Hindi Vidya Prachar Samiti's

Ramniranjan Jhunjhunwala College

of Arts, Science & Commerce

(Empowered Autonomous College)

Affiliated to

UNIVERSITY OF MUMBAI

Syllabus for T.Y.B.Sc (under NEP)

PROGRAM: B.Sc. ZOOLOGY

PROGRAM CODE: RJSUZOO

(REVISED in 2025-2026 in alignment with the NEP 2020 facilitating the inter-and multidisciplinary learning and multiple entry and exit of the students)

(CBCS 2025-2026)

PREAMBLE

The National Education Policy 2020 aims at imparting skill-based learning and caters to the multiple entry and exit facility for the students thus empowering them to acquire knowledge at their pace. In the three-year UG program, the student has two exit options. Students also have the option of choosing the Honors program of four years study in a given discipline and later converting it to five-year integrated PG degree program.

As an undergraduate student, he/she learns the core subject (Major), subject complementing the core subject (Minor), a course from other discipline; open elective course (OEC or GEC) and Vocational and Skill Enhancement course from the Major (VSEC). The remaining verticals under NEP 2020 are IKS (Indian Knowledge System), AEC (Ability Enhancement Course), VEC (Value Enhancement Course) and with progressive three years of UG, student also completes at different levels OJT (On Job Training), FP (Field Projects), CEP (Community Engagement Program), RP (Research Project) which helps him/her in understanding their roots, application of the knowledge for the benefit of self and the society. Vertical CC (Co-curricular activities and activities related to yoga and human well-being) helps in preparing youth with good character and interpersonal relationships.

The subject of Zoology offers the basic understanding about the vast diversity of the animal kingdom across the globe. It enables the students to strengthen their knowledge in Animal Sciences and in the other allied branches of Zoology. Keeping the interest of learner in mind, the syllabus has been carefully designed. It has a balance of the classical aspects of Zoology which includes topics like taxonomy, ecology, ethology, developmental biology, physiology, fishery science, animal husbandry and economic entomology. The syllabus also includes applied subjects like biochemistry, pathology, immunology, molecular biology and epidemiology.

The undergraduate curriculum has been meticulously designed by considering the need for the subject development, industry requirement, research outlook, competitive exams and entrepreneurship skills. Each unit included in the syllabus has clearly defined objectives. It focuses on outcome-based learning. It aims at inculcating the critical thinking, enhancing the analytical ability, developing writing skills of the students. The syllabus includes field trips to ecological habitats, agrofarms, national parks, sanctuaries, natural history museum, reputed research institutes and industries to widen the student's horizon. The students are encouraged to participate in various project-based activities.

Owing to the current needs of the industry and other sectors, the syllabi is designed in a manner that the learner will be able to apply the knowledge and skills acquired in varied fields. The course encourages a sense of responsibility and empathy towards all living beings, promoting sustainable practices in the learner.

PROGRAMME OUTCOMES (PO) OF UNDERGRADUATE DEGREE PROGRAMMES

Program outcome refers to the overall characteristic an individual is supposed to acquire on completion of the three-year degree program in Bachelor of Science. The attributes based on acquisition, accumulation, and processing of knowledge of the subject are transferable beyond the discipline and useful in different domains of life.

Critical Thinking: Concepts, methodology and ability to formulate questions stimulate the inquisitiveness and critical thinking amongst the students.

Scientific Temperament: The nurturing of the young minds to observe and analyse the experiments in the laboratory or a phenomenon occurring around them to obtain a logical scientific explanation for it.

Analytical Thinking: The ability to think analytically can be developed by training and practice. The syllabus offers the student to understand the concept and design projects or experiments based on them.

Domain knowledge: The domain knowledge is the key to the understanding of advances and complex subject matter.

Social Ethics: The students are exposed to different problems caused due to human activity. They learn to conduct themselves without creating a damage to fellow beings.

Animal Ethics: The sensitization towards ethical issues associated with use of animals in the laboratory is highlighted and the solutions to overcome it are introduced.

Problem Solving: The ability to handle a situation is enhanced in the students by problem solving assignments, case studies, projects to make them competent, conscious and creative individual.

Environmental Sustainability: Environment related issues are addressed through workshops, Guest lectures and field studies.

PROGRAMME SPECIFIC OUTCOMES (PSOS)-BSc PROGRAMME IN ZOOLOGY

PSO1	Understands the nature and basic concepts of systematic classification, ecology, biomolecules, animal biotechnology, cell biology, and genetics.
PSO2	Analyse and comprehend the concepts of developmental biology, genetics and molecular biology. Acquaint with the skills in fishery biology, animal husbandry and economic entomology to boost entrepreneurship skills.
PSO3	Acquire skills and necessary training for techniques in haematology, immunology, physiology, endocrinology, enzymology, molecular biology, toxicology, cancer biology and field biology. Enhance knowledge on biostatistics, alternate energy, Wild-life tourism. Wildlife conservation and epidemiology to provide wider job prospects in the realm of Zoology.
PSO4	Perform laboratory procedures as per standard protocols in the areas of animal diversity, genetics, biochemistry, molecular biology, physiology, immunology, developmental biology, environmental science and pollution.
PSO5	Apply ethical principles and knowledge in understanding of Zoology to one's own life and work. Applications of biological sciences in different areas that contributes towards nation building.

Credit Structure for B Sc Semester V as per NEP 2020 Implemented from the academic year 2025-2026
Major Subject: Zoology

Semester V

Level 5.5 Major Zoology

Courses	Course titles	Course code	Credits	Total Credits
Major Theory I	Anatomy, Embryology, Physiology-I	RJDSCZOO351	4	12
Major Theory II	Molecular Biology, Genetics and Wildlife Study	RJDSCZOO352	4	
Major Practical	Practicals based on Theory I	RJDSCZOOP351	2	
	Practicals based on Theory II	RJDSCZOOP352	2	
Discipline Specific Elective Course (DSE)	Department of Zoology offers students DSE – DSE-I Epidemiology DSE-II Behavioural Biology	RJDSEZOO351 RJDSEZOO352	4	4
Vocational Skill Enhancement Course (VSC)	Economic Zoology	RJVSCZOO351	3+1	4
Field Project (FP)	Field work with submission of field report	RJFPZOO351	2	2
Total Credits				22

DISTRIBUTION OF TOPICS AND CREDITS

T.Y.B.Sc. ZOOLOGY SEMESTER V

Course	Nomenclature	Credits	Duration
RJDSCZOO351	Anatomy, Embryology, Physiology-I	04	60 hours
RJDSCZOO352	Molecular Biology, Genetics and Wildlife Study	04	60 hours
RJDSCZOOP351	Practical I	02	60 hours
RJDSCZOOP352	Practical II	02	60 hours

SEMESTER	:	**V**
TITLE OF THE SUBJECT/COURSE	:	**ANATOMY, EMBRYOLOGY, PHYSIOLOGY-I**
COURSE CODE	:	**RJDSCZOO351**
CREDITS	:	**04**
DURATION	:	**60 Lectures**

LEARNING OBJECTIVES	
1	To acquaint learners with general idea of comparative anatomy of vertebrates
2	To familiarize the learner with the developmental stages of frog.
3	To introduce the different aspects of human blood and its clinical significance.
4	To comprehend the physiological aspects of homeostasis and endocrinology.

COURSE OUTCOMES	AFTER COMPLETING THE COURSE, THE LEARNER WILL BE ABLE TO:	PSO ADDRESSED	BLOOM'S TAXONOMY LEVEL
CO1	understand the anatomy of skin and digestive system of vertebrates	1,5	BT level I, II, III remember, understand and apply
CO2	understand the different event involved in the metamorphosis of frog.	2 &4	BT level IV Analyse draw connections among ideas
CO3	identify various components of blood and their importance.	3, 4	BT Level I, II, III remember, understand and apply
CO4	familiarize with adaptations of animals for regulation of heat and ionic balance.	3, 4	BT level II & IV Interpret, Compare and analyse

T.Y.B.Sc ZOOLOGY SEMESTER-V (THEORY)	HRS	Credits
PAPER I: ANATOMY, EMBRYOLOGY, PHYSIOLOGY-I **Course Code: RJDSCZOO351**	**60**	**4**
UNIT I: COMPARATIVE ANATOMY OF VERTEBRATES: I	**15**	
1.1 Skin: Anatomy and functions of vertebrate skin, epidermal and dermal derivatives, scales, claws, nails, hoofs, horns, antlers, beaks, feathers, hair, and glands. **1.2 Digestive system:** Digestive tube and associated glands, tooth structure, classification of teeth, dental formula in mammals.		
UNIT II: DEVELOPMENTAL BIOLOGY OF FROG	**15**	
2.1 Pre embryonic development :Egg, spawn **2.2 Post embryonic development :** cleavage, blastula, gastrula, neurula **2.3 Metamorphosis**.		
UNIT III: BASIC HAEMATOLOGY	**15**	
3.1 Composition of blood: plasma and its constituents, blood cells **3.2 Formed elements of blood:** **3.2.1 Erythrocytes:** Erythropoiesis, Structure and functions of RBC, variation in number, types of anaemia. **3.2.2 Haemoglobin:** Structure, formation and degradation, variants of haemoglobin (foetal, adult). **3.2.3 Leucocytes:** Leucopoiesis, types and functions, variation in number - leucocytosis and leukopenia. **3.2.4 Thrombocytes:** Thrombopoiesis, Structure, clotting factors, mechanism of clotting, variation in number-thrombopenia, thrombocytosis. **3.3 Blood volume:** Total quantity and regulation; haemorrhage.		
UNIT IV: HOMEOSTASIS: THERMOREGULATION AND IONIC REGULATION	**15**	
4.1 Homeostasis: External and internal environment; Control systems in Biology: Feedback mechanisms with example. **4.2 Thermoregulation:** **4.2.1** Mechanism of heat production and heat Loss: Shivering and Non-shivering thermogenesis, brown fat- special thermogenic tissues in mammals, Evaporative and Non-evaporative **4.2.2** Acclimation /acclimatization and adaptive response to temperature (Daily torpor, Hibernation, Aestivation) **4.3 Osmotic and Ionic regulation:** **4.3.1** Ionic regulation in iso-osmotic, hypo-osmotic and hyper-osmotic environment. **4.3.2** Problems of living in terrestrial environment: water absorption, salt water ingestion and salt excretion, metabolic water and behavioural adaptations		

SEMESTER	:	**V**
TITLE OF THE SUBJECT/COURSE	:	**MOLECULAR BIOLOGY, GENETICS AND WILDLIFE STUDY**
COURSE CODE	:	**RJDSCZOO352**
CREDITS	:	**04**
DURATION	:	**60 Lectures**

LEARNING OBJECTIVES	
1	To introduce molecular biology of gene alteration, its effects and repair mechanisms for DNA damage.
2	To acquaint learners with concepts of chromosomal aberrations various genetic disorders and diagnosis**.**
3	To introduce learner to the various national parks, sanctuaries and ecotourism.
4	To educate learners about threats to wildlife and the conservation measures necessary to protect it.

COURSE OUTCOMES	AFTER COMPLETING THE COURSE, THE LEARNER WILL BE ABLE TO:	PSO ADDRESSED	BLOOM'S TAXONOMY LEVEL
CO1	get an insight in the intricacies of chemical and molecular processes that alter the gene.	3, 4	BT Level I, II, III remember, understand and apply
CO2	identify chromosomal abnormalities and genetic disorders. They will understand the prenatal and diagnostics for detecting genetic defects.	2,4,5	BT level III &IV Apply and Analyse
CO3	understand importance of national parks, sanctuaries and need of ecotourism	3,4	BT level I & II Introduce and understand
CO4	gain knowledge about techniques used in wildlife conservation and laws associated with wildlife protection.	1,3, 5	BT level I, IV, V Remember, analyse and evaluate

T.Y.B.Sc ZOOLOGY SEMESTER-V (THEORY)	HRS	Credits
PAPER II: MOLECULAR BIOLOGY, GENETICS AND WILDLIFE STUDY **Course Code: RJDSCZOO352**	**60**	**4**
UNIT I: MOLECULAR BIOLOGY	**15**	
1.1: Mutations **1.1.1:** Point mutations - Deletion and insertion mutations, substitution mutation and its type (silent, missense and nonsense mutations, transition and transversion), frameshift mutations (due to Deletion and Insertion mutations). **1.1.2:** Trinucleotide repeat expansions - fragile X syndrome, Huntington disease **1.2: Mutagenic agents** **1.2.1:** Physical agents: Ionizing radiation (X-rays, α, β and γ rays), Non-ionizing radiation (UV light) **1.2.2:** Chemical agents: Base analogs (5-bromouracil); Intercalating agents (ethidium bromide); Deaminating agents (nitrous acid); Hydroxylating agents (hydroxylamine); Alkylating agents (mustard gas). **1.2.3:** Biological agents: transposable elements and viruses **1.3: Preventative and repair mechanisms for DNA damage** 1.3.1: Mechanisms that prevent DNA damage - superoxide dismutase and catalase 1.3.2: DNA repair Mechanisms - direct DNA repair (photoreactivation, excision repair), recombination repair, SOS repair.		
UNIT II: GENETICS	**15**	
2.1: Chromosomal Aberrations **2.1.1** Numerical: Aneuploid and Polyploidy (Autopolyploidy and Allopolyploidy); Non-disjunction during mitosis and meiosis. **2.1.2** Structural: Types, effects, significance and disorder: Deletion, Translocation , Inversion and Duplication. **2.2: Genetic Disorders** **2.2.1** Inborn Errors of Metabolism: Phenylketonuria, G-6-PD deficiency, Alkaptonuria, Albinism; **2.2.2** Single gene mutation (Cystic fibrosis), Multifactorial gene mutation (Breast Cancer) **2.2.3** Uniparental Diasomy: Angelman Syndrome and Prader-Willi Syndrome. **2.3: Diagnosis:** **2.3.1** Prenatal Diagnosis: Amniocentesis and Chorionic villus sampling **2.3.2** Banding techniques (G,C, Q), FISH, Protein truncation test (PTT). .		
UNIT III: WILDLIFE PROTECTED AREAS	**15**	
3.1 Community reserves: Concept and importance. **3.2 Protected Areas:** Important features of protected areas in India. **3.3 Notable national parks of Maharashtra:** Sanjay Gandhi, Tadoba.		

3.4 National parks and sanctuaries in India: Jim Corbett, Kaziranga, Nagarhole, Bhitarkanika, Marine National Park in Gulf of Kutch, Bharatpur bird sanctuary. **3.5 Global National parks:** Grand Canyon NP, Galapagos NP, Serengeti NP. *A Case Study of Sustainable Tourism in Yellowstone National Park , Masai Mara's tourism industry, Project Tiger, Bishnoi movement		
UNIT IV: WILDLIFE MANAGEMENT	**15**	
4.1 Introduction: Habit, Habitat & Territory of Wild Animals for developing management strategies. **4.2 Threats to Wildlife** **4.2.1:** Poaching and hunting, deforestation, encroachment, competition (intra-specific and inter-specific),Climate change, diseases (zoonosis and reverse zoonosis) **4.2.2:** Tourism and human animal conflict **4.3 Wildlife Conservation** **4.3.1:** Techniques and methods used for wildlife census: Aerial counts (wildlife drones), camera trap, line transect census and track surveys, capture mark recapture method, wildlife radio telemetry, GPS **4.3.2:** Forest management policies and Acts: Forest policy 1988; The Indian Forest Act, 1927; Indian Wildlife (Protection) Act, 1972 and Convention for International Trade of endangered species (CITES). *Case studies: Community based conservation and management in Namibia, Wolf reintroduction in Yellow Stone National Park, Silent Valley conservation- people's movement, Diclofenac and vulture population decline		

SEMESTER	:	**V CORE PRACTICAL COMPONENT**
TITLE OF THE SUBJECT/COURSE	:	**PRACTICAL I (Based on Paper I)**
COURSE CODE	:	**RJDSCZOOP351**
CREDITS	:	**02**
DURATION	:	**60 HRS**

LEARNING OBJECTIVES	
1	The student will learn to do the mounting of scales, cells and observe under a microscope.
2	The student will learn to carry out diagnostic biochemical estimations.
3	Student will learn to observe, analyse and interpret the results

COURSE OUTCOMES	AFTER COMPLETING THE COURSE, THE LEARNER WILL BE ABLE TO;	PSO ADDRESSED	BLOOM'S TAXONOMY LEVEL
CO1	handle instruments like compound microscope, hemocytometer.	4 , 5	III ,IV and V Calculate, evaluate and interpret
CO2	count cells using Neubauer chamber	4 , 5	III ,IV and V Calculate, evaluate and interpret
CO3	conduct basic CBC and biochemical diagnostic tests.	4 , 5	III ,IV and V Calculate, evaluate and interpret

T.Y.B.Sc ZOOLOGY SEMESTER-V (PRACTICALS)
PRACTICAL I (Based on Paper I)
Paper Code: RJDSCZOOP351
1. Mounting of fish scales - Placoid, cycloid and ctenoid. 2. Study of types of feathers/Horns 3. Study of integumentary systems - V.S. of skin of Shark, Frog, Calotes, Pigeon and Human 4. Identification of frog Spawn , cleavage, blastula, gastrula, neurula 5. Effect of different ionic conditions on RBC. 6. Enumeration of total count of Erythrocytes. 7. Enumeration of total count of Leucocytes. 8. Estimation of total serum/ plasma proteins by Folin's method. 9. Estimation of blood glucose by o-toluidine method. 10. Erythrocyte Sedimentation Rate by suitable method - Westergren or Wintrobe method (DEMO). 11. Estimation of haemoglobin by Sahli's acid haematin method(DEMO).

SEMESTER	:	**V CORE PRACTICAL COMPONENT**
TITLE OF THE SUBJECT/COURSE	:	**PRACTICAL II (Based on Paper II)**
COURSE CODE	:	**RJDSCZOOP352**
CREDITS	:	**02**
DURATION	:	**60 HRS**

LEARNING OBJECTIVES	
1	To learn the technique of karyotype analysis.
2	To learn interpretation of genetic formulae
3	To learn about different National parks and wildlife sanctuaries.
4	To familiarize them with some basic techniques of population analysis .

COURSE OUTCOMES	AFTER COMPLETING THE COURSE, THE LEARNER WILL BE ABLE TO;	PSO ADDRESSED	BLOOM'S TAXONOMY LEVEL
CO1	Prepare a karyogram from photograph and interpret the result	4 and 5	II and V identify and interpret
CO2	Write the genetic formula as well as interpret genetic formulae.	4 and 5	IV and V evaluate and interpret
CO3	Identify brand animals of different national parks and sanctuaries as well as locate different national parks on the map.	4 and 5	III and IV Categorise,and interpret
CO4	Conduct transect and quadrant method for population density study	4 and 5	IV ,V,VI evaluate ,interpret and create

T.Y.B.Sc ZOOLOGY SEMESTER-V (PRACTICALS)
PRACTICAL II (Based on Paper II)
Paper Code: RJDSCZOOP352

1. Karyotype (Idiogram) analysis for the following syndromes with comments on numerical and / or structural variations in chromosomes (no cutting of chromosomes):

a. Turner's syndrome
b. Klinefelter's syndrome
c. Down's syndrome
d. Cri-du-chat syndrome
e. D-G translocation
f. Edward's syndrome
g. Patau's syndrome.

2.Interpretation of genetic formulae: Deletion, duplication, inversion and translocation.

3. To mark national parks and sanctuaries on map of India.

4.To identify brand animals of various national parks, sanctuaries and comment on its IUCN status.

5. Analysis of community by line transect and quadrant method.

6. Field Visit

SKELETON PAPER FOR PRACTICAL I -SEMESTER V

RJDSCZOOP351

Total marks**: 50**

Q.1. Major experiment: **15M**

Enumeration of total count of Erythrocytes. / Enumeration of total count Leucocytes.

OR

Estimation of total serum/ plasma proteins by Folin's method / Detection of blood glucose by O-toluidine method.

Q.2.Minor experiment: **10M**

Mounting of fish scales - Placoid, cycloid and ctenoid

OR

Study on the effect of different concentrations of sodium chloride on RBC

Q.3. Identification - 5 spots 3 marks each **15 M**

A. Types of feathers
B. Types of horns
C. Study of integumentary systems - V.S. of skin of Shark, Frog, Calotes, Pigeon and Human
D. Identification of Spawn , cleavage, blastula, gastrula, neurula.
E. ESR/ HB

Q4. Viva Voce **05 M**

Q5. Journal and Attendance **05 M**

SKELETON PAPER FOR PRACTICAL II -SEMESTER V

RJDSCZOOP352

Total Marks **50**

Q.1. **Major experiment**: **10M**

Analysis of community by **A** Line transect method OR **B** Quadrant Method

Q.2.Minor experiment: **08 M**

Karyotype (Idiogram) analysis for the syndromes with comments on numerical and / or structural variations in chromosomes (no cutting of chromosomes).

Q.3. Identification - 4 spots 3 marks each **12 M**

To mark national parks and sanctuaries on map of India

To identify brand animals of various national parks, sanctuaries and comment on its IUCN status

Study of tracking instruments for wildlife

Interpretation of genetic formula

Q4. Excursion report and viva based on it. **10M**

Q5. Viva **05 M**

Q.6.Journal **05M**

SCHEME OF EXAMINATION (FOR BOTH SEMESTERS)

Internal examination

There would be two internal class tests comprising of 20 marks each **(Total 40 marks).**

Internal test shall be conducted in the form of MCQ Test/ Assignments/Presentations

Question paper pattern for external theory **Total: 60 marks**

Q.1

A ANY TWO 6 MARKS EACH--- 12 MARKS

B ANY ONE 3 MARKS

Q.2

A ANY TWO 6 MARKS EACH---- 12 MARKS

B ANY ONE 3 MARKS

Q.3

A ANY TWO 6 MARKS EACH---- 12 MARKS

B ANY ONE 3 MARKS

Q.4

A ANY TWO 6 MARKS EACH ---12 MARKS

B ANY ONE 3 MARKS

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SEMESTER VI

Credit Structure for B Sc Semester VI as per NEP 2020 Implemented from the academic year 2025-2026
Major Subject: Zoology

Semester VI

Level 5.5 Major Zoology

Courses	Course titles	Course code	Credits	Total Credits
Major Theory I	Anatomy, Embryology, Physiology-II	RJDSCZOO361	4	12
Major Theory II	Genetic Engineering, Cancer Biology, Zoogeography And Energy Resources	RJDSCZOO362	4	
Major Practical	Practicals based on Theory I	RJDSCZOOP361	2	
	Practicals based on Theory II	RJDSCZOOP362	2	
Discipline Specific Elective Course (DSE)	Department of Zoology offers students DSE – DSE-I Public Health And Disease DSE-II Ethology	RJDSEZOO361 RJDSEZOO362	4	4
Vocational Skill Enhancement Course (VSC)	Environmental Science and Pollution	RJVSCZOO361	2	2
OJT	Report on On-Job-Training	RJOJTZOO361	4	4
Total Credits				22

DISTRIBUTION OF TOPICS AND CREDITS

T.Y.B.Sc. ZOOLOGY SEMESTER V

Course	Nomenclature	Credits	Duration
RJDSCZOO361	Anatomy, Embryology, Physiology-II	04	60 hours
RJDSCZOO362	Genetic Engineering, Cancer Biology, Zoogeography And Energy Resources	04	60 hours
RJDSCZOOP361	Practical I	02	60 hours
RJDSCZOOP362	Practical II	02	60 hours

SEMESTER	:	**VI**
TITLE OF THE SUBJECT/COURSE	:	**ANATOMY, EMBRYOLOGY, PHYSIOLOGY-II**
COURSE CODE	:	**RJDSCZOO361**
CREDITS	:	**04**
DURATION	:	**60 Lectures**

LEARNING OBJECTIVES	
1	To introduce the learner to comparative development of nervous system and urinogenital system.
2	To acquaint learners with knowledge of developmental biology with chick as a model.
3	To introduce the topic of immunology with emphasis on building strong foundation about the immune system.
4	To understand the working of neurotransmitters and basics of cardiac physiology.

COURSE OUTCOMES	AFTER COMPLETING THE COURSE, THE LEARNER WILL BE ABLE TO:	PSO ADDRESSED	BLOOM'S TAXONOMY LEVEL
CO1	comprehend and differentiate between development of different vertebrate nervous systems and urinogenital systems.	1,5	BT level II, III, IV Compare, sketch and analyse
CO2	understand the basics of chick embryo development and the practical applications of studying chick embryology.	1,5	BT level IV Analyse draw connections among ideas
CO3	familiarise with types of immunity and the significant role of immune system.	3, 4	BT level II and III Understand and apply
CO4	identify the role of neurotransmitters and appreciate the working of human heart.	2. 3	BT level II and III Understand and apply

T.Y.B.Sc ZOOLOGY SEMESTER-VI (THEORY)	HRS	Credits
PAPER I: ANATOMY, EMBRYOLOGY, PHYSIOLOGY-II **Course Code: RJDSCZOO361**	**60**	**4**
UNIT I: COMPARATIVE ANATOMY OF VERTEBRATES: II	**15**	
1.1 Nervous system: Development and differentiation of primary brain vesicles and their cavities, flexures of the brain, Structural modification of vertebrate brain with reference to shark, frog, lizard, pigeon, and rabbit. **1.2 Urinogenital System:** Archinephros, pronephros, mesonephros, metanephros, structure of nephron, urinogenital ducts, urinary bladder in vertebrates		
UNIT II: DEVELOPMENTAL BIOLOGY OF CHICK	**15**	
2.1 Structure of Hen's egg, physico-chemical nature and forms of yolk - granular, platelets and spheres; fertilization and post fertilization events (cleavage, blastulation, gastrulation) **2.2 Structure of chick embryo -** 18hours, 24 hours, 33 hours, 48 hours and 72 hours **2.3 Extra embryonic membranes**		
UNIT III: BASIC IMMUNOLOGY	**15**	
3.1 Introduction to Immunology **3.2 Cells of the immune system:** B cells, T cells , null cells, macrophages, dendritic cells mast cells **3.3 Antigens:** Definition and properties; Haptens. **3.4 Antibodies:** Definition, basic structure, classes of antibodies – IgG, IgA, IgM, IgD & IgE **3.5 Innate immunity:** Definition, factors affecting innate immunity, Mechanisms of innate immunity (First and second line of defense). **3.6 Acquired immunity:** Definition, Antibody mediated and cell mediated immunity; Types: Active Acquired immunity (Natural and Artificial), Passive Acquired immunity(Natural and Artificial).		
UNIT IV: CHEMICAL MESSENGERS AND CARDIAC PHYSIOLOGY	**15**	
4.1 Chemical Messengers 4.1.1 Introduction and classification 4.1.2 Structure, function and clinical significance of Neurotransmitters (Acetylcholine, GABA, Dopamine, Serotonin Epinephrine) **4.2 Cardiac Physiology** 4.2.1 Vascular pumps: Suction pump in open circulation and pressure pump in closed circulation 4.2.2 Cardiac output, Venous Return, Pacemaker, Electrical activity in heart muscles: Electrocardiogram 4.2.3 Chemical and nervous regulation of heart		

SEMESTER	:	**VI**
TITLE OF THE SUBJECT/COURSE	:	**GENETIC ENGINEERING, CANCER BIOLOGY, ZOOGEOGRAPHY AND ENERGY RESOURCES**
COURSE CODE	:	**RJDSCZOO362**
CREDITS	:	**04**
DURATION	:	**60 Lectures**

LEARNING OBJECTIVES	
1	To understand the tools and techniques used in genetic engineering.
2	To impart the knowledge of cellular and molecular biology of cancer in cancer prevention, diagnosis and treatment.
3	To introduce the learner to distribution of animals and different zoogeographical realms.
4	To introduce the learner to alternative renewable and sustainable sources of energy

COURSE OUTCOMES	AFTER COMPLETING THE COURSE, THE LEARNER WILL BE ABLE TO:	PSO ADDRESSED	BLOOM'S TAXONOMY LEVEL
CO1	Learner will be familiarized with vast arrays of techniques of gene manipulation.	1,5	BT level IV Analyse draw connections among ideas
CO2	The student will understand at the cellular level the causes, preventive measures and treatment for cancer.	1	BT Level I, II, III remember, understand and apply
CO3	Learner will understand different mechanisms of distribution of animals across different zoogeographic realms	1	BT I, IV Rember, identify and categorise
CO4	Learner will known the alternative sources of energy and also different types of energy policies.	2,5	BT I,II,III Identify, classify and apply

T.Y.B.Sc ZOOLOGY SEMESTER-VI (THEORY)	HRS	Credits
PAPER II: GENETIC ENGINEERING, CANCER BIOLOGY, ZOOGEOGRAPHY AND ENERGY RESOURCES **Course Code: RJDSCZOO362**	**60**	**4**
UNIT I: GENETIC ENGINEERING	**15**	
1.1 Tools in Genetic Engineering **1.1.1 Enzymes involved in Genetic Engineering:** Restriction enzymes (types, examples and nomenclature), Ligases (*E. coli* DNA ligase, T4 DNA ligase), polynucleotide kinase, phosphatases, DNA polymerases, reverse transcriptase, terminal transferase. **1.1.2 Vectors for gene cloning:** General properties, advantages and disadvantages of cloning vectors - plasmid vectors (pBR322), phage vectors (λ Phage), cosmid vectors (c2XB). **1.1.3 Cloning techniques:** Cloning after restriction digestion - blunt and cohesive end ligation, creation of restriction sites using linkers and adapters, cDNA synthesis (Reverse transcription), genomic and cDNA libraries. **1.2 Techniques in Genetic Engineering** 1.2.1 PCR technique and its applications. 1.2.2 Blotting techniques and their applications.		
UNIT II: CANCER BIOLOGY	**15**	
2.1 Introduction: General properties of cancer cells, cell cycle: (Eukaryotic cell cycle and its regulation). **2.2 Cell Signalling:** Signalling molecules and their receptor; functions of cell surface receptors; Intracellular signal transduction pathway. Programmed cell death. **2.3 Causes of Cancer:** carcinogens (radiation, chemical and viral), Oncogenes, Tumor suppressor genes. **2.4 Prevention and diagnosis** **2.5 Treatment:** Chemotherapy, Radiation therapy, Immunotherapy and Gene therapy. *Case Study: Punjab cancer train,vaccination programme for cancer prevention in India.		
UNIT III: ZOOGEOGRAPHY	**15**	
3.1 Introduction: Plate tectonics and continental drift theory **3.2 Animal Distribution and Barriers** 3.2.1 Isolating Mechanisms 3.2.2 Patterns of animal distribution - continuous, discontinuous and bipolar 3.2.3 Barriers of distribution -Topography, climate, vegetation, large water masses, land mass, lack of salinity and special characteristic habit (homing instinct).		

3.2.4 Means of dispersal - land bridges, natural rafts and drift wood, favouring gales, migration by host, accidental transportation and by human agencies **3.3 Zoogeographical Realms:** Afrotropical, Australasian, Indo-malayan, Nearctic, Neotropical, Oceanian, Palearctic.		
UNIT IV: ALTERNATE ENERGY RESOURCES	**15**	
4.1 Introduction: Overview and significance of alternative energy sources, Global Energy Demand and Sustainability Challenges **4.2 Major alternate energy resources:** Solar energy, Wind energy, Tidal energy, Geothermal energy, Nuclear energy, Biomass & biofuels. **4.3 Future of Alternate Energy and Innovations:** Emerging Technologies in Energy Generation (Perovskite Solar Cells, Next-Gen Wind Turbines) **4.4** Energy Policy and Regulation for Renewables, Sustainability Metrics and Carbon Neutrality Goals *Case Studies: Germany's Renewable Energy Transition (Energiewende), Iceland's Geothermal Energy Use, Shirdi Sansthan Solar Kitchen, Wind farms near Kanyakumari		

SEMESTER	:	**VI CORE PRACTICAL COMPONENT**
TITLE OF THE SUBJECT/COURSE	:	**PRACTICAL I (Based on Paper I)**
COURSE CODE	:	**RJDSCZOOP361**
CREDITS	:	**02**
DURATION	:	**60 HRS**

LEARNING OBJECTIVES	
1	To familiarize them with different stages of chick embryo development.
2	To introduce the learner to the basic techniques in immunology
3	To develop skills of observation, identification , anlayse and interpret.

COURSE OUTCOMES	AFTER COMPLETING THE COURSE, THE LEARNER WILL BE ABLE TO;	PSO ADDRESSED	BLOOM'S TAXONOMY LEVEL
CO1	Understand and differentiate between the different developmental stages of the chick embryo.	4 and 5	II and V identify and interpret
CO2	Perform techniques like western blotting and counting of WBC.	4 and 5	II and V evaluate and interpret
CO3	Identify the histological sections	4 and 5	III and IV Categorise and interpret
CO4	To interpret Electrocardiogram	4 and 5	IV and V Evaluate and, interpret

T.Y.B.Sc ZOOLOGY SEMESTER-VI (PRACTICALS)
PRACTICAL I (Based on Paper I)
Paper Code: RJDSCZOOP361

1. Comparative study of brain of shark, frog, lizard, bird (pigeon/ fowl) & rat.
2. Study of Chick embryo: cleavage, blastula, gastrula, structure of chick embryo - 18 hours, 24 hours, 33 hours, 48 hours and 72 hours.
3. Western Blotting Technique
4. Leucocyte differential count
5. Cells of immune system- B cells, T cells , null cells, macrophages, dendritic cells mast cells.
6. Organs of immune system: PRIMARY (Bone marrow, Thymus) and SECONDARY ORGANS (lymph node, spleen).
7. Study of ECG and disorders of heart function (tachycardia, bradycardia and ventricular fibrillation)

SEMESTER	:	**V CORE PRACTICAL COMPONENT**
TITLE OF THE SUBJECT/COURSE	:	**PRACTICAL II (Based on Paper II)**
COURSE CODE	:	**RJDSCZOOP362**
CREDITS	:	**02**
DURATION	:	**60 HRS**

LEARNING OBJECTIVES	
1	To develop critical thinking, problem-solving ability and analytical skills
2	To make them aware about Zoogeographical distribution of animals on earth
3	To develop skills of observation, identification , anlayse and interpret.

COURSE OUTCOMES	AFTER COMPLETING THE COURSE, THE LEARNER WILL BE ABLE TO;	PSO ADDRESSED	BLOOM'S TAXONOMY LEVEL
CO1	Solve problem related to molecular biology and develop critical thinking and analytical skills	4 and 5	III, IV and V Solve, analyse and interpret
CO2	Identify and classify animals based of Zoogeographical realms	4 and 5	II and V evaluate and interpret
CO3	Calulate mitotic index of cells	4 and 5	III and IV calculate and interpret
CO4	Understand applications of different alternate energy resources.	4 and 5	II and V Understand and, apply

T.Y.B.Sc ZOOLOGY SEMESTER-VI (PRACTICALS)
PRACTICAL II (Based on Paper II)
Paper Code: RJDSCZOOP362
1. Problems based on restriction enzymes. 2. Calculation of mitotic index from the photograph (onion root tip or cancer cells). 3. Identification of zoogeography realms. 4. Study of application of alternative energy resources (Solar panel, Biogas plant, Photovoltaic cell, Windmill). 5. Field Visit

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16. Principles of Environmental Science: W.P.Cunningham&M.A.Cunningham. Tata
17. McGraw Hill. · Ecology: N.S.Subramanyam.&AVSS.Sambamurthy, Narosa.
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SKELETON PAPER FOR PRACTICAL I -SEMESTER VI

RJDSCZOOP361

Total marks: 50

Q.1. Major experiment: **12M**

Western Blotting technique
OR
Leucocyte differential count

Q.2. Minor Experiment: **10M**
Sketch , label and describe Brain of shark, frog, lizard, bird(pigeon/ fowl) & rat

Q.3.Identification of the given slide/ specimen **15M**

A. Study of Chick embryo: cleavage, blastula, gastrula, structure of chick embryo - 18 hours, 24 hours, 33 hours, 48 hours and 72 hours (ANY 3
)

B. Identification of cells of immune system- B cells, T cells , null cells, macrophages, dendritic cells mast cells. Organs of immune system: Primary (Bone marrow, Thymus) and Secondary (lymph node, spleen) (ANY 2)

Q4. Identify the given ECG and disorders of heart function (ANY 2) **8M**

Q5. Journal and Attendance **5M**

SKELETON PAPER FOR PRACTICAL II -SEMESTER VI

RJDSCZOOP362

Total Marks 50

Q.1. Major experiment:

Problems based on restriction enzymes **10M**

Q.2.Minor experiment:

Calculate the mitotic index from the given slide / photograph. **05M**

Q.3. Identification of the zoogeographic realms (ANY 3) **09M**

Q4. Identification of alternative sources of energy (ANY 3) **06M**

Q5. Excursion report and viva based on it **10M**

Q6. Viva Voce **05M**

Q.7. Journal and Attendance **05 M**

SCHEME OF EXAMINATION (FOR BOTH SEMESTERS)

Internal examination

There would be two internal class tests comprising of 20 marks each **(Total 40 marks).**

Internal test shall be conducted in the form of MCQ Test/ Assignments/Presentations

Question paper pattern for external theory **Total: 60 marks**

Q.1

A ANY TWO 6 MARKS EACH--- 12 MARKS

B ANY ONE 3 MARKS

Q.2

A ANY TWO 6 MARKS EACH---- 12 MARKS

B ANY ONE 3 MARKS

Q.3

A ANY TWO 6 MARKS EACH---- 12 MARKS

B ANY ONE 3 MARKS

Q.4

A ANY TWO 6 MARKS EACH ---12 MARKS

B ANY ONE 3 MARKS

Mapping of the course to Local/ Regional/National/International relevance

Class	Course Name	Course Code	Local Relevance	Regional Relevance	National Relevance	International Relevance
T Y B Sc Zoology DSC	**ANATOMY, EMBRYOLOGY, PHYSIOLOGY-I**	**RJDSCZOO351**	Domain knowledge.	Domain knowledge. To understand the interconnection between the regional diversity and genetic differences in vertebrates.	Domain knowledge in embryology. Significance of homeostasis in physiology.	To master the concept of haematology and homeostasis
T Y B Sc Zoology DSC	**ANATOMY, EMBRYOLOGY, PHYSIOLOGY-II**	**RJDSCZOO361**	Domain knowledge in chick embryology.	Domain knowledge in cardiac physiology, embryology	Domain knowledge in cardiac physiology, immunology	To master the concept of immunology
T Y B Sc Zoology DSC	**MOLECULAR BIOLOGY, GENETICS AND WILDLIFE STUDY**	**RJDSCZOO352**	Domain knowledge.	Domain knowledge in human genetic disorders. National parks and sanctuaries present in the region	Domain knowledge in human genetic disorders. National parks and sanctuaries across National	Global National parks and wild life management
T Y B Sc Zoology DSC	**GENETIC ENGINEERING, CANCER BIOLOGY, ZOOGEOGRAPHY AND ENERGY RESOURCES**	**RJDSCZOO362**	Domain knowledge in alternative energy resources	Domain knowledge in alternative energy resources	Domain knowledge in cancer biology	Distribution of animals in different realm. Domain knowledge in cancer biology and genetic engineering
T Y B Sc Zoology DSC	Practical	RJDSCZOOP351 RJDSCZOOP361 RJDSCZOOP352 RJDSCZOOP362	To study the physiological adaptations of the animals found locally.	To study the physiological adaptations of the animals found regionally	Training in the SOP of instruments.	Training in the field of developmental biology, heamatology and immunlogy