



SIES

College of Arts,
Science &
Commerce (Autonomous)

RISE WITH EDUCATION

NAAC REACCREDITED - 'A' GRADE

(Affiliated to University of Mumbai)

Faculty: Science

Program: F.Y.B.Sc

Subject: ZOOLOGY

Academic Year: 2023 – 2024

**Revised Syllabus in Zoology under
Choice Based Credit System (CBCS)
Approved by the Board of Studies in Zoology
Effective from academic year 2023-24 under the aegis of
National Education Policy (NEP)**

Preamble

“Where the mind is without fear and the head is held high”

— A poem written by Nobel Laureate Rabindranath Tagore (Nobel Prize in Literature in 1913), the poem represents Tagore’s vision of a new and awakened India (it is quoted in this preamble in the context of India’s National Education Policy – New Education Policy).

The implementation of India’s National Education Policy 2020 (NEP) in this academic year, has significant relevance, especially in the context of our institution, since, this year, our institution has been bestowed with ‘Empowered Autonomous Status’. Universal high-quality education is fundamental for achieving full human potential, besides developing an equitable and just society, and promoting national development. It is the best way forward for developing and maximizing our country’s rich talents and resources which eventually will determine the future of our country. Although, under the aegis of academic autonomy, our institution has the privilege of ‘academic freedom’, however, we are also aware of the fact that ‘freedom’ comes with ‘responsibility’ and moreover, it needs to be justified with ‘academic excellence’. Therefore, one of the ways to achieve this, is through restructuring and refining the curriculum, which is pivotal in shaping the educational outcomes of an academic institution. Thus, a modest attempt has been made to design an effective syllabus that will preserve the essence of the subject, besides inculcating critical thinking and developing analytical reasoning amongst the students.

At the undergraduate level this syllabus will enable students to have a sound foundation of the Major subject - Zoology, besides encouraging an interdisciplinary approach by integration and inclusion of a few courses under Vocational Skill Course (VSC), Skill Enhancement Course (SEC), Generic/Open Electives (GE/OE), a course related to Indian Knowledge System (IKS), Ability Enhancement Course (AEC), Value Education Course (VEC), and Co-Curricular Courses (CC). Some of the key features of this revised syllabus are as follows:-

- ✓ **Mandatory/Core Course** – A course which is aimed at understanding the fundamental concepts of Zoology by inclusion of topics such as Life Processes - vital processes that make life possible through an understanding of the adaptations animals have evolved that best suit the milieu in which they thrive; Ecology - to understand the relation between organisms and their environment through the study of “life at home”; Biodiversity - which will sensitize students about the bio wealth nature has bestowed on humans, and to treat the natural resources with humane and responsible attitude in this era of global warming Animal Biotechnology - so as to acknowledge the emerging field of Biotechnology that blends the technological advancements and the natural wealth – the living organisms, for improving human life.
- ✓ **Vocational Skill Course** – A course, which is aimed at providing hands-on training, competencies, proficiency to students to enhance their skills & employability. For example: Bioinstrumentation – to give students a hands-on experience of instrumentation used in laboratory facility which will enable them to operate instruments independently.
- ✓ **Skill Enhancement Course** – A course, which is aimed at imparting practical skills, nurturing soft skills etc., to enhance the employability of students. For example: Animal Systematics – to introduce the students to the diversity of animal life to understand that part of the world around us comprising of various life forms, besides gaining an insight into field biology which will enable them to be equipped with the skills of understanding taxonomy of animal kingdom.
- ✓ **Generic or Open Elective** – An elective course generally chosen from an unrelated subject / discipline with the intention to seek multidisciplinary exposure. For example, any one of the following elective courses such as: Understanding the History of Mumbai (Course offered by Department of History) or Basics of Banking and Finance (Course offered by Department of Economics) or Stress Management (Course offered by Department of Psychology) or Fundamentals of Advertising (Course offered by Department of Commerce).
- ✓ **Indian Knowledge System** – A course which will make students aware of the vast repositories of ancient traditional knowledge in India in fields such as Literature, Culture, Indian traditional systems of medicine, Astronomy, Yoga, Arthashastra, etc.
- ✓ **Ability Enhancement Course** – A course which is aimed at enabling the students to acquire & demonstrate the core linguistic skills, achieve competency in Modern Indian Language (such as Marathi / Hindi among others) and in English Language.
- ✓ **Value Education Course** – A course which is based upon the content that leads to knowledge enhancement through various areas of study such as Understanding India, Constitution of India, Environment studies, Sustainable Development.
- ✓ **Co-Curricular Courses** – A course which will provide student’s a sense of identity & belonging, as well as appreciation of other cultures & identities; For example: courses such as National Cadet Corps (NCC), National Service Scheme (NSS), Yoga education, Health & Wellness, Sports, Cultural activities, courses related to Fine / Applied / Performing Arts etc.

This syllabus is a collective and constructive effort of the faculty, experts from research institutions, alumni and the board members whose valuable suggestions and expertise were instrumental in materializing this syllabus. The comments and recommendations of the contributors and reviewers have been carefully considered and implemented wherever feasible.

For effective teaching-learning, teachers are advised not to follow the syllabus too rigidly, but to exercise their professional discretion and judgement in implementing it. After all teaching is about creating a conducive environment for learners to sustain enthusiasm about the subject. We sincerely hope that all stakeholders from faculty to learners exploring this course will appreciate the importance of a well-designed curricular framework in shaping educational outcomes.

In conclusion, we hope this syllabus will encourage and maximize learning among students to develop open, inquiring minds for holistic development, thereby justifying the essence and spirit of National Education Policy.

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Members of the Board of Studies in the subject of Zoology

- ✓ *Professor (Dr.) Manisha Kulkarni – Professor, Department of Zoology, Institute of Science, Mumbai (Vice Chancellor's Nominee)*
- ✓ *Professor (Dr.) Manoj Mahimkar – Principal Investigator, Cancer Research Institute, ACTREC, Kharghar, Navi Mumbai; (Subject expert from outside the Parent University to be nominated by the Academic Council)*
- ✓ *Dr. Sasikumar Menon – Director, Institute for Advanced Training & Research in Interdisciplinary Sciences (IATRIS), (Therapeutic Drug Monitoring Lab), Sion, Mumbai; Faculty, Pharma Analytical Sciences, Ruia College, Mumbai (Subject Expert from outside college/Industry expert)*
- ✓ *Mr. Kedar Gore – Director, The Corbett Foundation (Non-profit Organization), Mumbai, (Subject expert from outside college / Representative from Corporate sector / Allied area)*
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Syllabus Committee

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F.Y.B.Sc – Zoology – Semester I (Syllabus Grid)

Course name and code	Unit	Topic Headings	Credits
SEMESTER – I			
Major / Subject			
Mandatory/Core Paper: Life Processes – I, Ecology and Animal Biotechnology – I			
SIUZOCC111 Theory	1	Life Processes - I	3
	2	Ecology	
	3	Animal Biotechnology	
Practical	1	Practicals based on Mandatory paper	1
Vocational Skill Course (VSC): Bioinstrumentation (Semester I/II)			
SIUZOVS111 Theory	1	Principle, working and application of Microscope, Colorimeter, pH meter, Centrifuge, Electrophoresis and Chromatography	1
Practical	1	Practicals based on Vocational Skill Course	1
Skill Enhancement Course (SEC): Animal Systematics (Semester I/II)			
SIUZOSE111 Practical	1	Conceptual understanding of systematics, taxonomy, phylogeny to inculcate and develop skills for practical's based on Skill Enhancement Course	2
Generic or Open Elective (GE or OE) (Semester I/II)			
Theory and Tutorial	1	An elective course generally chosen from an unrelated subject / discipline with the intention to seek multidisciplinary exposure. For example, any one of the following elective courses such as: Understanding the History of Mumbai (Course offered by Department of History) or Basics of Banking and Finance (Course offered by Department of Economics) or Stress Management (Course offered by Department of Psychology) or Fundamentals of Advertising (Course offered by Department of Commerce)	4
Indian Knowledge System (IKS) (Semester I/II)			
Theory	1	Course which will make students aware of the vast repositories of ancient traditional knowledge in India in fields such as Literature, Culture, Indian traditional systems of medicine, Astronomy, Yoga, Arthashastra, etc.	2
Ability Enhancement Course (AEC) (Semester I/II)			
Theory	1	Course which is aimed at enabling the students to acquire & demonstrate the core linguistic skills, achieve competency in Modern Indian Language (such as Marathi / Hindi among others) and in English Language	2
Value Education Course (VEC) (Semester I/II)			
Theory	1	Course which is based upon the content that leads to knowledge enhancement through various areas of study such as Understanding India, Constitution of India, Environment studies, Sustainable Development	2
Co-Curricular Course (CC) (Semester I/II)			
Tutorial / Participation	1	Course which will provide students a sense of identity & belonging, as well as appreciation of other cultures & identities; Example: courses such as National Cadet Corps (NCC), National Service Scheme (NSS), Yoga education, Health & Wellness, Sports, Cultural activities, Fine/Applied/Visual/Performing Arts	2

F.Y.B.Sc – Zoology – Semester II (Syllabus Grid)

Course name and code	Unit	Topic Headings	Credits
SEMESTER – II			
Major / Subject			
Mandatory/Core Paper: Life Processes – II, Biodiversity and Animal Biotechnology – II			
SIUZOCC121 Theory	1	Life Processes - II	3
	2	Biodiversity	
	3	Animal Biotechnology	
Practical	1	Practicals based on Mandatory paper	1
Vocational Skill Course (VSC): Bioinstrumentation (Semester I/II)			
SIUZOV511 Theory	1	Principle, working and application of Microscope, Colorimeter, pH meter, Centrifuge, Electrophoresis and Chromatography	1
Practical	2	Practicals based on Vocational Skill Course	1
Skill Enhancement Course (SEC): Animal Systematics (Semester I/II)			
SIUZOSE111 Practical	1	Conceptual understanding of systematics, taxonomy, phylogeny to inculcate and develop skills for practical's based on Skill Enhancement Course	2
Generic or Open Elective (GE or OE) (Semester I/II)			
Theory and Tutorial	1	An elective course generally chosen from an unrelated subject / discipline with the intention to seek multidisciplinary exposure. For example, any one of the following elective courses such as: An overview of cultural aspects of Maharashtra (Course offered by Department of History) or Credit and Insurance market (Course offered by Department of Economics) or Consumer Psychology (Course offered by Department of Psychology) or Introduction to e-commerce (Course offered by Department of Commerce)	4
Indian Knowledge System (IKS) (Semester I/II)			
Theory	1	Course which will make students aware of the vast repositories of ancient traditional knowledge in India in fields such as Literature, Culture, Indian traditional systems of medicine, Astronomy, Yoga, Arthashastra, etc.	2
Ability Enhancement Course (AEC) (Semester I/II)			
Theory	1	Course which is aimed at enabling the students to acquire & demonstrate the core linguistic skills, achieve competency in Modern Indian Language (such as Marathi / Hindi among others) and in English Language	2
Value Education Course (VEC) (Semester I/II)			
Theory	1	Course which is based upon the content that leads to knowledge enhancement through various areas of study such as Understanding India, Constitution of India, Environment studies, Sustainable Development	2
Co-Curricular Course (CC) (Semester I/II)			
Tutorial / Participation	1	Course which will provide students a sense of identity & belonging, as well as appreciation of other cultures & identities; Example: courses such as National Cadet Corps (NCC), National Service Scheme (NSS), Yoga education, Health & Wellness, Sports, Cultural activities, Fine/Applied/Visual/Performing Arts	2

Programme: Bachelor of Science, B.Sc. – Zoology

The characteristic graduate attributes comprising of Programme Outcomes, Programme Specific Outcomes and Course Outcomes for a science graduate in the subject of Zoology are as follows:

Note the list of abbreviations:

PO: Programme Outcome, PSO: Programme Specific Outcome, CO: Course Outcome

Cognitive Levels:- R: Remember, U: Understand, Ap: Apply, An: Analyze, E: Evaluate, C: Create

Serial Number	Details of Programme Outcomes (POs)
PO1 (Skill Level)	Problem Solving Ability (<i>U, Ap</i>) <ul style="list-style-type: none"> • Apply the knowledge of various courses learned under a program to break down complex problems into simple components. • Adopt and assimilate problem-based learning models and apply one's learning to solve real life problem situations.
PO2 (Skill Level)	Critical Thinking (<i>U, An, E</i>) <ul style="list-style-type: none"> • Develop critical thinking based on a rationale to identify assumptions, verifying the accuracy and validity of assumptions, and making informed decisions. • Inculcate the ability of logical reasoning to question the rationale behind concepts, ideas, and perspectives.
PO3 (Skill Level)	Effective Communication Skills (<i>Ap, C</i>) <ul style="list-style-type: none"> • Improve written and oral communication skills so as to express thoughts and ideas effectively. • Demonstrate the ability to listen carefully and imbibe soft skills to convey and receive instructions clearly. • Develop presentation skills to present complex information in a clear, lucid and concise manner.
PO4 (Skill Level)	Proficiency with Information and Communication Technology (<i>U, An, E</i>) <ul style="list-style-type: none"> • Demonstrate ability to access, evaluate and use a variety of relevant information resources inclusive of internet and electronic media for the purpose of collating and analysing data. • Understand the scope and limitations of tools or software's used in Information and Communication Technology.
PO5 (Skill Level)	Leadership Skills and Team Work (<i>U, Ap, An, C</i>) <ul style="list-style-type: none"> • Demonstrate leadership skills formulating an inspiring vision, thereby building a team, motivating and inspiring team members to engage and achieve that vision. • Develop management skills to guide people in taking tasks to their logical conclusion. • Inculcate the ability to facilitate coordinated effort as a group or team in the interests of common cause and recognise the contribution of team members.
PO6 (Attitude Level)	Self-directed and Lifelong Learning (<i>U, Ap, An</i>) <ul style="list-style-type: none"> • Demonstrate the ability to work independently and take responsibility for one's actions. • Acquire the ability to explore and evolve by becoming self-sufficient and self-reliant. • Adapt lifelong learning approaches to broaden one's horizons for personal growth and development.

PO7 (Attitude Level)	Ethical Values and Environmental Concerns (<i>U, Ap, E</i>) <ul style="list-style-type: none"> • Embrace moral or ethical values in conducting one's life and implement ethical practices in all aspects of life. • Create awareness and concern for environmental and sustainability issues. • Understand and realize the significance and relevance of co-habitation and co-evolution in attaining the needs of sustainable development.
PO8 (Attitude Level)	Gender Sensitization and Community Service (<i>U, Ap, An</i>) <ul style="list-style-type: none"> • Respect gender sensitivity, gender equity and gender justice. • Encourage mutual understanding and express empathetic social concern towards different value systems and different strata of society. • Engage in community service through Institutional Social Responsibility.

Serial Number	Details of Programme Specific Outcomes (PSOs)
PSO1	Conceptual Understanding and Emerging Applications (<i>R, U, Ap, An</i>) <ul style="list-style-type: none"> • Inculcate conceptual and coherent understanding of zoology, and demonstrate a broad understanding of animal diversity, including fundamental and systematic knowledge of the scientific classification, taxonomy and evolutionary relationships of major groups of animals. • Understand the nature and basic concepts of cell biology, biochemistry, animal physiology, molecular biology, ecology among other topics, so as to recognize the relationships between structure and functions at different levels of biological organization for the major groups of animals. • Demonstrate interest in different areas of zoology so as to analyse the scope of emerging applications of biological sciences in medicine, genetics, wildlife, etc and apply appropriate methodologies with cutting edge tools/techniques in biological sciences to seek solutions to emerging problems faced by mankind. • Demonstrate the relevance of the procedural subject knowledge that creates different types of professionals related to the disciplinary/subject area of zoology, including professionals engaged in research and development, teaching and government/public service.
PSO2	Analytical reasoning and Scientific Inquiry (<i>U, An, E</i>) <ul style="list-style-type: none"> • Inculcate a sense of inquiry and capability for asking relevant or appropriate questions, articulating problems or concepts or questions. • Encourage the ability to analyse, interpret and draw conclusions from qualitative/quantitative data and critically evaluate ideas, experiences, theories and concepts by following scientific approach to knowledge development from an open minded and reasoned perspective. • Develop analytical skills involving paying attention to detail and imbibe the ability to construct logical arguments using correct technical language related to the relevant subject. • Analyse and interpret data/information collected or related to experiments or investigations, using appropriate methods involving Biostatistics, Bioinformatics among others and report accurately the findings of the experiment/investigations while relating the conclusions/ findings to relevant theories of zoology.
PSO3	Laboratory Skills and Fieldwork (<i>R, U, E, C</i>) <ul style="list-style-type: none"> • Understand and apply standard operating procedures as per Good Laboratory Practices so as to develop laboratory skills and qualities required for successful career in teaching, research, industry, etc. • Demonstrate awareness regarding animal ethics, human ethics, conservation of flora and fauna, so as to promote safe environment and ecosystem, in the pursuit of disciplinary knowledge. • Develop instrumentation handling skills and laboratory techniques relevant to academia and industry, integrate knowledge, skills with technical competency, so as to create solutions for issues and problems related to biological sciences. • Demonstrate leadership qualities, command trust and respect, thereby, motivating and inspiring team members to work effectively in diverse teams during excursions or study tours. Realise the relevance of participation in field studies in the context of teamwork as well as life on the outdoors.

PSO4	<p>Research Aptitude and Interdisciplinary Approach (<i>Ap, An, E, C</i>)</p> <ul style="list-style-type: none">• Inculcate and adapt to research aptitude and culture, integrate research-based knowledge in an interdisciplinary framework, and realise the relevance of choosing research as an alternative career option.• Demonstrate the awareness regarding compliance with research ethics, awareness about conflicts of interests and Intellectual Property Rights, and avoiding unethical behaviour such as fabricating, falsifying or misrepresenting data or to committing plagiarism.• Inculcate the ability to recognise cause and effect relationships, formulate hypothesis, reporting the results of an experiment or investigation, and application of research tools for analysis and interpretation of data.• Inculcate an interdisciplinary approach, to understand and consolidate fundamental concepts through inquiry based curriculum, develop critical thinking and problem solving ability required to solve different types of biology related problems with well-defined solutions, and tackle open-ended problems that may cross disciplinary-area boundaries.
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Course Outcomes for FYBSc

At the root of all (science) education (Core Learning Outcome):

“The imaginative and original mind need not be overawed by the imposing body of present knowledge or by the complex and costly paraphernalia which today surround much of scientific activity. The great shortage in science now is not opportunity, manpower, money, or laboratory space. What is really needed is more of that healthy skepticism which generates the key idea – the liberating concept.” – *P.H. Abelson*

Purity of mind leads to clarity in thought and action for creation of an original archaic work. As well, to consciously attempt the basic pursuit of understanding human existence.

Semester I – Theory

Course Code: SIUZOCC111

Course Name: Mandatory/Core Paper: Life Processes – I, Ecology and Animal Biotechnology

The study of this course will accomplish the following outcomes:

Unit	Course Outcome (CO)	Cognitive Level	Affinity with PO/ PSO
Life Processes - I	CO CC111.1: Elucidate the interplay between structure and function in animal biology which has survival value. Facilitate clarity on the working of human machine through analysis of animal physiology (physiological processes – inner working of animals). Account for the bodily processes as movement and locomotion, nutrition, respiration and circulation.	<i>R, U</i>	<i>PO1, PO2, PO6</i> <i>PSO1, PSO2</i>
Ecology	CO CC111.2: Outline concepts of ecology – a study of where (place) and how (interaction) organisms live on earth, and realise that any imbalances in the delicate ecological networking of organisms could lead to problems of global environmental concern. Recognise that living things transform energy.	<i>R, U</i>	<i>PO1, PO2, PO6, PO7, PO8</i> <i>PSO1, PSO3, PSO4</i>
Animal Biotechnology	CO CC111.3: Introduction to biotechnology – a field of endeavour and a frontier open for invention by application of technological advancements to biological systems for human benefit. Insight into transgenesis, animal cloning, gene therapy for benefit of mankind, and application.	<i>R, U, An</i>	<i>PO2, PO6, PO7, PO8</i> <i>PSO1, PSO2, PSO3, PSO4</i>

PRACTICAL

“*Study nature not books.*” – An old dictum.

The practical course in Zoology is designed for first hand study of animal life through observation of preserved specimens, *in situ* organ systems, microscopic examination of permanent slides, etc. as well as to perform experiments to strengthen the concept base.

It is an effort to invigorate a thought process that can analyse and reason for the sake of awareness, hence to reach a valid answer.

Semester I – Practical

Course Code: SIUZOCCP111 (Mandatory/Core)

Course Name: Practical based on SIUZOCC111

Course Outcome CO CCP111	Details	Cognitive Level	Affinity with PO/ PSO
	<ol style="list-style-type: none"> 1. Explain essential life processes as digestion, excretion-osmoregulation and movement-locomotion by microscopic examination of one-celled animalcule, <i>Paramecium</i>. 2. Account for functional morphology in animals by examining (preserved/ fresh, wherever applicable) nutritional apparatus, respiratory structures, hearts and blood smears of selected animals. 3. Emphasize the role of factors like pH and temperature for enzyme functioning by testing amylase activity, under physiology of digestion. 4. Examine a beating heart under light microscope and determine its rate by using crustacean arthropod <i>Daphnia</i>. 5. Explain coexistence and coevolution of animal forms through animal interaction study. 6. Insight into the chemistry of biomolecules – proteins and carbohydrates by their qualitative detection. 	<i>R, U, Ap, An, E</i>	<i>PO1, PO2, PO6, PO7</i> <i>PSO1, PSO2, PSO3, PSO4</i>

Semester II – Theory

Course Code: SIUZOCC121

Course Name: Mandatory/Core Paper: Life Processes – II, Biodiversity and Animal Biotechnology – II

The study of this course will accomplish the following outcomes:

Unit	Course Outcome (CO)	Cognitive Level	Affinity with PO/ PSO
Life Processes - II	<p>CO CC121.1: Elucidate the interplay between structure and function in animal biology which has survival value. Facilitate clarity on the working of human machine through analysis of animal physiology (physiological processes – inner working of animals). Account for the bodily processes as excretion and osmoregulation, control and coordination, and reproduction.</p>	<i>R, U</i>	<i>PO1, PO2, PO6</i> <i>PSO1, PSO2</i>
Biodiversity	<p>CO CC121.2: Insight into the wealth of living forms on earth for wise and sustainable usage of these natural resources for man's livelihood as well as recreational activity.</p>	<i>R, U, An</i>	<i>PO2, PO6, PO7, PO8</i>

			<i>PSO1, PSO2, PSO4</i>
Animal Biotechnology	CO CC121.3: Introduction to biotechnology – a field of endeavour and a frontier open for invention by application of technological advancements to biological systems for human benefit. Insight on applications in food and enzyme technology and environmental biotechnology	R, U, Ap	<i>PO1, PO2, PO6, PO7, PO8</i> <i>PSO1, PSO2, PSO4</i>

Semester II – Practical

Course Code: SIUZOCCP121 (Mandatory/Core)

Course Name: Practical based on SIUZOCC121

Course Outcome CO CCP121	Details	Cognitive Level	Affinity with PO/ PSO
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	<ol style="list-style-type: none"> 1. Observe under light microscope the structure of an excretory organ – septal nephridium present in an invertebrate – earthworm 2. Analyse the Urine and detect normal and abnormal composition 3. Extraction/ detection of another biomolecule – nucleic acids (DNA and RNA) and confirm their presence by specific bio-chemical tests. 4. Differentiate between the two broad categories of bacteria using Gram staining, a method that can serve as preliminary diagnostic test for bacterial infection disease 5. Discuss and perform a simple method to evaluate the quality of milk sample by checking its bacterial load, which has a direct impact on fitness of milk for human consumption and hence on commercial value of milk. Understand the International Organization for Standardization (ISO) criteria for milk quality. 6. Immobilize Amylase and detect its optimum activity 7. Explain fermentation, an age-old process known to mankind and meat tenderization, both with applications in food industry for consumer satisfaction. 	<i>R, U, AP, An</i>	<i>PO1, PO2, PO6, PO7, PO8</i> <i>POS1, POS2, PSO3, PSO4</i>
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Vocational Skill Course (VSC)			
Course Code: SIUZOVSI11			
Course Name: Bioinstrumentation			
Unit	Course Outcome CO VS111	Cognitive Level	Affinity with PO/ PSO
Bioinstrumentation	<ul style="list-style-type: none"> • Understand the Principle, working and application of Microscope, Colorimeter, centrifuge, electrophoresis and basic chromatography 	<i>R, U, Ap, An</i>	<i>PO1, PO2, PO6, PO7</i> <i>PSO1, PSO2, PSO3 PSO 4</i>
Practicals based on Bioinstrumentation	<ul style="list-style-type: none"> • Analyze the importance of laboratory safety practices and safety symbols, for awareness regarding conduct as a science student. • Describe the handling and use/ function of basic laboratory equipments/ instruments 	<i>R, U, Ap, An</i>	<i>PO1, PO2, PO6, PO7</i> <i>PSO1, PSO2, PSO3 PSO 4</i>

	in an undergraduate course laboratory. • Apply the knowledge of working of electrophoresis and basic chromatography		
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Skill Enhancement Course (SEC)			
Course Code: SIUZOSE111			
Course Name: Animal Systematics			
Course Outcome CO SE111		Cognitive Level	Affinity with PO/ PSO
	<ul style="list-style-type: none"> • Discuss levels of organization in animal kingdom on which animal body plans are made. • Elaborate on animal diversity (Protozoa to Arthropoda) and inquire into the relatedness of taxa in animal kingdom by direct observation preserved specimens/ permanent slides of chosen representatives from each phylum. • Identify, describe and classify animal representatives of different phyla (Mollusca to Chordata) as well as analyse the evolutionary connect between them. • Discuss vital life processes – digestion, excretion, nervous control and reproduction, through observation of structures/ organs in different animal specimens (preserved or fresh) and permanent slides, and clarify their possession by these animals 	<i>R, U, Ap, An</i>	<i>PO1, PO2, PO6, PO7</i> <i>PSO1, PSO2, PSO3 PSO 4</i>

Semester – I Theory
Mandatory/Core Paper SIUZOCC111
Life Processes – I, Ecology and Animal Biotechnology - I

Learning Objectives

- To attempt an inquiry into the vital processes that make life possible through an understanding of the adaptations animals have evolved that best suit the milieu in which they thrive.
- To understand the relation between organisms and their environment through Ecology i.e., the study of “life at home”.
- To acknowledge the emerging field of Biotechnology that blends the technological advancements and the natural wealth – the living organisms, for improving human life.

Expected Outcomes

- ✓ Students will be equipped knowledge of functionality of life, diversity of animals and manipulating genomes for economic and social wellbeing.
- ✓ Students will be able to apply the knowledge gained for appearing competitive examinations in future.
- ✓ Enhanced knowledge of physiology can be excellent skill set for students pursuing career in biological sciences.

Unit 1: Life Processes – I

15 Lectures

1.1 Movement and Locomotion

- 1.1.1: Amoeboid movement
- 1.1.2: Ultrastructure of cilia and ciliary movements
- 1.1.3: Action of muscles (Role of muscles in movement)

1.2 Nutrition

- 1.2.1: Types of nutrition: Autotrophic and heterotrophic
- 1.2.2: Apparatus for nutrition:

- a. Food vacuole: Animals without alimentary canal, ex. *Amoeba*
 - b. Animals with incomplete alimentary canal, ex. *Hydra*
 - c. Animals with complete alimentary canal, ex. Bird
- 1.2.3: Physiology of digestion in vertebrates and symbiotic digestion in ruminants

1.3 Respiration

- 1.3.1: Types of respiratory surfaces:
- a. General body surface: Cell membrane, ex. *Amoeba*; Skin - ex. Earthworm and Frog
 - b. Specialized respiratory structures: trachea and spiracles, gills of fish, lungs of frog and human, air sacs of bird
- 1.3.2: External respiration and cellular respiration with reference to human

1.4 Circulation

- 1.4.1: Types of circulating fluids: water, coelomic fluid, lymph and blood
- 1.4.2: Types of circulation: Protoplasmic streaming, open and closed circulation, single and double circulation
- 1.4.3: Hearts: Heart in *Daphnia*, cockroach and chordates (one, two, three and four-chambered hearts)
- 1.4.4: Structure of cardiac muscle

Unit 2: Ecology

15 Lectures

- 2.1: Concept of Ecosystem
- 2.2: Concepts of energy flow, food chain and food web
- 2.3: Biogeochemical cycles
- 2.3.1: Carbon cycle, oxygen cycle, nitrogen cycle, phosphorus cycle and water cycle
- 2.3.2: Human activities affecting biogeochemical cycles
- 2.4: Animal interactions: Symbiosis - mutualism, commensalism, parasitism, predation and antibiosis

Unit 3: Animal Biotechnology – I

15 Lectures

3.1 Biotechnology and Gene therapy

- 3.1.1: Recombinant DNA technology in production of insulin, alpha-1-antitrypsin, tissue plasminogen activator (tPA) and Human growth hormone (hGH).
- 3.1.2 : Gene therapy: *Ex vivo* and *In vitro* approach; Gene therapy for Severe Combined Immunodeficiency (SCID) and Cystic fibrosis
- 3.1.3: Ethical issues with reference to gene therapy

3.2 Transgenic Animals and Animal Cloning

- 3.2.1: Transgenic animals
- 3.2.2: DNA Micro injection, Retro-viral method of gene transfer
- 3.2.3: Nuclear transfer technology
- 3.2.4: Animal cloning experiments for “Dolly”

Semester – I Practical

Course Code: SIUZOCCP111 (Mandatory/Core)

Course Name: Practical based on SIUZOCC111

1. Study of *Paramecium* culture to observe cyclosis, food vacuole, contractile vacuole and ciliary movement and irritability in *Paramecium* by demonstration of release of trichocysts
2. Study of effect of pH and temperature on the activity of enzyme amylase/ trypsin
3. Rate of oxygen consumption by cockroach (demonstration only)
4. Determination of rate of heartbeat in *Daphnia*
5. Study of Animal interactions: -
 - a. Mutualism: Termite and *Trichonympha*

- b. Antibiosis: Effect of antibiotics on bacterial growth in a petriplate
 - c. Parasitism: 1. Ectoparasite – Head louse and bed bug; 2. Endoparasite – *Trichinella spiralis*
 - d. Predation: Praying mantis and spider
6. Qualitative tests for Carbohydrates proteins and Lipids

Semester – II Theory
Mandatory/Core Paper SIUZOCC121
Life Processes - II, Biodiversity and Animal Biotechnology – II

Learning Objectives

- To attempt an inquiry into the vital processes that make life possible through an understanding of the adaptations animals have evolved that best suit the milieu in which they thrive.
- To acknowledge the importance of the natural treasure – the biodiversity around us, and to be judicious in the utilization of this natural economy.
- To acknowledge the emerging field of Biotechnology that blends the technological advancements and the natural wealth – the living organisms, for improving human life.

Expected Outcomes

- ✓ Students will be equipped knowledge of functionality of life, diversity of animals and manipulating genomes for economic and social wellbeing.
- ✓ Students will be able to apply the knowledge gained for appearing competitive examinations in future.
- ✓ Enhanced knowledge of physiology can be excellent skill set for students pursuing career in biological science.

Unit 1: Life Processes – II

15 Lectures

1.1 Excretion and Osmoregulation

- 1.1.1: Concepts of excretion and osmoregulation
- 1.1.2: Categorization of animals on the basis of principal nitrogenous excretory products
- 1.1.3: Ornithine cycle, formation of urea; deamination and detoxification

1.2 Control and Coordination

- 1.2.1: Irritability
- 1.2.2: Structure of neuron; sense organs – human eye and ear
- 1.2.3: Conduction of nerve impulse: Resting potential, action potential and refractory period: Synaptic transmission
- 1.2.4: Endocrine regulation: Hormones as chemical messengers; feedback mechanisms

1.3 Reproduction

- 1.3.1: Gametogenesis; structure of egg and sperm of mammal
- 2.3.2: Fertilization in animals; *In vitro* fertilization
- 1.3.3: Oviparity, viviparity and ovoviviparity

Unit 2: Biodiversity and its Conservation

15 Lectures

- 2.1: Introduction to Biodiversity - Definition, Concepts, Scope and Significance
- 2.2: Levels of Biodiversity - Introduction to Genetic, Species and Ecosystem Biodiversity
- 2.3: Introduction of Biodiversity Hotspots- (Western Ghats and IndoBurma Border)
- 2.4: Values of biodiversity - Direct and Indirect use value
- 2.5: Threats to Biodiversity - Habitat loss and Man-Wildlife conflict
- 2.6: Biodiversity conservation and management
- 2.6.1: Conservation strategies: in situ, ex-situ, National parks, Sanctuaries and Biosphere reserves.
- 2.6.2: Introduction to International efforts: International Union for Conservation of Nature and Natural Resources (IUCN).
- 2.6.3: Introduction to National conservation efforts: Project Tiger, Project Rhinoceros (IVR2020)
- 2.6.4: Introduction to Indian Wildlife (Protection) Act, 1972

Unit 3: Animal Biotechnology – II

15 Lectures

3.1 Food Biotechnology

3.1.1: Applications of biotechnology in making bread, beer, wine, yogurt and cheese

3.2 Enzyme Technology

3.2.1: Enzymes as meat tenderizers

3.2.2: Biodetergents

3.2.3: Concept of enzyme immobilization

3.3 Environmental Biotechnology

3.3.1: Bioremediation: Concepts and applications

3.3.2: *Ex situ* and *In situ* Bioremediation

3.3.3: Case studies related to Bioremediation

Semester – II Practical

Course Code: SIUZOCCP121 (Mandatory/Core)

Course Name: Practical based on SIUZOCC121

1. Mounting of septal nephridium of earthworm (from preserved specimen)
2. Urine analysis for detection of normal and abnormal constituents; Detection of uric acid from excreta of bird or cockroach
3. Extraction and qualitative detection of nucleic acids: DNA (SDS-NaCl extraction) and RNA (Phenol extraction)
4. Study of bacteria using Gram stain
5. To evaluate the quality of milk by Methylene Blue Reduction Test (MBRT)
6. Preparation and assay of immobilization of enzyme amylase/ yeast cells in beads of calcium alginate (visual observation for comparing the colour intensity in test tubes)
7. To demonstrate fermentation of grape juice/ sugar cane juice or any fruit juice (Detection of alcohol generated during fermentation by benzoic acid)
8. Effect of Papain (raw papaya extract) as a meat tenderizer.

Semester I / II – Vocational Skill Course (VSC)

Course Code: SIUZOVS111

Bioinstrumentation

Learning Objectives

- To give students a hands-on experience of instrumentation used in laboratory facility.
- To expose students to concept in biological sciences by experiment-based learning.

Expected Outcomes

- ✓ Students will be able to operate instruments in laboratory facility independently.
- ✓ Students will be equipped with principle and working of instruments used in laboratory.
- ✓ Students will be gaining analytical skills based on experimental learning.

Unit 1: Bioinstrumentation

15 Lectures

1.1 Principle, working and application of Microscope: Simple and Compound

1.2 Principle, working and application of Centrifuge: High speed Centrifuge

1.3 Principle, working and application of Colorimeter, pH meter

1.4 Principle, working and application of Electrophoresis: Agarose Gel Electrophoresis (AGE) and Poly Acrylamide Gel Electrophoresis (PAGE)

1.5 Principle, working and application of Chromatography: Paper and Thin Layer Chromatography (TLC)

Practicals Based on Bioinstrumentation

1. Introduction to basic laboratory safety: safety rules, safety symbols and precautions; safety practices with respect to accidents which may occur while working in a laboratory (chemical spillage, burns, etc.); principle, working and use of fire extinguishers.
2. Handling of common laboratory equipment's/ instruments: Burner, microscope, centrifuge, colorimeter, balance, homogenizer; Handling of glassware
3. Separation of amino acids by ascending paper chromatography
4. Thin layer chromatography of lipids using silica gel coated aluminium-backed TLC sheets and silica gel coated glass plates
5. Adsorption chromatography using chalk to separate plant pigments or other pigments/ dyes (Food colours)
6. Demonstrate agarose gel electrophoresis for the separation of egg white proteins and compare with a protein ladder or standard protein sample

Semester I / II – Skill Enhancement Course (SEC)

Course Code: SIUZOSE111

Animal Systematics

Learning Objectives

- To do an introductory survey of the diversity of animal life to understand that part of the world around us comprising of various life forms. Also, to gain an insight into field biology.

Expected Outcomes

- ✓ Students will be equipped with the skill of understanding taxonomy of animal kingdom.
- ✓ Students will be able to gain and apply the practical knowledge in field studies in future.
- ✓ Enhanced knowledge of classification can be an excellent skillset for students pursuing career in field biology.

Practicals based on Animal Systematics - I

1. Levels of Organization in Animal Kingdom
 - a. Symmetry:
 1. Asymmetric organization: *Amoeba*
 2. Radial symmetry: Sea anemone, *Aurelia*
 3. Bilateral symmetry: *Planaria*/ liver fluke
 - b. Coelom condition:
 1. Acoelomate: T.S. of *Planaria*/ liver fluke
 2. Pseudocoelomate: T.S. of *Ascaris*
 3. Coelomate: T.S. of earthworm
 - c. Metamerism: Ametamerism, Psuedometamerism and Eumetamerism
 - d. Specialization of body parts for division of labour: Insect – Head, thorax and abdomen
 - e. Cephalization:
 1. Cockroach – Head
 2. Prawn/ crab – Cephalothorax
2. Animal Diversity
 - a. Phylum Protozoa: *Amoeba*, *Paramoecium*, *Euglena*, *Plasmodium*
 - b. Phylum Porifera: *Leucosolenia*, Bath sponge
 - c. Phylum Cnidaria / Coelenterata: *Hydra*, *Obelia colony*, *Aurelia*, Sea anemone, any one coral

- d. Phylum Platyhelminthes: *Planaria*, liver fluke and tapeworm
 - e. Phylum Nematelminthes: *Ascaris* (male and female)
 - f. Phylum Annelida: *Nereis*, earthworm and leech
 - g. Phylum Arthropoda: Crab, lobster, *Lepisma*, beetle, dragonfly, butterfly, moth, spider, centipede, millipede
 - h. Phylum Mollusca: *Chiton*, *Dentalium*, *Pila*, bivalve, *Sepia* and *Nautilus*
 - i. Phylum Echinodermata: Starfish, brittle star, sea urchin, sea cucumber, feather star
3. Field visit to Zoo / Aquarium / Museum / Natural habitats

Practicals based on Animal Systematics - II

1. Animal Diversity
 - a. Phylum Hemichordata: *Balanoglossus*
 - b. Subphylum Urochordata: *Herdmania*
 - c. Subphylum Cephalochordata: *Amphioxus*
 - d. Division Agnatha: Class Cyclostomata: *Petromyzon/ Myxine*
 - e. Class Pisces: Subclass Chondrichthyes: Shark, skates, sting ray/ electric ray Subclass Osteichthyes: *Sciaena*, flying fish
 - f. Class Amphibia: Frog, toad, caecilian, salamander
 - g. Class Reptilia: Chameleon, *Calotes*, turtle/ tortoise, snake, alligator/ crocodile
 - h. Class Aves: Kite, kingfisher, duck
 - i. Class Mammalia: Shrew, hedgehog, guinea pig, bat
2. Study of wheel organ of *Amphioxus*, scroll valve of shark, digestive system of pigeon, ruminant stomach
3. Observation of sagittal section of mammalian kidney, Bowman's capsule (under high power)
4. Observation of hen's egg with developing embryo at any stage of development
5. Study of mammalian brain (entire and sagittal section with the help of specimen/ model); observation of T.S. of mammalian spinal cord.
6. Geographical Mapping of National Parks and Sanctuaries
7. Field visit to Zoo / Aquarium / Museum / Natural habitats

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