedical research.
4. Bioremediation of pollutants by selected soil microorganisms.
5. Estimation of DNA by UV double beam spectrophotometry.

Major 802: Biotechnology **Credits: 04**

Major 802T: Biotechnology **Credits: 03**

Course objectives and expected outcome

This course teaches organization and expression of plants and animal genome and plant and animal tissue culture. Students learn about transgenic animals, their application in pharmaceutical industry, cloning and its importance. This course prepares the students for appreciating its benefits and applications in biotechnological, pharmaceutical, medical and agricultural field. Knowledge about different cloning vectors, cDNA libraries, different hybridization techniques, transgenic animal production.

Course Contents:

Sl.No.	Contents	Lecture
1.	**Introduction:** Organization of prokaryotic and eukaryotic genome, Concept of genomics, History of Biotechnology and Application	5
2.	**Recombinant DNA technology:** Cloning vectors; Plasmids, Cosmids, Phagemids, Lambda Bacteriophage, M13, BAC, YAC, MAC, shuttle vector and Expression vectors. Restriction enzymes: Nomenclature, detailed study of Type I, II & III., Enzymes and Procedure of recombinant DNA technology.	10
3.	**Molecular Techniques in Gene manipulation:** Transformation techniques: Calcium chloride method and electroporation Construction of genomic and cDNA libraries and screening by colony and plaque hybridization, Gel electrophoresis, Southern, Northern and Western blotting; DNA sequencing: Sanger method; Polymerase Chain Reaction, DNA Finger Printing and DNA microarray	16
4.	**Genetically Modified Organisms:** Production of cloned and transgenic animals: Nuclear Transplantation, Retroviral Method, DNA microinjection. Applications of transgenic animals: Production of pharmaceuticals, production of donor organs, knockout mice	6
5.	**Culture Techniques and Applications:** Animal cell culture, expressing cloned genes in mammalian cells, Molecular diagnosis of genetic diseases (Cystic fibrosis, Sickle cell anemia)	8

Suggested Readings:

- Brown, T.A.(1998).Molecular Biology Labfax II: Gene Cloning and DNA Analysis. II Edition, Academic Press, California, USA.
- Glick, B.R. and Pasternak, J. J.(2009). Molecular Biotechnology-Principles and Applications of Recombinant DNA. IV Edition, ASM press, Washington, USA.
- Weaver. Molecular Biology of Gene.5thedition.
- Primrose & Twyman. Principles of Gene Manipulation and Genomics.7th edition.
- P. K. Gupta: Biotechnology and Genomics, Rastogi publishers(2003).

Major 802P: Biotechnology **Credits: 01**

Course Contents:

1. Genomic DNA isolation from E. coli
2. Plasmid DNA isolation (pUC 18/19) from E. coli
3. Restriction digestion of plasmid DNA.
4. Construction of circular and linear restriction map from the data provided.
5. Calculation of transformation efficiency from the data provided.
6. To study following techniques through photographs a. Southern Blotting b. Northern Blotting c. Western Blotting d. DNA Sequencing (Sanger's Method) e. PCR f. DNA fingerprinting 7. Project report on animal cell culture

RESEARCH PROJECT **Credit 12**

1. Topic specific research work will be carried out under respective guide/co-guide.
2. A comprehensive report should be submitted.
3. Power point presentation of research report
4. The research outcomes of their project work may be published in peer-reviewed Journal or may be presented in conferences/seminars or may be patented.

Or **Credit (4×3=12)**

ZOODSE801

ZOODSE802

ZOODSE803

Minor 801: Animal Behaviour **Credits: 04**

Minor 801T: Animal Behaviour **Credits: 03**

Course objectives and expected outcome

This course will introduce you to animal behavior research and its (very recent) history. We shall investigate the origins (ultimate cause) of behaviour, its role in an animal's survival and reproduction, and how behaviours evolve across evolutionary time. We will explore the evolution of benevolence, reproductive behaviour and communication. We will also discuss how animals choose foraging strategies, avoid predators, find suitable territories, and decide to migrate. The topic of behavioral research in zoos and its importance in species conservation will be examined. The course also covers the proximate reasons of behaviour, what drives behaviour, and the importance of ontogeny (organismal development). Although the basis of conduct lies in neurobiology and the brain, these will not be explored in length in this course. We will talk about the role of memory and learning in animal behaviour.

Course Contents:

Sl. No.	Topics	Allotted Lecture
1.	**Unit I-Concept of Ethology** • Introduction - Origin & history of Ethology • Brief profiles of Karl von Frish, Ivan Pavlov, Konard Lorenz, Niko Tinbergen. • Mechanism of Behaviour. Proximate & ultimate causes of behaviour. Stimulus, Releaser & Sign Stimulus.	7
2.	**Unit 2 - Classification of behavioural Patterns** • Behavioural Patterns: Stereotyped Behaviours, FAP, acquired behaviour, Instinct vs Learnt Behaviour, Associative learning, classical and operant Conditioning, Habituation, Imprinting, Conflict behaviours.	13
3.	**Unit 3. Social behaviour obstacles solving ecological behaviour, reproductive behaviour** • Social behaviour, Concept of society. • Communication and the senses. Ritualization, Signals, Altruism, Insect society with honey bee as example, Foraging in honey bee and advantages of the waggle dance. • Foraging behaviour -(Finding food, selecting food, capturing food, consuming food) Territorial behaviours, Antipredatory behaviours, Aggressive behaviours, Play behaviours. • Reproductive behaviour - Asymmetry of sex Sexual dimorphism, Male Choice, Inter sexual selection (male rivalry), Intra sexual selection (female choice), Diversity in mating system. Courtship behaviour,	14

	Parental care, Problems of offspring recognition, ethogram.	
4.	**Unit 4 - Introduction to Chronobiology** • Historical developments in Chronobiology Biological oscillation: the concept of Average, amplitude, phase and period, adaptive significance of biological clocks.	5
5.	**Unit 5: 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, Photo period and regulation of seasonal reproduction of vertebrates, Role of melatonin, many behaviours in animals are rhythmic in nature.	6

Suggested Readings:

- Animal Behaviour by Drickamar.
- John Alcock, Animal Behaviour, Sinauer Associate Inc., USA.
- Paul W. Sherman and John Alcock, Exploring Animal Behaviour, Sinauer
- Associate Inc., Massachusetts, USA.
- Chronobiology Biological Timekeeping: Jay. C. Dunlap, Jennifer. J. Loros Patricia J. De Coursey (ed). 2004, Sinauer Associates, Inc. Publishers, Sunderland, MA, USA
- Insect Clocks D.S. Saunders, C.G.H. Steel, X., Afopoulou (ed.) R.D. Lewis. (3rdEd) 2002 Barens and Noble Inc. New York, USA
- Biological Rhythms: Vinod Kumar (2002) Narosa Publishing House, Delhi/ Springer-Verlag, Germany.

Minor 801 P: Animal Behaviour **Credits: 01**

Course Contents:

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.
4. To study the phototaxis behaviour in insect larvae.