



Hindi Vidya Prachar Samiti's
Ramniranjan Jhunjhunwala College
of Arts, Science & Commerce
(Empowered Autonomous College)

Affiliated to

UNIVERSITY OF MUMBAI

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

PROGRAM: B.Sc. ZOOLOGY

PROGRAM CODE: RJSUZOO

Under NEP: Major Subject Zoology

SEMESTER III

Course Code: RJMAJZOO231

(REVISED in 2024-2025 in alignment with the NEP 2020 facilitating the inter-and multidisciplinary learning and multiple entry and exit of the students)

(CBCS 2024-2025)

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 (OEC or GEC) 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. The syllabus also includes applied subjects like biochemistry, pathology, immunology.

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, 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 Enzymology, developmental biology, histology and molecular biology. Acquaint with the skills in fishery biology, medical diagnostics and environment management to boost entrepreneurship skills.
PSO3	Acquire skills and necessary training for techniques in haematology, immunology, physiology, endocrinology, enzymology, molecular biology, toxicology and field biology. Enhance knowledge on biostatistics, bioinformatics, Wild-life tourism 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 biology and ethology.
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.

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S.Y.B.Sc NEP Zoology Major Syllabus Semester -III & IV

Credit Structure for B Sc Semester III as per NEP 2020 Implemented
from the academic year 2024-2025
Major Subject: Zoology

Semester III

Level 5.0 Major Zoology

Courses	Course titles	Course code	Credits	Total Credits
Major Theory I	Enzymology & Metabolism -I	RJMAJZOO231	2	6
Major Theory II	Study of biological processes-I & Mammalian Histology	RJMAJZOO232	2	
Major Practical	Practical's related to Theory I	RJMAJZOOP231	1	
	Practical's related to Theory II	RJMAJZOOP232	1	
Minor Theory I Botany/Chemistry	As offered by the Dept of Botany/Chemistry (student has made a choice while taking admission)		2	3
Minor Practical	Practical based on Minor theory I		1	
Minor Zoology (to be offered to students who have made a choice of Zoology as Minor subject) 3 Credit				
Minor Zoology Theory	Enzymology & Metabolism -I	RJMINZOO231	2	2
Minor Zoology Practical		RJMINZOOP231	1	1
Open Elective Course (OEC)/ Generic Elective Course (GEC)	Zoology students will choose OEC/GEC from the basket of courses offered by Commerce and Arts. Department of Zoology offers students OEC -Insights into Animal World, to students from Arts and Commerce faculties.	RJOECZOO231	3	3
Skill Enhancement Course (SEC)	Aquascaping- Aquarium Management	RJSECZOO231	2 (Practical based)	2
Ability Enhancement Course (AEC)	English Modern Indian Language Hindi/Marathi	RJAECENG231 RJAECHIN231/ RJAECMAR231	2 +2	4
Co-curricular Course (CC)	Co-curricular/ Extension activities /Community service (30 hour)	RJCCZOO231	2	2
Field Project (FP)	Field work with submission of field report	RJFPZOO231	2	2
Total Credits			22	22

DISTRIBUTION OF TOPICS AND CREDITS

S.Y.B.Sc. ZOOLOGY SEMESTER III

Course	Nomenclature	Credits	Duration
RJMAJZOO231	Enzymology & Metabolism -I	02	30 hours
RJMAJZOO232	Study of biological processes-I & Mammalian Histology	02	30 hours
RJMAJZOOP231	Practical I	01	30 hours
RJMAJZOOP232	Practical II	01	30 hours

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SEMESTER	:	III
TITLE OF THE SUBJECT/COURSE	:	ENZYMOLOGY & METABOLISM-I
COURSE CODE	:	RJMAJZOO231
CREDITS	:	02
DURATION	:	30 HRS

LEARNING OBJECTIVES	
1	The learner will be introduced to the concept of enzyme and principles of enzyme kinetics.
2	To understand the enzyme inhibition.
3	To understand the concept of metabolism.

COURSE OUTCOMES	AFTER COMPLETING THE COURSE, THE LEARNER WILL BE ABLE TO:	PSO ADDRESSED	BLOOM'S TAXONOMY LEVEL
CO1	appreciate the integration of enzymes into functioning of metabolic pathways.	2	BT level 1, 2 &3 Classify, describe and apply
CO2	comprehend the basics of enzyme kinetics.	2,4	BT level 2, 3&4 Understand, apply and correlate
CO3	Understand the interconnection of the carbohydrate metabolism	2	BT level 2,3 &4 Interpret, apply & analyse
CO4	Understand the application of enzymes in physiology, health sciences and industry.	5	BT level 3&4 Application, Analysis

S.Y.B.Sc ZOOLOGY SEMESTER-III (THEORY)	HRS	Credit
PAPER I: ENZYMOLOGY & METABOLISM-I Course Code: RJMAJZOO231	30	02
UNIT I		
ENZYMOLOGY	15	
1.1: Introduction and Nomenclature: Definition, Structure of enzyme, co-factors and co-enzymes, nomenclature, and classification (based on IUB - Enzyme Commission) of enzymes. 1.2: Enzyme Action and Kinetics: Mechanism of enzyme action; Factors affecting enzyme activity -pH, temperature, substrate. Derivation of Michaelis-Menten equation and Lineweaver-Burk plot; Concept and significance of Km, Vmax. 1.3: Enzyme Inhibition: Inhibitors, Types of Inhibitors (Competitive, non-competitive & uncompetitive inhibitors) and their kinetics . Case study: Biomarker enzymes in human diseases, Enzymes in textile industry		
UNIT II		
METABOLISM-I	15	
2.1 Study of Buffer, pKa, Henderson-Hasselbach equation. 2.2 Introduction to metabolism: Concept of metabolic pathways, anabolism, and catabolism. 2.3 Carbohydrate metabolism: Glycolysis, TCA cycle, ETS, Gluconeogenesis, Glycogenesis and Glycogenolysis. Case Study: Disorders based on carbohydrate metabolism.		

REFERENCES

1. Principles of Biochemistry, 2005, 2nd and 3rd edn. Lehninger A.L. Nelson D.L. and Cox M.M ,
2. Fundamentals of Biochemistry, Dr AC Deb, 1983, New Central Book Agency Ltd.
3. Biochemistry, L Stryer, 3rd/4th/5th ed, 1989 , Freeman and Co. NY
4. Harper's Biochemistry, 1996, 26th edition, Murray R.K. Granner D.K. Mayes P.A. Rodwell V.M. Hall international USA
5. Outline of Biochemistry, 1976, E.E. Conn and P.K. Stumpf. John Wiley and Sons USA
6. Biochemistry , U Satyanarayan and Chakrapani, 2017, 5th ed. Elsevier.

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SEMESTER	:	III CORE PRACTICAL COMPONENT
TITLE OF THE SUBJECT/COURSE	:	ENZYMOLOGY & METABOLISM-I
COURSE CODE	:	RJMAJZOOP231
CREDITS	:	01
DURATION	:	30 Hours

LEARNING OBJECTIVES	
1	To gain the skill for conduction enzyme assay.
2	To gain expertise in handling colorimeter
3	To gain practical skill to plan, execute, evaluate, analyse and interpret.
4	To develop skills for recording scientific experiments.

COURSE OUTCOMES	AFTER COMPLETING THE COURSE, THE LEARNER WILL BE ABLE TO;	PSO ADDRESSED	BLOOM'S TAXONOMY LEVEL
CO1	Gain practical skill to design, conduct, evaluate, analyse and interpret the experiment.	1, 4,5	BT Level 3,4,5
CO2	Handle instruments like colorimeter and pH meter	1, 3, 4,5	BT level 3,4,5

S.Y.B.Sc ZOOLOGY SEMESTER-III (PRACTICALS)
PRACTICAL: ENZYMOLOGY AND METABOLISM- I
Paper Code: RJMAJZOOP231
1. Study the effect of varying pH on amylase activity. 2. Study the effect of varying temperature on amylase activity. 3. Preparation of buffers using Henderson-Hasselbalch equation. 4. To determine pKa of given weak acid. 5. Study of colorimeter and selection of ideal filter. 6. Determination of unknown concentration of solution using colorimeter.

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SEMESTER	:	III
TITLE OF THE SUBJECT/COURSE	:	STUDY OF BIOLOGICAL PROCESSES-I & MAMMALIAN HISTOLOGY
COURSE CODE	:	RJMAJZOO232
CREDITS	:	02
DURATION	:	30 HRS

LEARNING OBJECTIVES	
1	To study the physiological process in living organisms.
2	To compare physiology of different organisms.
3	To understand concepts of histology in the organisms.

COURSE OUTCOMES	AFTER COMPLETING THE COURSE, THE LEARNER WILL BE ABLE TO:	PSO ADDRESSED	BLOOM'S TAXONOMY LEVEL
CO1	Understand the complexity of physiology in evolutionary hierarchy.	2,5	BT level 1, 2 &3 Describe, sketch and apply
CO2	Compare the differences in the function and structure relationship of organisms.	2,3	BT level 3&4 Compare and illustrate
CO3	Comprehend the complex tissues found in living organism.	2,3,4,5	BT level 1,2,3 Define, understand and apply

S.Y.B.Sc ZOOLOGY SEMESTER-III (THEORY)	HRS	Credit
PAPER II-Title: STUDY OF BIOLOGICAL PROCESSES-I & MAMMALIAN HISTOLOGY Course Code: RJMAJZOO232	30	02
UNIT I	15	
STUDY OF BIOLOGICAL PROCESSES- I		
1.1 Study of Nutritional Apparatus: Amoeba, Hydra, Amphioxus, Pigeon, Ruminants. 1.2 Study of Excretory and Osmoregulatory structures: Amoeba, Planaria, Earthworm. 1.3 Study of Respiratory organs: Earthworm, Fish, Frog and Pigeon. 1.4 Study of types of Reproduction: Asexual (Fission, fragmentation, gemmule formation, budding) & Sexual (Conjugation)		
UNIT II	15	
MAMMALIAN HISTOLOGY		
2.1 Concept and scope of histology 2.2 Histological structure and functions of: Lung, Stomach, Intestine, Liver, Kidney, Ovary and Testis. Case study: Histopathology of any one mammalian organ		

REFERENCES

1. Vertebrate Zoology Volume I- Jordan and Verma , S. Chand and Co.
2. Invertebrate Zoology Volume II- Jordan and Verma , S. Chand and Co.
3. Invertebrate Zoology- Majupuria T. C., Nagin S.and Co.
4. Chordate Zoology- Dhami P. S. and Dhami J. K. , R. Chand and Co.
5. Modern Textbook of Zoology: Invertebrates, R.L.Kotpal
6. Invertebrate Zoology- Dhami P. S. and Dhami J. K., R. Chand and Co.
7. Introduction to Vertebrates- Moore Cambridge University- Low Priced Edition.
8. Zoology- Miller S. A. and Harley J. B., Tata McGraw Hill.
9. Modern Textbook of Zoology, Invertebrates, Kotpal R. L.
10. Bailey's Text Book of Histology, 6th Ed: Scientific book Agency
11. Mammalian Histology- Kishore R Pawar and Ashok E Desai, Nirali Publications, 2016.

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SEMESTER	:	III CORE PRACTICAL COMPONENT
TITLE OF THE SUBJECT/COURSE	:	STUDY OF BIOLOGICAL PROCESSES-I & MAMMALIAN HISTOLOGY
COURSE CODE	:	RJMAJZOOP232
CREDITS	:	01
DURATION	:	30 HRS

LEARNING OBJECTIVES	
1	To gain practical skill to plan, execute, evaluate, analyse and interpret.
2	To enhance the observation skills.
3	To develop skills for tissue identification

COURSE OUTCOMES	AFTER COMPLETING THE COURSE, THE LEARNER WILL BE ABLE TO;	PSO ADDRESSED	BLOOM'S TAXONOMY LEVEL
CO1	Gain practical skill to design, conduct, evaluate, analyse and interpret the experiment.	1, 4	BT Level 3,4,5
CO2	Handle instruments like microscope	1, 3, 4	BT level 3,4,5
CO3	Culturing of Paramoecium	3,4	BT Level 5

S.Y.B.Sc ZOOLOGY SEMESTER-III (PRACTICALS)
Practical: STUDY OF BIOLOGICAL PROCESSES I & MAMMALIAN HISTOLOGY
Paper Code: RJMAJZOOP232
1. Detection of normal and abnormal constituents in urine. 2. Detection of Ammonia from water. 3. Detection of uric acid from bird excreta. 4. Study of nutritional apparatus- Amoeba, Hydra, Pigeon and ruminant stomach. 5. Culture of Paramecium-study of cyclosis, contractile vacuole (DEMONSTRATION) 6. Study of respiratory structures- Fish (bony & cartilaginous), frog, air sac in birds, lungs of rat 7. Study of oxygen consumption using respirometer (DEMONSTRATION). 8. Study of binary fission, conjugation in Paramecium, Gemmule of sponge, Budding in hydra. 9. Study of T.S of mammalian organs- stomach, intestine, liver, kidney, ovary, testis .

Scheme of Examinations

1. Internal examination 20 marks by MCQ/Assignment/Project/Survey/Presentation/Seminar
2. One External (Semester End Examination) of 30 marks. Duration 1 hour.
3. One combined Practical Examination at the end of Semester consisting of 50 marks with minimum 20 marks for passing.
4. Minimum marks for passing Semester End Theory and Practical Exam are 40 %.
5. Students must appear for Internals to be eligible for the Semester End Examination.
6. Students must appear Semester End Examination to be able to complete total credits for a given Semester.
7. For any KT examinations, there shall be Examination on Demand and students must register for the same.
8. Two short field excursions for habitat studies (one per semester) are compulsory.
9. Field work with submission of field report of quality can be considered under 20 marks internal.
10. A candidate will be allowed to appear for the practical examinations if he/she submits a certified Journal of S.Y.B.Sc. Zoology or a certificate from the Head of the Department / Institute to the effect that the candidate has completed the practical course of SY.B.Sc. Zoology as per the minimum requirements.
11. In case of loss of journal, a candidate must produce a certificate from the Head of the Department /Institute that the practicals for the academic year were completed by the student. However, such a candidate will be allowed to appear for the practical examination, but the marks allotted for the journal (if any) will not be granted.
12. HOD's decision, in consultation with the Principal, shall remain final and abiding to all.

S.Y.B.Sc Zoology Semester III

THEORY EVALUATION AND ASSESSMENT

COURSE CODE: RJMAJZOO231

(Based on the centralized guidelines given by EC under NEP2020)

Evaluation (Theory): Total marks per course – 50 Marks

- **Internals- 20 marks**
- **External- Semester End Examination – 30 marks**
- Question paper covering all units and topics.

Evaluation of Practical per Semester - 50 marks

Key to set effective Question paper

Question	KNOWLEDGE	UNDERSTANDING	APPLICATION and ANALYSIS	TOTAL MARKS- Per unit
Unit 1	05	05	05	15
Unit 2	05	05	05	15
-TOTAL- Per objective	10	10	10	30
% WEIGHTAGE	50	30	20	100%

SKELETON PAPER FOR THEORY -SEMESTER IV

Total Marks 30

Q1. Attempt any 3 from 6 questions of the following (BASED ON UNIT I). 15 marks

Q2. Attempt any 3 from 6 questions the following (BASED ON UNIT II). 15 marks

(*Subject to change in pattern, marks will remain same)

S.Y.B.Sc Zoology Semester III

PRACTICAL EVALUATION PATTERN

COURSE CODE: RJMAJZOOP231 & RJMAJZOOP232

(Based on the centralized guidelines given by EC under NEP 2020)

Total marks: 50

Q.1 Major experiment: 15M

Demonstrate the effect of changing pH on amylase activity.

OR

Demonstrate the effect of changing temperature on amylase activity.

OR

Determine the concentration of given solution using colorimeter.

OR

Selection of ideal filter using colorimeter.

Q.2.Minor experiment: 10M

Determination of ammonia from the given water sample.

OR

Determine the uric acid content from the given sample.

OR

Calculation of preparation of buffers using HH equation.

OR

Determine the _____ (normal / abnormal) constituents of the urine.

OR

Determine the pKa of given weak acid

Q3. Identification: (a,b,c,d,e) 15M

- a. Study of nutritional apparatus Amoeba, Hydra, Pigeon and ruminant stomach.
- b. Study of respiratory structures Fish (bony & cartilaginous), frog, air sac in birds, lungs of rat
- c. Study of binary fission, conjugation in Paramecium, Gemmule of sponge, Budding in hydra.
- d. and e: Study of T.S of mammalian organs- stomach, intestine, liver, kidney, ovary, testis

Q4. Viva. 05M

Q5. Journal and attendance. 05M

Note for Examiner: Modify difficulty level of Major /Minor expt. in comparison to MINOR BATCH

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

Class	Course Name	Course Code	Local relevance	Regional relevance	National relevance	International relevance
S Y B Sc Zoology Major	Enzymology & Metabolism -I	RJMAJZOO231	Domain knowledge . To understand the energy metabolism in the body.	Domain knowledge. To understand the interconnection between the regional diversity and genetic differences in population wrt to metabolism.	Domain knowledge in enzymology and metabolism.	To master the concept of enzyme kinetics
S Y B Sc Zoology Major	Study of biological processes - I & Histology	RJMAJZOO232	To understand the physiology of animals wrt their distribution locally.	To understand the physiology of animals wrt their distribution in varied habitats.	Domain knowledge.	Domain knowledge.
S Y B Sc Zoology Major	Practical	RJMAJZOOP231 RJMAJZOOP232	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 mammalian histology, culturing of paramecium

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Mapping of the course to Employability/ Entrepreneurship/Skill development

Class	Course Name	Course Code	Topic focussing on Employability/ Entrepreneurship/skill development	Employability/Entrepreneurship/Skill development	Specific activity
SYBSc Zoology	Enzymology and Metabolism -I	RJMAJZOO231	Enzymology focuses on study and application of enzymes in industry, health care and research. Metabolism	The understanding of enzyme kinetics will help in career as researcher, lab technician, industry in quality control Knowledge of metabolism enhances the ability to interrelate and interpret leading to development of analytical skills which will aid in careers related to research, pathology laboratory & health care	Enzyme kinetics Enzyme inhibitors Application of enzymes as biomarkers in diagnostics, health care and industry. Relationship of metabolism and their relation to human health.
SYBSc Zoology	Study of Biological processes I & Developmental biology	RJMAJZOO232	Study of biological processes Mammalian Histology	The understanding of physiology will help to build careers in health industry as paramedics. Study of invertebrates can be utilized to manufacture fish food as entrepreneur. The study of histology will enhance the observation skills and can be useful in career as researcher, and health care industry	Study of Life processes in invertebrates and vertebrates. Study of structure of different types of mammalian tissue

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SYBSc Zoology	Practical I	RJMAJZOO231	Enzymology and Metabolism I	The practical will develop the skill of precision, analytical ability and critical thinking. Handling of instruments according to SOP. Writing of the experiment scientifically. These skills will be useful in building career as researcher, laboratory technician, healthcare industry It will improve the observation skill, identification and comparing skills. The culturing of invertebrates like paramecium which is a fish food. Thus it will help in careers pertaining to research, health care and pathology laboratories	Enzyme assay Use of colorimeter, pH meter Titration. Drawing graphs Study of slides and specimens Use of Microscope Preparation of paramecium culture
SYBSc Zoology	Practical II	RJMAJZOO232	Study of Biological processes and Mammalian histology		

Integration of Cross cutting Issues

Class	Course Code	Cross Cutting Issues
S Y B Sc Zoology Major	RJMAJZOO231 RJMAJZOO232 RJMAJZOO231 RJMAJZOO232	Ethics, Environment and Sustainability UNSDG 2,4, NEP2020 Interdisciplinary

SEMESTER IV



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

PROGRAM: B.Sc. ZOOLOGY

PROGRAM CODE: RJSUZOO

SEMESTER IV

Course Code: RJMAJZOO241

(REVISED in 2024-2025 in alignment with the NEP2020 facilitating the inter-and multidisciplinary learning and multiple entry and exit of the students)

(CBCS 2024-2025)

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S.Y.B.Sc NEP Zoology Major Syllabus Semester -III & IV

Credit Structure for B Sc Semester IV as per NEP 2020 Implemented
from the academic year 2024-2025
Major Subject: Zoology

Semester IV

Level 5.0 Major Zoology

Courses	Course Title	Course code	Credits	Total Credits
Major Theory I	Molecular Biology & Metabolism II	RJMAJZOO241	2	6
Major Theory II	Study of biological processes-II & Developmental Biology	RJMAJZOO242	2	
Major Practical	Practicals related to Theory I	RJMAJZOOP241	1	
	Practicals related to Theory II	RJMAJZOOP242	1	
Minor Theory I Botany/Chemistry	As offered by the Dept of Botany/Chemistry (student has made a choice while taking admission)		2	3
Minor Practical			1	
Minor Zoology (to be offered to students who have made a choice of Zoology as Minor subject)				
Minor Zoology Theory I	Molecular biology & Metabolism -II	RJMINZOO241	2	2
Minor Zoology Practical	Practicals related to Theory II	RJMINZOOP241	1	1
Open Elective Course (OEC)/ Generic Elective Course (GEC)	Zoology students will choose OEC/GEC from the basket of courses offered by Commerce and Arts. Department of Zoology offers students OEC/GEC Environment and its management, to students from Arts and Commerce faculties.	RJOECZOO241	3	3
Skill Enhancement Course (SEC)	Food adulterants and safety measures	RJSECZOO241	2 (Practical based)	2
Vocational Skill Course(VSC)	Basics in medical diagnostics	RJVSCZOO241	2 (Practical based)	2
Ability Enhancement Course (AEC)	English Modern Indian Language Hindi/Marathi	RJAECENG241 RJAECHIN241 RJAECMAR241	2	2
Co-curricular Course (CC)	Co-curricular/ Extension activities /Community service (30 hour)	RJCCZOO241	2	2
Community Engagement Project (CEP)		RJCEPZOO241	2	2
Total Credits			22	22

DISTRIBUTION OF TOPICS AND CREDITS

S.Y.B.Sc. ZOOLOGY SEMESTER IV

Course	Nomenclature	Credits	Duration
RJMAJZOO241	Molecular Biology & Metabolism II	02	30 hours
RJMAJZOO242	Study of biological processes-II & Developmental Biology	02	30 hours
RJMAJZOOP241	Practical I	01	30 hours
RJMAJZOOP242	Practical II	01	30 hours

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SEMESTER	:	IV
TITLE OF THE SUBJECT/COURSE	:	MOLECULAR BIOLOGY & METABOLISM II
COURSE CODE	:	RJMAJZOO241
CREDITS	:	02
DURATION	:	30 hours

LEARNING OBJECTIVES	
1	The learner will be introduced to the concepts of molecular biology.
2	To understand the flow of genetic information.
3	To understand the concept of lipid and protein metabolism.

COURSE OUTCOMES	AFTER COMPLETING THE COURSE, THE LEARNER WILL BE ABLE TO:	PSO ADDRESSED	BLOOM'S TAXONOMY LEVEL
CO1	appreciate the relationship between DNA and RNA	2	BT level 1, 2 & 3 Classify, describe and apply
CO2	comprehend the flow of genetic information at molecular level	3,4	BT level 2, 3 & 4 Understand, apply and correlate
CO3	Understand the mechanisms of the protein and lipid metabolism	2	BT level 2,3 & 4 Interpret, apply & analyse
CO4	Understand the inter-relationships of metabolic processes.	5	BT level 3&4 Application, Analysis

S.Y.B.Sc ZOOLOGY SEMESTER-IV (THEORY)	HRS	Credit
PAPER I: MOLECULAR BIOLOGY & METABOLISM II Course Code: RJMAJZOO241	30	02
UNIT I		
MOLECULAR BIOLOGY	15	
1.1 DNA and RNA as genetic material: Griffith's transformation experiment, Avery-Macleod and McCarty experiment, Hershey-Chase experiment. Singer & Conrat experiment. 1.2 Genetic code: History, concept & properties. 1.3 Flow of genetic information in prokaryotes: Chromosomal DNA (nucleoid) structure, DNA replication, Transcription, Translation. 1.4 Operon: Concept of Operon, Structure & regulation of lac operon Case studies: Mitochondrial DNA and forensics		
UNIT II		
METABOLISM-II	15	
2.1 Lipid Metabolism: Catabolism and Anabolism (β - Oxidation), Ketogenesis 2.2 Protein Metabolism: Catabolism and Anabolism 2.3 Amino acid Metabolism: transamination, deamination (oxidative and non-oxidative), Urea cycle. 2.4 Intermediary metabolism: Acetyl – CoA as a common product in metabolism of carbohydrates, proteins and lipids. Case Study: Obesity, Diabetic ketoacidosis, Respiratory distress syndrome		

REFERENCES

1. Principles of Biochemistry, 2005, 2nd and 3rd edn. Lehninger A.L. Nelson D.L. and Cox M.M,
2. Biochemistry, L Stryer, 3rd/4th/5th ed, 1989, Freeman and Co. NY
3. Harper's Biochemistry, 1996, 26th edition, Murray R.K. Granner D.K. Mayes P.A. Rodwell V.M. Hall international USA
4. Biochemistry, U. Satyanarayan and Chakrapani, 2017, 5th ed. Elsevier.
5. Introduction to Molecular Biology; Peter Paoletta; Tata McGraw Hill; 2010.
6. Molecular Biology; David Freifelder; Narosa Publishing House; 2008.

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SEMESTER	:	IV CORE PRACTICAL COMPONENT
TITLE OF THE SUBJECT/COURSE	:	MOLECULAR BIOLOGY & METABOLISM-II
COURSE CODE	:	RJMAJZOO241
CREDITS	:	01
DURATION	:	30 HOURS

LEARNING OBJECTIVES	
1	To gain the skill for quantitative assays.
2	To gain expertise in handling colorimeter.
3	To gain practical skill to plan, execute, evaluate, analyse and interpret.
4	To develop skills for solving problems related to transcription and translation.

COURSE OUTCOMES	AFTER COMPLETING THE COURSE, THE LEARNER WILL BE ABLE TO;	PSO ADDRESSED	BLOOM'S TAXONOMY LEVEL
CO1	Gain practical skill to design, conduct, evaluate, analyse and interpret the experiment.	1, 4	BT Level 3,4,5
CO2	Understand and analyse molecular data,	2, 3, 4	BT level 3,4,5

S.Y.B.Sc ZOOLOGY SEMESTER-IV (PRACTICALS)
Practical: Molecular Biology and Metabolism- II
Paper Code: RJMAJZOOP241
1. Quantitative estimation of DNA by Diphenylamine method. 2. Quantitative estimation of RNA by Orcinol method. 3. Problems based of Transcription, translation and genetic code. 4. Estimation of creatinine from serum/urine sample. 5. Estimation of total cholesterol from plasma sample.

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SEMESTER	:	IV
TITLE OF THE SUBJECT/COURSE	:	STUDY OF BIOLOGICAL PROCESSES-II & DEVELOPMENTAL BIOLOGY
COURSE CODE	:	RJMAJZOO242
CREDITS	:	02
DURATION	:	30 HRS

LEARNING OBJECTIVES	
1	To study the physiological process in living organisms.
2	To compare physiology of different organisms.
3	To understand embryonic developmental stages of organism.

COURSE OUTCOMES	AFTER COMPLETING THE COURSE, THE LEARNER WILL BE ABLE TO:	PSO ADDRESSED	BLOOM'S TAXONOMY LEVEL
CO1	Understand the complexity of physiology in evolutionary hierarchy.	2,5	BT level 1, 2 &3 Describe, sketch and apply
CO2	Compare the differences in the functional and structural relationship of organisms.	2,3	BT level 3&4 Compare and illustrate
CO3	Comprehend the uniqueness of stages in the process of development.	2,3,4	BT level 1,2,3 Define, understand and apply

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S.Y.B.Sc ZOOLOGY SEMESTER-IV (THEORY)	HRS	Credit
PAPER II-Title: STUDY OF BIOLOGICAL PROCESSES-II & DEVELOPMENTAL BIOLOGY Course Code: RJMAJZOO242	30	02
UNIT I	15	
STUDY OF BIOLOGICAL PROCESSES II		
1.1 Circulation: Types of circulation, Circulating fluids (coelomic fluid, haemolymph, lymph and blood). Structure of vertebrate Hearts- Two/Three /Four chambered 1.2 Locomotory organs: Pseudopodia, cilia, Striated muscle fibre in human 1.3 Control and coordination: Neurons: Types, structure and working.		
UNIT II	15	
DEVELOPMENTAL BIOLOGY		
2.1 Gametogenesis, Structure of human gametes 2.2 Types of Fertilisation: External and Internal (Oviparity, viviparity, ovo-viviparity) 2.3 Types of Eggs, Cleavage, Blastula (Amphibia, Bird and Mammal) 2.4 Gastrulation: Epiboly, Emboly, invagination, involution and infiltration 2.5 Fate of Germinal Layers		

REFERENCES

1. Vertebrate comparative anatomy, Function, Evolution: K. V. Kardong, 3rd Ed. Tata McGraw Hill publication.
2. Chordate Zoology- Dhami P. S. and Dhami J. K. , R. Chand and Co.
3. Modern Textbook of Zoology: Invertebrates, R.L.Kotpal
4. Developmental Biology- 5th Edition, Scot F. Gilbert, Sinauer Associates Inc.
5. Developmental Biology- Subramoniam T., Narosa Publishers.

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SEMESTER	:	IV CORE PRACTICAL COMPONENT
TITLE OF THE SUBJECT/COURSE	:	STUDY OF BIOLOGICAL PROCESSES-II & DEVELOPMENTAL BIOLOGY
COURSE CODE	:	RJMAJZOOP242
CREDITS	:	01
DURATION	:	30 HOURS

LEARNING OBJECTIVES	
1	To acquaint the learners about the biological processes in different organisms.
2	To gain practical skill of slide observation and paramecium culture.
3	To develop observation skills in embryonic development

COURSE OUTCOMES	AFTER COMPLETING THE COURSE, THE LEARNER WILL BE ABLE TO;	PSO ADDRESSED	BLOOM'S TAXONOMY LEVEL
CO1	Understand the biological processes in different organisms	1, 4	BT Level 3,4,5
CO2	Use instruments like microscope effectively	1, 3, 4	BT level 3,4,5
CO3	Differentiate different stages of embryonic development	3,4	BT Level 5

S.Y.B.Sc ZOOLOGY SEMESTER-IV (PRACTICALS)
Practical: Study of biological processes II & Developmental Biology
Paper Code: RJMAJZOOP242
1. Study of hearts- Cockroach, Shark, Calotes, Crocodile, Pigeon, Mammal (goat). 2. Measurement of heartbeat in Daphnia (DEMONSTRATION). 3. Study of locomotory structures- Amoeba, Cockroach, Starfish, Fish, Bird-wings & feet. 4. Study of ciliary movement in Paramoecium (DEMONSTRATION). 5. Study of irritability in Paramoecium (DEMONSTRATION). 6. Study of different types of muscles. 7. Study of Fish eggs, frog spawn, hen's egg 8. Study of embryonic cleavage, blastula and gastrula. a. Types of embryonic cleavages: Holoblastic and Meroblastic b. Types of blastula- Coeloblastula, Steroblastula, Discoblastula. c. Gastrular movements: Epiboly and Emboly.

Scheme of Examinations

1. Internal examination 20 marks by MCQ/Assignment/Project/Survey/Presentation/Seminar
2. One External (Semester End Examination) of 30 marks. Duration 1 hour.
3. One combined Practical Examination at the end of Semester consisting of 50 marks with minimum 20 marks for passing.
4. Minimum marks for passing Semester End Theory and Practical Exam are 40 %.
5. Students must appear for Internals to be eligible for the Semester End Examination.
6. Students must appear Semester End Examination to be able to complete total credits for a given Semester.
7. For any KT examinations, there shall be Examination on Demand and students must register for the same.
8. Two short field excursions for habitat studies (one per semester) are compulsory.
9. Field work with submission of field report of quality can be considered under 20 marks internal.
10. A candidate will be allowed to appear for the practical examinations if he/she submits a certified Journal of S.Y.B.Sc. Zoology or a certificate from the Head of the Department / Institute to the effect that the candidate has completed the practical course of SY.B.Sc. Zoology as per the minimum requirements.
11. In case of loss of journal, a candidate must produce a certificate from the Head of the Department /Institute that the practicals for the academic year were completed by the student. However, such a candidate will be allowed to appear for the practical examination, but the marks allotted for the journal (if any) will not be granted.
12. HOD's decision, in consultation with the Principal, shall remain final and abiding to all.

S.Y.B.Sc Zoology Semester IV

THEORY EVALUATION AND ASSESSMENT

COURSE CODE: RJMAJZOO241

(Based on the centralized guidelines given by EC under NEP2020)

Evaluation (Theory): Total marks per course – 50 Marks

- **Internals- 20 marks**
- **External- Semester End Examination – 30 marks**
- Question paper covering all units and topics.

Evaluation of Practical per Semester - 50 marks

Key to set effective Question paper

Question	KNOWLEDGE	UNDERSTANDING	APPLICATION and ANALYSIS	TOTAL MARKS- Per unit
Unit 1	05	05	05	15
Unit 2	05	05	05	15
-TOTAL- Per objective	10	10	10	30
% WEIGHTAGE	50	30	20	100%

SKELETON PAPER FOR THEORY -SEMESTER IV

Total Marks 30

Q1. Attempt any 3 from 6 questions of the following (BASED ON UNIT I). 15 marks

Q2. Attempt any 3 from 6 questions the following (BASED ON UNIT II). 15 marks

(*Subject to change in pattern, marks will remain same)

S.Y.B.Sc Zoology Semester IV

PRACTICAL EVALUATION PATTERN

COURSE CODE: RJMAJZOOP241 & RJMAJZOOP242

(Based on the centralized guidelines given by EC under NEP 2020)

Total marks: 50

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

Estimate the amount of DNA in the given tissue sample by Diphenylamine method.

OR

Estimate the amount of RNA in the given tissue sample by Orcinol method.

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

Estimation of cholesterol from the given plasma/serum sample.

OR

Estimation of creatinine from the given plasma/serum sample.

Q.3. Problems based on transcription/translation/genetic code. **05M**

Q.4. Identification: 2 marks each **10 M**

- Study of hearts- Cockroach, Shark, Calotes, Crocodile, Pigeon, Mammal (goat).
- Study of locomotory structures- Amoeba, Cockroach, Starfish, Fish, Bird-wings & feet, Types of muscles.
- Study of Fish Eggs, frog spawn, hen's egg,
- Study of Embryonic cleavages (holoblastic and meroblastic) and Types of Gastrular movements: Epiboly and Emboly.
- Types of blastula- Coeloblastula, Steroblastula, and Discoblastula.

Q.5. Field report **05M**

Q.6. Journal and attendance. **05M**

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Note for Examiner: Modify difficulty level of Major /Minor expt. in comparison to MINOR BATCH

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

Class	Course Name	Course Code	Local relevance	Regional relevance	National relevance	International relevance
S Y B Sc Zoology Major	Molecular Biology & Metabolis m II	RJMAJZOO24 1	Domain knowledge. To understand the energy metabolism in the body.	Domain knowledge. To understand the interconnectio n between the geographical population and changes in metabolism.	Domain knowledge in molecular biology and metabolism.	To master the concept of transcription and translation
S Y B Sc Zoology Major	Study of biological processes- II & developme ntal biology	RJMAJZOO24 2	To understand the physiology of animals wrt their distribution locally and structures of different organs.	To understand the physiology of animals wrt their distribution in varied habitats.	Domain knowledge.	Domain knowledge.
S Y B Sc Zoology Major	Practical	RJMAJZOOP2 41 RJMAJZOOP2 42	To study the physiological adaptations of the animals found locally. To understand the process for estimation of biochemical parameters of local population.	To study the physiological adaptations of the animals found regionally	Training in Problem solving ability.	Training in the field of developmental biology, culturing of paramecium

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Mapping of the course to Employability/ Entrepreneurship/Skill development

Class	Course Name	Course Code	Topic focussing on Employability / Entrepreneurship/skill development	Employability/Entrepreneurship/Skill development	Specific activity
SYBSc Zoology	Molecular Biology & Metabolism II	RJMAJZOO241	Molecular biology focuses on study of flow of genetic information useful in health care and research. Metabolism	Understanding of molecular biology will help the learner to work in research institutes for health care, cancer research etc. Knowledge of metabolism enhances the ability to interrelate and interpret leading to development of analytical skills which will aid in careers related to research, pathology laboratory and health care	Application of basic knowledge in developing protein sequences. Relationship of metabolism and their relation to human health.
SYBSc Zoology	Study of biological processes-II & developmental biology	RJMAJZOO242	Study of biological processes Developmental biology	The understanding of physiology will help to build careers in health industry as paramedics. Study of invertebrates can be utilized to manufacture fish food as entrepreneur. The study of developmental biology will enhance the observation skills and can be useful in career as researcher, and health care industry	Study of Life processes in invertebrates and vertebrates. Study of developmental stages of organisms

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SYBSc Zoology	Practical I	RJMAJZOOP241	Molecular biology and Metabolism II	The practical will develop the skill of precision, analytical ability and critical thinking. Handling of instruments according to SOP. Writing of the experiment scientifically. These skills will be useful in building career as researcher, laboratory technician, healthcare industry It will improve the observation skill, identification and comparing skills. The culturing of invertebrates like paramecium which is a fish food. Thus it will help in careers pertaining to research, health care and pathology laboratories	Use of colorimeter, Estimation of biochemical parameters, Solving problems related to transcription and translation.
SYBSc Zoology	Practical II	RJMAJZOOP242	Study of biological processes-II & developmental biology		Study of slides and specimens Use of Microscope Preparation of paramecium culture

Integration of Cross cutting Issues

Class	Course Code	Cross Cutting Issues
S Y B Sc Zoology Major	RJMAJZOO241 RJMAJZOO242 RJMAJZOOP241 RJMAJZOOP242	Ethics, Environment and Sustainability, Good health and well being UNSDG 2,4,3 NEP2020 Interdisciplinary