



SOMAIYA
VIDYAVIHAR

K J Somaiya College of Science & Commerce
Autonomous (Affiliated to University of Mumbai)



Learning Outcomes based Curriculum Framework

(LOCF)

For

B.Sc. Zoology

Undergraduate Programme

From

Academic year

2021-22



SOMAIYA
VIDYAVIHAR

K J Somaia College of Science & Commerce
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Vision & Mission

Mission:

Equip the student with knowledge and skills of their chosen vocation,

Inculcate values.

Provide them opportunities for all, round growth and prepare them for life.

Vision:

- To equip the students with advanced knowledge and skills in their chosen vocation.
- To provide value-based education and opportunities to students.
- To help them to face challenges in life.
- To nurture a scientific attitude, temperament and culture among the students.
- To continually review, develop and renew the approach to build India of the Founder's dream.

Goals and Objectives:

- To build a strong Academia-Industry bridge.
- To provide flexibility in the courses offered and proactively adapt to the changing needs of students and the society.
- To establish a centre for multidisciplinary activities.
- To mould individuals who would nurture the cultural heritage of our country and contribute to the betterment of the society.

Board of studies in Zoology

Undergraduate and Post graduate

	Name	Designation	Institute/Industry
Head of the Department			
1	Dr. Vikrant Deshmukh	Chairman	K J Somaiya College of Science and Commerce
Subject Expert nominated by Vice-Chancellor			
1	Dr. Meghna Talpade	Associate Professor	Mithibai College, Vile Parle
Subject experts			
1	Dr. Arshad Ali Haider	Assistant Professor	Maharashtra College, Mumbai Central
2	Dr. Vaishali Somane	Associate Professor	MD College, Parel
Representative from Industry/corporate sector/allied area			
1	Mr. Amit Sharma	Deputy Technical Manager	Ultratech Environmental Consultancy and Laboratory, Thane
Meritorious Alumnus			
1	Ms. Roshni Yadav	MSc Oceanography 2018-19	K J Somaiya College of Science and Commerce
Faculty of the specialisation			
1	Dr. Amol Patwardhan	Assistant Professor	K J Somaiya College of Science and Commerce
2	Ms. Shreya Patil	Assistant Professor	K J Somaiya College of Science and Commerce



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3	Dr. Shanti Upadhye	Assistant Professor	K J Somaiya College of Science and Commerce
4	Ms. Chetana Kanekar	Assistant Professor	K J Somaiya College of Science and Commerce
5	Ms. Madhuri Padaya	Assistant Professor	K J Somaiya College of Science and Commerce
6	Ms. Sadaf Zakariya	Assistant Professor	K J Somaiya College of Science and Commerce
7	Ms. Roshni Yadav	Assistant Professor	K J Somaiya College of Science and Commerce
8	Ms. Meghna Verma	Assistant Professor	K J Somaiya College of Science and Commerce



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Foreword

Autonomy reflects efforts for excellence in academic performances, capability of self-governance and enhancement in the quality of education. In the year 2012, the UGC and University of Mumbai conferred the Autonomous Status to K. J. Somaiya College of Science and Commerce. Post this recognition and having several accolades to our credit, we made significant changes to our existing syllabi to reflect the changing business, industrial and social needs. A holistic education that provides opportunities to gain and share knowledge, experiment and develop beyond curriculum, is offered at our college.

Autonomous college carries a prestigious image for the students and the teachers, and we have made a collaborative attempt to maintain a high level of quality in the standard of education that we impart.

Structured feedback obtained from the students, alumni and the experts from the industry and the changes suggested by them were duly incorporated in the syllabi. The Board of Studies constituted for each department meets to carry out in depth discussions about different aspects of the curriculum taking into cognizance the recent trends in the discipline.

The IQAC team has facilitated the conduct of a number of workshops and seminars to equip the faculty with the necessary skill set to frame the syllabi and competencies to deliver the same. Training was also provided to employ innovative evaluation methods pertaining to higher cognitive levels of revised Bloom's taxonomy. This



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ensured the attainment of the learning outcomes enlisted in the syllabus. Audits are conducted to critically review the practices undertaken in teaching, learning and evaluation. Innovative learning methodologies such as project-based learning, experiential learning and flip- class learning practiced by a committed fleet of faculty, supported by several hands have been our unique outstanding propositions. All efforts have been made to nurture the academic ambitions as well as the skills in co-curricular activities of the most important stakeholder i. e. student.

With sincere gratitude, I acknowledge the constant support and guidance extended by Shri Samir Somaiya, President- Somaiya Vidyavihar, and all the esteemed members of the Governing board and Academic council of the College. I also would like to acknowledge the Heads of the Departments and all the faculty members for their meticulous approach, commitment and significant contribution towards this endeavour for academic excellence.

Dr. Pradnya Prabhu
Principal



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Acknowledgement

Syllabus Revision is an essential part of academic sustenance. At the outset, I would like to thank our Principal Dr. Pradnya Prabhu for her guidance and support during the curriculum restructuring process. I am also deeply obliged to all the esteemed members of the Board of Studies, for their constructive suggestions and contributions.

Above all, I am indebted to my young and vibrant colleagues in the Department of Zoology for their sincere and efficient efforts during the compiling of the restructured syllabus.

Dr. Vikrant Deshmukh

Chairman

Board of Studies in Zoology



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Preamble

This Learning Outcome-based Curriculum Framework (LOCF) supports the fundamental principle of providing quality education in India. We endeavour to mould young minds to participate, contribute and add value to every milestone in their path towards academic excellence. The introduction of Choice Based Credit System (CBCS) has maximized the benefits of the newly designed curriculum manifold.

The LOCF will assist teachers to envisage the outcome expected from the learners at the end of the programme. It will help them to strategize their teaching effectively. At the same time, this document will guide the students through the new curriculum and help them acquire all the skills and knowledge sets required for their personal and academic growth. Higher education qualifications such as bachelor's degree Programme are awarded on the basis of demonstrated achievement of outcomes and academic standards; and this is the very essence of this curriculum.

1. Introduction

The B.Sc. Zoology program is developed by keeping in mind the interest of learners to explore the field of Zoology. The flexible framework helps to maintain the ethos of Zoology degree programmes through periodic programme review within a broad framework of agreed/expected graduate attributes, qualification descriptors, programme learning outcomes and course-level learning outcomes. The B.Sc. program is planned in such a way that it allows flexibility and innovation in programme design, syllabi development, teaching-learning process and quality assessment of student's learning levels. Updating of teaching learning pedagogy and outcome-based education form the pillars of the programme.



2. Learning Outcome based Curriculum Framework

LOCF focuses on curriculum framework, curriculum aims, learning targets and objectives. The curriculum framework also provides examples of effective learning, teaching and assessment practices. As the curriculum development is a collaborative and an on-going enhancement process, the LOCF instructs periodic reviews and revisions of the curriculum in accordance with the ever-changing needs of students, teachers and society.

2.1 Nature and extent of B.Sc. Zoology

The B.Sc. Zoology programme is of three years duration. Each year is divided into two semesters. The degree program in Zoology is designed to include both classical core topics from basic branches like Taxonomy, phylogeny, anatomy, physiology, ecology, evolution etc. along with applied branches such as genetics, biotechnology, biostatistics and animal husbandry. The Zoology programme thus strikes a perfect balance between fundamental and contemporary concepts. The scope of each topic varies with the nature of the specific branch. In our endeavour to improve the employability of graduates of the Zoology program, the curriculum offers courses on entrepreneurial skills in Zoology and its allied fields like eco-tourism, wildlife photography, aquaculture and zoo keeping.

2.2 Programme Education Objectives (PEOs):

The overall aims of bachelor's degree program in zoology are to:

1. Elucidate core knowledge and skills in Zoology.
2. Demonstrate innovative attitude and scientific temperament towards wildlife and nature at large.
3. Spread awareness about wildlife and related topics in the society.
4. Employ the knowledge of Zoology to environmental and entrepreneurial domains of society.
5. Display traits of global citizenship, empathy for all life forms and sustainability
6. Develop a career in zoology and its allied branches.
7. Express their ideas clearly and concisely, both orally and in writing
8. Formulate their thoughts constructively and communicate effectively to people across society to emphasize their views.

3. Graduate Attributes in Zoology

Attributes expected from the graduates of B.Sc. Zoology Programme are:

GA 1: An understanding of the diversity of animals from the evolutionary, functional, and ecological perspective

GA 2: An appreciation of the uniqueness of Indian biodiversity and wildlife

GA 3: An awareness of the importance of research to the development of the discipline of Zoology

GA 4: An understanding of the gaps or deficits in the current knowledge and attempt to fill those gaps.

GA 5: Skills specific to the study of animals such as making observations, generating and presenting data, experimental design, statistical analysis, writing reports, identifying species, mounting specimens, using microscopes and interpreting classification keys.

GA 6: Personal skills in written and oral communication, analysis, problem solving and decision making.

GA 7: Curiosity, creativity and the ability to learn and to work both independently and effectively as part of a team.

GA 8: An appreciation of the ethical and social issues relating to research on animals.

GA 9: Better citizenship and social awareness for environment and other global issues.

4. Qualification descriptors

Upon successful completion of the programme, students receive a Bachelor's degree in Zoology. B.Sc. Zoology graduates of this department acquire knowledge pertaining to various core and applied branches under Zoology along with the development of Practical skills in this subject. The graduates are expected to demonstrate the extensive knowledge of various concepts in Zoology and their applications. The graduates are thus able to contribute to research and development, teaching, government, and public sectors. This programme will establish a solid foundation for the student to pursue higher studies in Zoology such as Post Graduation or further research in the subject.

The list below provides a synoptic overview of possible career paths provided by an undergraduate training in Zoology:

1. Academics
2. Research
3. Eco tourism
4. Pharmaceutical Industry
5. Life science-based Industries
6. Food quality monitoring and packaging technology
7. Environmental monitoring and Analysis
8. Wildlife Photography
9. Wildlife Journalism
10. Animal Behaviour Psychology
11. Medical Laboratory Technology
12. Clinical Research Institutes
13. Entrepreneurship (Apiculture, Aquaculture, Vermiculture, etc.)
14. Government Service

Job Roles for B.Sc. Zoology graduate:

After graduation one can seek a professional career as:

1. Academicians
2. Researchers
3. Forest Officer
4. Eco tourism facilitators
5. Medical Representatives
6. Technicians in Industries/Laboratories
7. Officers/ Managers in Environmental monitoring, Quality Control and Packaging Technology
8. Wildlife Photographers
9. Wildlife Journalists
10. Animal Behaviour Psychologists
11. Entrepreneurs
12. Clinical Researchers
13. Data Analysts

Higher Education options for B.Sc. Zoology graduate:

1. M.Sc. in Zoology [by papers]
2. M.Sc. in Life Sciences
3. M.Sc. in Wildlife and Biodiversity Conservation
4. M.Sc. in Environmental Science
5. M.Sc. in Genetic Engineering
6. M.Sc. in Nutraceuticals
7. Integrated MSc – PhD in above specializations
8. M.Sc. by research in the above specializations
9. MBA in Hospital Management
10. B. Ed/M.Ed.



11. Paramedical Courses – Nursing, Lab Technician etc.
12. DMLT
13. L.L.B/ L.L.M in Wildlife laws, Environmental laws
14. B. Library Science
15. Clinical Research
16. Medical coding

The learners who complete three years of full-time study of an undergraduate programme of study will be awarded a bachelor's degree in Zoology.

5. Programme Learning Outcomes (PLOs)

After the successful completion of modules in different courses of B.Sc. Zoology, the learner will be able to:

PLO I: Identify and classify animals up to phylum and class level.

PLO II: Differentiate between various animal groups, their life processes and roles in nature.

PLO III: Perform practical techniques in Zoology.

PLO IV: Describe animal habitat requirements, behaviour and evolution.

PLO V: Explain biomolecules, anatomy, physiology, cytology, development, diseases of animals, applications of biotechnology and biostatistics.

PLO VI: Analyse the role of genetics and molecular biology in animal breeding, fishery biology, entomology and related research programmes.

PLO VII: Apply classical principles of zoology and environment to real vocations.

PLO VIII: Practise sustainable lifestyle and advocate conservation strategies.

5.1 Course Mapping

Semester	PLO	I	II	III	IV	V	VI	VII	VIII
	Course								
I	CC I	√	√	√	√			√	√
	CC II			√	√	√	√	√	
	CC III					√	√	√	
	AECC I FC*								
	SEC I STPI								
	SEC II BCE**								
II	CC I	√	√	√	√			√	
	CC II		√	√	√	√		√	√
	CC III					√	√	√	√
	AECC I FC*								
	SEC I STP2								
	SEC II ICHI***								
III	CC I	√	√	√	√	√		√	
	CC II		√	√		√	√	√	
	CC III		√	√	√		√	√	
	AECC I FC*								

IV	SEC I STP3								
	SEC II ICH2***								
	CC I			√	√	√		√	
	CC II			√	√	√	√	√	
	CC III		√	√		√		√	√
	AECC I FC*								
V	SEC I STP4								
	SEC II ICH3***								
	CC I	√	√	√	√	√			
	CC II		√	√		√	√	√	
	CC III			√		√	√	√	
	CC IV			√	√	√		√	√
	DSE I			√	√			√	√
	DSE II	√	√	√	√			√	
	DSE III	√	√	√	√			√	√
	DSE IV			√		√		√	√
	AECC I EVS								
	SEC I			√			√	√	
SEC II	√	√	√	√	√	√	√	√	

VI	CC I	√	√	√	√	√		√	
	CC II			√	√	√		√	
	CC III		√	√	√	√		√	
	CC IV			√		√		√	√
	DSE I			√		√	√	√	√
	DSE II			√			√	√	√
	DSE III			√			√	√	√
	DSE IV			√		√	√	√	
	AECC I								
	EVS								
	SEC I	√	√	√	√	√	√	√	√
SEC II	√	√	√	√	√	√	√	√	

* FC = Foundation Course

** BCE = Basic communication in English

*** ICH = Indian Cultural Heritage (Value Education)



6. Structure of B.Sc. Zoology programme

The curriculum frame work is designed around the choice-based credit system (CBCS). The programme consists of three years and six semesters (two semesters per year). To acquire a degree in B.Sc. Zoology a learner must study

1. Core Courses (CC):

- A course which is required to be opted by a candidate as a core course.
- There are eighteen Core courses (CC), two each, in semesters I and II; three each in semesters III and IV and four each in semesters V and VI (for 6 units).
- Each Core Courses is compulsory, except in F.Y.B.Sc where an option is offered to the learner to pick between CC2 and CC3 in semester 1 and 2.
- Each CC is comprised of 2 credits for theory ie. 30 hours; 3 lectures of each 50 min per week and 1 credit for practical of two hour per week in every semester.
- The purpose of fixing core papers is to ensure that the institution follows a minimum common curriculum to adhere to common minimum standard with other universities/institutions.
- The course designed under this category aims to cover the basics that a student is expected to imbibe in that discipline.

2. Ability Enhancement Compulsory Courses (AECC)

- There are six AECC courses. Student must take two Ability Enhancement Compulsory Courses (AECC) in semester I and one AECC each in semesters II-VI.
- The AECC courses offered are:
AECC 1- Foundation Course (2 credits) (Semester I-IV),
AECC 2-Environmental Science (2 credits) (Semester V and VI).



3. Skill Enhancement Course (SEC):

- a) They are designed to provide skill-based knowledge and contain both lab/hands on training/field work.
- b) The main purpose of these courses is to provide life skills in hands on mode to increase employability.
- c) There are Twelve skill enhancement courses offered. Each student is supposed to take two in each semester I-IV (Sports training program, Basic communication in English and Indian Cultural Heritage) of 1 credit each. There are four discipline-related skill enhancement courses (SEC), two offered in each semester V and semester VI each of 2 credit. The student is supposed to choose one SEC in Semester V and VI.

4. Discipline Specific Elective Courses (DSE):

- a) Elective courses offered under the main discipline subject of study.
- b) There are eight discipline specific elective courses (DSE), four in each semesters V and VI. The student is supposed to choose two out of four in each semester V and VI.
- c) Each DSE theory course is of 2 credits i.e. 30 hour; 3 lectures of each 50 min per week and 1 credit for practical of two hour per week in every semester.
- d) Research Project is offered as an option for the student to choose in lieu of a regular DSE course

5. Generic Elective Course (GE)

- a) Students can opt for one interdisciplinary Generic Elective Course (GE) in each of the semester V and VI.
- b) Generic elective courses are offered in cognate disciplines by different departments in the college.
- c) Credits for these courses are granted as additional credits.

6.1 Content

Sr. No	Semester	Course number	Course Code	Course title
Core Course (CC)				
1	I	CC I	21USIZOCCINCE	Study of Non-chordates and general ecology
2		CC II	21USIZOCC2PBM	Proteins and carbohydrates, Basic biotechnology and Mendelian and non-Mendelian inheritance
		CC III	21USIZOCC3NPT	NPTEL/MOOC (as available)
3		CC P	21USIZOCCP	Based on CC I and CC II
4	II	CC I	21US2ZOCCIHCE	Hemichordates, Chordates and Ethology
5		CC II	21US2ZOCC2LAE	Lipids and Nucleic Acids, Applied Biotechnology, Evolution and Biodiversity
		CC III	21US2ZOCC3NPT	NPTEL/MOOC (as available)
6		CC P	21US2ZOCCP	Based on CC I and CC II
7	III	CC I	22US3ZOCCINCC	Adaptation in Non-chordates, Chordates and Comparative Vertebrate Embryology
8		CC II	22US3ZOCC2CBG	Cell biology and Genetics
9		CC III	22US3ZOCC3EFF	Economic entomology, Animal Farming, Aquaculture and fisheries

10		CC P	22US3ZOCCP	Based on CC I, CC II and CC III
11	IV	CC I	22US4ZOCCIEET	Ecosystems and Population dynamics, Animal behaviour, Study of tissue
12		CC II	22US4ZOCC2HNG	Homeostasis, Nutrition and Health, Human Genetics disorders
13		CC III	22US4ZOCC3PWZ	Parasitology - protozoan, helminth and arthropod; Wildlife Conservation and Zookeeping
14		CC P	22US4ZOCCP	Based on CC I, CC II and CC III
15	V	CC I	23US5ZOCCIEAE	Animal Type Study- Earthworm, Mammalian Anatomy and Embryology
16		CC II	23US5ZOCC2HAI	Haematology and Immunology
17		CCP I	23US5ZOCCPI	Based on CCI and CCII
18		CC III	23US5ZOCC3MBR	Molecular Biology and Recombinant DNA Technology
19		CC IV	23US5ZOCC4SEE	Study of Environment and Etiology of Diseases
20		CC P II	23US5ZOCCP2	Based on CCIII and CCIV

21	VI	CC I	23US6ZOCCISEH	Animal type study- Shark, Endocrinology and Histology
22		CC II	23US6ZOCC2ANP	Animal Physiology
23		CC P I	23US5ZOCCPI	Based on CCI and CCII
24		CC III	23US6ZOCC3TEP	Toxicology, Evolution and Population genetics
25		CC IV	23US6ZOCC4MSB	Environmental Studies and Biostatistics
26		CC P II	23US5ZOCCP2	Based on CCIII and CCIV
Discipline Specific Electives (DSE)				
1	V	DSE I	23US5ZODSIMFM	Marine Ecology and Non-Conventional Fishing methods
2		DSE II	23US5ZODS2ENT	Entomology
3		DSE III	23US5ZODS3ECZ	Economic zoology
4		DSE IV	23US5ZODS4PHH	Public health and hygiene
5		DSE P	23US5ZODSP	Practical Based on DSE Courses
6	VI	DSE I	23US6ZODSIFPF	Fish pathology and fishery products
7		DSE II	23US6ZODS2ELI	Entrepreneurship, Environmental law & patenting and Information technology

8		DSE III	23US6ZODS3REM	Research Methodology
9		DSE IV	23US6ZODS4ART	Assisted reproductive technologies.
10		DSE P	23US6ZODSP	Practical Based on DSE Courses
Skill Enhancement Courses (SEC)				
1	I	SEC I	21USISEISTPI	Sports Training Program Level I
2		SEC II	21USISE2BCE	Basic Communication in English
3	II	SEC I	21US2SEISTP2	Sports Training Program Level II
4		SEC II	21US2SE2ICHI	Indian cultural Heritage Level I (value education)
5	III	SEC I	22US3SEISTP3	Sports Training Program Level III
6		SEC II	22US3SE2ICH2	Indian cultural Heritage Level II (value education)
7	IV	SEC I	22US4SEISTP4	Sports Training Program Level IV
8		SEC II	22US4SE2ICH3	Indian cultural Heritage Level III (value education)
9	V	SEC I	23US5ZOSEILTZ	Laboratory Techniques in Zoology
10		SEC II	23US5ZOSE2API	Apiculture

11	VI	SEC I	23US6ZOSEIASC	Aquarium Science
12		SEC II	23US6ZOSE2ITR	Industrial training/ internship
Ability Enhancement Compulsory Course (AECC)				
1	I	AECC I	21USIAEIFOC	Foundation Course
2	II	AECC I	21US2AEIFOC	Foundation Course
3	III	AECC I	22US3AEIFOC	Foundation Course
4	IV	AECC I	22US4AEIFOC	Foundation Course
5	V	AECC I	23US5AEIEVS	Environmental Science
6	VI	AECC I	23US6AEIEVS	Environmental Science

6.2 Credit distribution for B.Sc. Zoology

Semester	Course number	Course title	Credits		
			Theory	Practical	Total
I	CC I	Study of non-chordates and general ecology	2	1	3
	CC II/ CC III	Proteins and carbohydrates, Basic biotechnology and Mendelian and non-Mendelian inheritance OR NPTEL/MOOC (as available)	2	1	3
	AECC I	Foundation Course	2		2
	SEC I	Sports Training Programme Level I	1		1
	SEC II	Basic Communication in English	1		1
II	CC I	Hemichordates, Chordates and Ethology	2	1	3

	CC II/ CC III	Lipids and Nucleic Acids, Applied Biotechnology, Evolution and Biodiversity OR NPTEL/MOOC (as available)	2	1	3
	AECC I	Foundation Course	2		2
	SEC I	Sports Training Program Level II	1		1
	SEC II	Indian cultural Heritage Level I (value education)	1		1
III	CC I	Adaptation in Non- chordates, Chordates and Comparative Vertebrate Embryology	2	1	3
	CC II	Cell biology and Genetics	2	1	3
	CC III	Economic entomology, Animal Farming, Aquaculture and fisheries.	2	1	3
	AECC I	Foundation Course	2		2
	SEC I	Sports Training Program Level III	1		1
	SEC II	Indian cultural Heritage Level II (value education)	1		1
IV	CC I	Ecosystems and Population dynamics, Animal behaviour, Study of tissue	2	1	3
	CC II	Homeostasis, Nutrition and	2	1	3

		Health, Human Genetics disorders			
	CC III	Parasitology - protozoan, helminth and arthropod; Wildlife Conservation and Zookeeping	2	1	3
	AECC I	Foundation Course	2		2
	SEC I	Sports Training Program Level IV	1		1
	SEC II	Indian cultural Heritage Level III (value education)	1		1
V	CC I	Animal Type Study- Earthworm, Mammalian Anatomy and Embryology	2	1	3
	CC II	Haematology and Immunology	2	1	3
	CC III	Molecular Biology and Recombinant DNA Technology	2	1	3
	CC IV	Study of Environment and Etiology of Diseases	2	1	3
	DSE I/II	Marine Ecology and Non-conventional Fishing methods/Entomology	2	1	3
	DSE III/IV	Economic Zoology/Public health and hygiene	2	1	3
	AECC I	Environmental science	2		2

	SEC I/II	Laboratory Techniques in Zoology/ Apiculture	2		2
VI	CC I	Animal type study- Shark, Endocrinology and Histology	2	1	3
	CC II	Animal Physiology	2	1	3
	CC III	Toxicology, Evolution and Population genetics	2	1	3
	CC IV	Environmental Studies and Biostatistics	2	1	3
	DSE I/II	Fish pathology and fishery products/Entrepreneurship, Environmental law & patenting and Information technology	2	1	3
	DSE III/IV	Research Methodology/Assisted reproductive technologies.	2	1	3
	AECC I	Environmental science	2		2
	SEC I/II	Aquarium Science/Industrial training or internship	2		2

6.3 Semester Schedule

Semester	Core Course number	Core Course (CC) title	Discipline Specific Electives (DSE)	Generic Elective Course (GE)	Skill Enhancement Course (SEC)	Ability Enhancement Compulsory Course (AECC)
I	CC I	Study of non-chordates and general ecology	-	-	1] Sports Training Programme Level I	Foundation Course
	CC II/ CC III	Proteins and carbohydrates, Basic biotechnology and Mendelian and non-Mendelian inheritance OR NPTEL/MOOC (as available)	-	-	2] Basic Communication in English	
II	CC I	Hemichordates, Chordates and Ethology	-	-	1] Sports Training	Foundation Course

	CC II/ CC III	Lipids and Nucleic Acids, Applied Biotechnology, Evolution and Biodiversity OR NPTEL/MOOC (as available)	-	-	Program Level II 2] Indian cultural Heritage Level I (Value Education)	
III	CC I	Adaptation in Non- chordates, Chordates and Comparative Vertebrate Embryology	-	-	1] Sports Training Program Level III 2] Indian cultural Heritage Level II (Value Education)	Foundation Course
	CC II	Cell biology and Genetics	-	-		
	CC III	Economic entomology, Animal Farming, Aquaculture and fisheries.	-	-		

	CC II	Haematology and Immunology				
	CC III	Molecular Biology and Recombinant DNA Technology				
	CC IV	Study of Environment and Etiology of Diseases				
VI	CC I	Animal type study- Shark, Endocrinology and Histology	DSE I/II and DSE III/IV	GE	SEC I/ II	Environmental Science
	CC II	Animal Physiology				
	CC III	Toxicology, Evolution and Population genetics				
	CC IV	Environmental Studies and Biostatistics				



6.4 Course Learning Objectives

The three-year undergraduate Zoology programme is designed to familiarize students with the fundamental and applied aspects of Zoology. The objective of creating a structured syllabus in Zoology is to make the concepts and basics of zoology clear and interesting to student and to ensure the development of vertical growth in the subject. The rationale behind this is to enable students to develop scientific aptitude and critical thinking. It is our attempt that students achieve this objective through systematic reading and class lectures and through feedback on their written work-assignments, project/research papers, presentations, discussions, debates, etc. Our goal is to enable students to think objectively, take cognizant decisions, develop necessary curiosity towards Zoology to pursue the same as a successful career in the future.

7. Detailed B.Sc. Zoology Syllabus

F. Y. B.Sc. Syllabus with effect from the Academic year 2021–2022

Syllabus - F. Y. B.Sc. Zoology

Course No.	Course Title	Course Code	Credits	Hr.	Periods (50 min)	Module	Lectures per module (50 minutes)	Examination		
								Internal Marks	External Marks	Total Marks
SEMESTER I										
Core courses THEORY										
I	Study of Non-Chordates and General Ecology	2IUSIZOC CINCE	2	30	36	3	12	40	60	100
II	Protein and Carbohydrates, Basic Biotechnology and Genetics	2IUSIZOC C2PBM	2	30	36	3	12	40	60	100
Core courses PRACTICAL										
		2IUSIZOC CP	2	75	90			40	60	100
SEMESTER II										
Core courses THEORY										
I	Hemichordates, Chordates and Ethology	2IUS2ZOC CIHCE	2	30	36	3	12	40	60	100
II	Lipids and Nucleic Acids, Applied Biotechnology, Evolution and Biodiversity	2IUS2ZOC C2LAE	2	30	36	3	12	40	60	100
Core courses PRACTICAL										
		2IUS2ZOC CP	2	75	90			40	60	100



F.Y. B. Sc. (ZOOLOGY) SEMESTER I

Core Course- I

COURSE TITLE: Study of Non-Chordates and General Ecology

COURSE CODE: 2IUSIZOCCINCE [CREDITS - 02]

Course Learning Outcomes

After the successful completion of the Course, the learner will be able to:

1. Discuss various levels of organization in animal kingdom.
2. Classify the given non-chordate up to class level based on its characteristic features.
3. Summarize characteristics and classification of Arthropoda, Mollusca, and Echinodermata
4. Justify various minor phyla as connecting links.
5. Describe the various branches and underlying principles of ecology.
6. Explain different type of animal interactions

Module 1	Levels of organization, Protozoa to Annelida	[12L]
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Learning Objectives:

The module is intended to

1. Explain the basic concepts in levels of organization.
2. Describe characteristics of kingdom Protista and from phylum Porifera to Annelida of kingdom Animalia.
3. Classify each phylum of Kingdom Animalia up to class level.
4. Discuss examples of each class.

Learning Outcomes:

After the successful completion of the module, the learner will be able to:

1. Differentiate between unicellular, multicellular, tissue and organ level of organization.
2. Define - acoelomate, pseudocoelomate, coelomate organism and metamerism.
3. Enlist the general characteristics of Kingdom Protista
4. Describe general characteristics of Phylum Porifera to Annelida of kingdom Animalia.
5. Classify the examples of above-mentioned phyla up to class level

1.1	Levels of organization: 1.1.1 Unicellular and multicellular organization 1.1.2 Diploblastic and triploblastic condition 1.1.3 Development of coelom 1.1.4 Symmetry, Segmentation and Cephalization	[2L]
1.2	Unicellular organization: Kingdom: Protista	[2L]
1.3	Multicellular organization: 1.3.1 Colonization level- Phylum Porifera 1.3.2 Division of labour (tissue grade organization)- Phylum Coelenterata	[4L]
1.4	Triploblastic acoelomate and pseudocoelomate organization 1.4.1 Acoelomate organization - Phylum Platyhelminthes 1.4.2 Pseudocoelomate organization - Phylum Nematelminthes	[2L]
1.5	Triploblastic coelomate organization - Phylum Annelida (Classification up to Class level for above mentioned phyla)	[2L]

References:

- Zoology, Stephen A. Miller and John P. Harley, Tenth Edition, McGraw Hill Education, 2016.
- Invertebrates, Richard C. Brusca, Wendy Moore, Stephen M. Shuster, Third Edition, Sinauer Associates, Inc., Publishers USA, 2015.

Module	Arthropoda to Echinodermata and Minor Phyla	[12L]
2		

Learning Objectives:

This module is intended to:

1. Illustrate the intricacies of classical zoology with respect to higher Non-Chordates and Minor Phylum.
2. Describe the characteristics and classes of phylum Arthropoda, Mollusca and Echinodermata
3. Integrate the adaptive characteristics of animals belonging to minor Phyla.

Learning Outcomes:

After the successful completion of the module, the learner will be able to:

1. Elaborate the concepts of Classical Zoology.
2. Catalogue various higher order Non-chordates to their respective Phyla and classes.
3. Investigate the reasons for separate taxonomic group of minor phyla.
4. Explain minor phyla as the evolutionary link between the major phyla.

2.1	Animals with jointed appendages: Phylum Arthropoda	[6L]
2.2	Animals with mantle: Phylum Mollusca	
2.3	Animals with enterocoel: Phylum Echinodermata	
2.4	Minor Phyla 2.4.1 Ctenophora 2.4.2 Bryozoa	[6L]

	2.4.3 Rotifera 2.4.4 Onychophora (Classification up to Class level for all above mentioned phyla)	
<p>References:</p> <ul style="list-style-type: none"> • Modern Textbook of Zoology Invertebrates, R. L. Kotpal, 12th Edition, Rastogi Publication, January 2019. • Invertebrate Zoology, E. L. Jordan and P.S. Verma, 5th Edition, S. Chand Publication. • Invertebrate Zoology, Robert D. Barnes, Seventh Edition, Cengage Publication, January 2006. 		
Module 3	General Ecology	[12L]
<p>Learning Objectives:</p> <p>The module is intended to</p> <ol style="list-style-type: none"> 1. Explain the basics of ecological working like energy transfer, food chain and food web. 2. Describe the movement of some elements through various components of an ecosystem through biogeochemical cycles. 3. Explain the effect of anthropogenic activities on biogeochemical cycles. 4. Illustrate various animal interactions 		
<p>Learning Outcomes:</p> <p>After the successful completion of the module, the learner will be able to:</p> <ol style="list-style-type: none"> 1. Define basic terminologies of ecology. 2. Describe the process of energy transfer and working of food chains and food webs in ecosystems. 3. Schematically describe various biogeochemical cycles 4. Reason how anthropogenic activities affect the biogeochemical cycles and in turn the entire ecosystem. 		

5. Identify animal interactions.		
3.1	Concept of Ecosystem 3.1.1 Definition and Branches. 3.1.2 Introduction to ecosystem services	[3L]
3.2	Energy flow in Ecosystem – Energy Generation, Energy Transfer, Food chain and Food web	[3L]
3.3	Biogeochemical cycles: Concept, Process with examples, anthropogenic activities affecting biogeochemical cycles. 3.3.1 Carbon 3.3.2 Oxygen 3.3.3 Nitrogen 3.3.4 Phosphorus	[3L]
3.4	Concept of animal interactions: 3.4.1 Symbiosis 3.4.2 Mutualism 3.4.3 Commensalism 3.4.4 Parasitism 3.4.5 Predation 3.4.6 Antibiosis	[3L]
References: <ul style="list-style-type: none"> Principles of Environmental Science: W.P.Cunningham & M.A.Cunningham. Tata McGraw Hill. Ecology: N.S.Subramanyam & AVSS.Sambamurthy, Narosa Publications. 		



Question paper Template

F.Y. B. Sc. (ZOOLOGY) SEMESTER I

Core Course- I

COURSE TITLE: Study of Non-Chordates and General Ecology

COURSE CODE: 2IUSIZOCCINCE [CREDITS - 02]

Module	Remembering/ Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total marks
I	15	10	5	-	-	-	30
II	15	10	5	-	-	-	30
III	20	5	5	-	-	-	30
Total marks per objective	50	25	15	-	-	-	90
% Weightage	55	28	17	-	-	-	100

F.Y. B. Sc. (ZOOLOGY) SEMESTER I

Core Course- II

COURSE TITLE: Protein and Carbohydrates, Basic Biotechnology and Genetics

COURSE CODE: 2IUSIZOCCIIPBM

[CREDITS - 02]

Course Learning Outcomes		
<p>After the successful completion of the Course, the learner will be able to:</p> <ol style="list-style-type: none"> 1. Elaborate on various types of biomolecules found in the cell and their functions. 2. Summarise structure, functions and importance of proteins and carbohydrates. 3. Identify specific branches of biotechnology with respect to applications. 4. Describe the working and applications of basic instruments used in the biotechnology laboratory. 5. Demonstrate basic concepts of genetics and Mendelian laws using crosses and examples. 6. Recall Non-Mendelian inheritance and its types with examples. 		
Module 1	Molecular basis of life – Proteins and Carbohydrates	[12L]
<p>Learning Objectives:</p> <p>The module is intended to</p> <ol style="list-style-type: none"> 1. Explain proteins and carbohydrates as biomolecules. 2. Make the learner understand various types, structures and functions of proteins and carbohydrates. 3. Enlist the commercial uses of proteins and carbohydrates. 4. Discuss how proteins and carbohydrates play an integral role in our body. 		
<p>Learning Outcomes:</p> <p>After the successful completion of the module, the learner will be able to:</p>		

<ol style="list-style-type: none"> 1. Elucidate the chemical structure and biological role of all major micro and macro molecules found in the cell. 2. Elaborate on various sub types of biomolecules and their functions. 3. Classify different types of carbohydrates, proteins, and amino acids. 4. Enlist the commercial importance of carbohydrates. 5. Analyze role of protein and carbohydrates in functioning of human body. 		
1.1	Biological micro- and macro-molecules Monomeric constituents, polymers, and significance of carbon.	[2L]
1.2	<p>Proteins</p> <p>1.2.1 Amino acids: Types based on carboxylic, amino and aromatic group.</p> <p>1.2.2 Peptide bond formation</p> <p>1.2.3 Structure of proteins: Primary, secondary, tertiary, and quaternary structure.</p> <p>1.2.4 Biological role of proteins</p> <p>1.2.5 Commercially important Amino acids and proteins.</p>	[5L]
1.3	<p>Carbohydrates</p> <p>1.3.1 Nomenclature, classification, Glycosidic bond. Types of carbohydrates: (Structure, Properties and Functions)</p> <p>1.3.2 Monosaccharides: Glucose, fructose, galactose Disaccharides: Maltose, sucrose, lactose Polysaccharides: Starch, glycogen, chitin, heparin</p> <p>1.3.3 Biological role of carbohydrates</p> <p>1.3.4 Carbohydrates of industrial significance</p>	[5L]
<p>References:</p> <ul style="list-style-type: none"> • Biochemistry by U. Satyanarayana. • Fundamentals of Biochemistry by J. L Jain. 		

Module 2	Basic Biotechnology	[12L]
<p>Learning Objectives:</p> <p>This module is intended to:</p> <ol style="list-style-type: none"> 1. Recapitulate the history of biotechnology. 2. Emphasize on all the major breakthroughs in biotechnology. 3. Explain the layout of a biotechnology laboratory, basic laboratory practices and equipments. 4. Make the learner understand various molecular separation techniques. 		
<p>Learning Outcomes:</p> <p>After the successful completion of the module, the learner will be able to:</p> <ol style="list-style-type: none"> 1. Define all the basic terminologies introduced to them in biotechnology. 2. Enlist numerous applications of biotechnology. 3. Describe the working and applications of basic instruments used in the biotechnology laboratory. 4. Summarize various aseptic techniques. 5. Restate the principles of molecular separation techniques. 6. Apply electrophoresis and chromatography to basic experiments 		
2.1	<p>Concept of Biotechnology and an overview of achievements and scope.</p> <p style="padding-left: 40px;">2.1.1 History of Biotechnology</p> <p style="padding-left: 40px;">2.1.2 Branches of Biotechnology – Green, Blue, White and Red</p> <p style="padding-left: 40px;">2.1.3 Recent breakthroughs in biotechnology</p>	[3L]
2.2	<p>Fundamentals of laboratory techniques in biotechnology</p> <p style="padding-left: 40px;">2.2.1 Introduction to basic instruments – Design, Principle, Working and Applications. Incubator, BOD Incubator,</p>	[4L]

	Autoclave, Oven, Colony Counter, Magnetic Stirrer, Rotary Shaker and Laminar Air Flow. 2.2.2 Aseptic techniques – Sterilization and Disinfection.	
2.3	Molecular Separation Techniques: 2.3.1 Chromatography: Paper, Adsorption and TLC 2.3.2 Electrophoresis – Agarose and PAGE	[5L]
References: <ul style="list-style-type: none"> • Textbook of Biotechnology by H.K.Das, 4th Edition. 2010. Publisher - John Wiley • A textbook of Biotechnology by R.C.Dubey, 5th edition 2014. Publisher - S.Chand • Biotechnology by U.Satyanarayana, 1st edition.2005, Publisher - Books and Allied Pvt Ltd. • Biotechnology: Principles and Applications by S.C.Rastogi 2007. Publisher - alpha Science 		
Module 3	Genetics	[12L]
Learning Objectives: The module is intended to <ol style="list-style-type: none"> 1. Make the learner understand Mendelian and Non-Mendelian inheritance 2. Build basic concepts which will help in understanding genetics. 3. Discuss various traits in plants and animals and human traits showing Non-Mendelian Inheritance pattern. 4. Teach use of Punnet squares 5. Make the learner understand various applications of genetics. 		
Learning Outcomes: After the successful completion of the module, the learner will be able to:		

<ol style="list-style-type: none"> 1. Define basic terminologies in genetics. 2. Describe Mendel's law of inheritance. 3. Explain and give examples of incomplete dominance and co-dominance. 4. Describe types of epistasis with examples. 5. Discuss lethal genes and give examples of the traits observed in humans. 6. Illustrate cytoplasmic inheritance with examples. 7. Use Punnett square and practice genetics problems based on the topics mentioned above. 8. Apply knowledge of genetics to real life 		
3.1	Introduction: Basic terminologies in genetics	
3.2	Mendelian Genetics: 3.2.1 Mendel's Laws of inheritance of characters 3.2.2 Monohybrid and Dihybrid cross, Test Cross	[2L]
3.3	Deviation from Mendel's laws of inheritance 3.3.1 Incomplete dominance, co- dominance 3.3.2 Gene Interaction- Epistasis: recessive, dominant, double recessive and double dominant epistasis	[2L]
3.4	Lethal genes and types [examples relevant to human genetics] 3.4.1 Dominant lethal genes 3.4.2 Recessive lethal genes 3.4.3 Conditional lethal genes 3.4.4 Gametic lethal genes	[3L]
3.5	Extranuclear inheritance 3.5.1 Cytoplasmic inheritance: Kappa particles in Paramecium. 3.5.2 Maternal inheritance- shell coiling in Limnaea	[2L]



3.6	Applications of Genetics: Role of Genetic Counsellor	[2L]
References: <ul style="list-style-type: none">• Genetics, Verma P. S. and Agarwal V. K., S. Chand and Co., New Delhi.• Genetics, fourth edition, Veer Bala Rastogi, Medtech, India.• Genetics, 2014, 4th rev Edn., 3rd reprint, Gupta P. K., Rastogi Publications, Meerut.• Fundamentals of Genetics, fourth edition, B.D Singh.• Genetics, 2004, 1st Edn. Sarin, C., Tata McGraw Hill, New Delhi.• Principles of Genetics, 2006, 8th Edn., Gardner E. J., Simmons M. J. and Snustad D. P., Wiley India Pvt Ltd.• Genetics, 1985, 3rd revised Edn., Strickberger M. W., Macmillan USA.		



F.Y. B. Sc. (ZOOLOGY) SEMESTER I

Core Course- III

COURSE TITLE: MOOC - NPTEL COURSES

COURSE CODE: 2IUSIZOCC3NPT

[CREDITS - 02]

AS AN OPTION FOR CC2

Course Learning Outcomes

After the successful completion of the Course, the learner will be able to

1. Be part of the Largest online repository in the world of courses in engineering, basic sciences and selected humanities and social sciences subjects
2. Learn from teachers at IIT Guwahati and IIT Madras
3. Define all basic terminologies with respect to genetic engineering.
4. Explain the various parts and processes related to genetic engineering
5. Describe the basic concepts of Developmental Biology
6. Elaborate on the genetic basis of development process

Credits [O2] SEMESTER	NPTEL COURSE NAME*
SEMESTER - I	GENETIC ENGINEERING: THEORY AND APPLICATIONS https://nptel.ac.in/courses/1O2/1O3/1O21O3O7 4/



SEMESTER - I	INTRODUCTION TO DEVELOPMENTAL BIOLOGY https://nptel.ac.in/courses/102/106/10210608 4/
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* The courses can change or vary according to the availability on NPTEL website.

**Students opting for the NPTEL courses may have to pay some additional charges in order to avail certificates for the respective course.

***The student can choose any one of these courses as an alternative to 100 marks theory of course-2, in each semester.



Question Paper Template

F.Y. B. Sc. (ZOOLOGY) SEMESTER I

Core Course- II

COURSE TITLE: Protein and Carbohydrates, Basic Biotechnology and Genetics

COURSE CODE: 2IUSIZOCIIIPBM

[CREDITS - 02]

Module	Remembering/ Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total marks
I	15	5	5	5	-	-	30
II	15	10	5	-	-	-	30
III	15	10	5	-	-	-	30
Total marks per objective	45	25	15	5	-	-	90
% Weightage	50	28	17	6	-	-	100



F. Y. B. Sc. (ZOOLOGY)

SEMESTER I - Practical

COURSE CODE: 2IUSIZOCCP Credit- 02

Learning Objectives:

The Practical is intended to make the learner-

1. Develop basic laboratory skills in the learner.
2. Observe and identify various animal groups.
3. Understand the differences in the life processes of various animals.
4. Discuss role of invertebrates as indicator organisms.
5. Hone the analytical and problem-solving skills of the learner.
6. Extract relevant information from OERs.
7. Solve problems based on Mendel's Laws of Genetics

Learning Outcomes:

After the successful completion of the practical, the learner will be able to:

1. Identify and describe various organisms with respect to their levels of organization.
2. Recall structure and function of systems involved in various life processes across the animal kingdom.
3. Detect the optimum conditions required for the activity of enzymes.
4. Estimate the population density of some aquatic invertebrates using subsampling method.
5. Observe microscopic organisms effectively using compound light microscope.
6. Identify the components of the mixture using different separation techniques.

Core Course I

**Study of Non-Chordates and General
Ecology**

Practical Course-I

1. Levels of organization in Animals
 - A. Symmetry:
 - i. Asymmetric organization: Amoeba
 - ii. Radial symmetry: Sea anemone, Aurelia
 - iii. Bilateral symmetry: Planaria / liver fluke
 - B. Acoelomate: T.S. of Planaria / liver fluke
 - C. Pseudocoelomate: T.S. of Ascaris
 - D. Coelomate: T.S. of Earthworm
 - E. Segmentation
 - i. Pseudo segmentation: Tapeworm
 - ii. Metamerism: Earthworm
 - iii. Specialization of body parts for division of labour: Head, thorax and abdomen - Insect
 - A. Cephalization
 - i. Cockroach – Head
 - ii. Prawn/ crab – Cephalothorax
2. Canal system in sponges
3. Ciliary movement in paramecium
4. Section of cilium
5. Types of ingestion in Amoeba
6. Study of nutritional apparatus: Amoeba, L.S. of Hydra, Planaria, digestive system of cockroach and earthworm, Amphioxus, Scroll valve of Shark, Bird digestive system and Ruminant stomach.
7. Study of Cyclosis and chemotaxis in Paramecium
8. Detection of gut enzymes in Cockroach
9. Study of effect of pH on amylase activity.



10. Study of trachea and spiracles from cockroach, study of gills of fish, lung of frog and mammal.
11. Study of heart of cockroach, study of whole mount and L.S. of following hearts: Fish (2- chambered), Frog (3-chambered), Mammal (4-Chambered).
12. Study of the rate of heartbeat in Daphnia.
13. Study of permanent slides of blood smear of frog and mammal.
14. Study of animal interaction: Commensalism: Echeneis and Shark
Mutualism:
15. Hermit crab and Sea anemone, Termite and Trichonympha, Antibiosis: Effect of antibiotic on bacterial growth on a petri plate, Parasitism: Ectoparasite – Head louse and Bed bug, Endoparasite: Trichinella spiralis, Predation: Praying mantis and Spider
16. Study of population density of Daphnia by sub-sampling method.
17. Observation of representative specimens for each phylum

Core Course II	Protein and Carbohydrates, Basic Biotechnology and Genetics
<ol style="list-style-type: none"> 1. Introduction to basic laboratory safety practices, precautions, and safety rules. 2. Handling of common laboratory equipment (instrument and glassware): Burner, autoclave, centrifuge, colorimeter, balance, homogenizer, water bath, electrophoresis apparatus. 3. Study of Microscope: Use, care and functions of its components. 4. Aseptic techniques: Autoclaving and Packaging of test tubes, pipettes, petri-plates, conical flask; Aseptic transfer of liquids between burners (only demonstration by instructor) 5. Paper chromatography for separation of amino acids. 	



6. Adsorption chromatography using chalk to separate plant pigments or other pigments.
7. Qualitative tests for proteins and carbohydrates.
8. Problems based on genetics.
9. Study of Open Educational Resources: Any two Databases of NCBI, e-pathshala
10. Human Pedigree Symbols and Analysis: Dominant, recessive and X-linked characters.

References:

- Chordate Zoology, E.L.Jordan, P.S. Verma, S. Chand & Company Ltd.
- The life of Vertebrates; J.Z. Young; ELBS - Oxford University Press Third edition, 2006.
- Textbook of chordate Zoology, Vol. II, G.S. Sandhu, H. Bhaskar Campus Book International, First edition, 2005.
- Biochemistry by U. Satyanarayana.
- Laboratory Manual provided by Department of Zoology
- Genetics, Verma P. S. and Agarwal V. K., S. Chand and Co., New Delhi.
- Genetics, fourth edition, Veer bala Rastogi, Medtech, India.

F.Y. B. Sc. (ZOOLOGY) SEMESTER II

Core Course- I

COURSE TITLE: Hemichordates, Chordates and Ethology

COURSE CODE: 2IUS2ZOCCIHCE [CREDITS - 02]

Course Learning Outcomes		
<p>After the successful completion of the Course, the learner will be able to:</p> <ol style="list-style-type: none"> 1. Describe unique characteristics of Hemichordates, Protochordates and Vertebrates. 2. Classify Aves and Mammals up to order level. 3. Explain development and types of behaviour. 4. Elaborate on the biological and cognitive aspects of learning 		
Module I	Hemichordates, Chordates up to Reptiles	[12L]
<p>Learning Objectives:</p> <p>The module is intended to</p> <ol style="list-style-type: none"> 1. Identify key features of Hemichordates. 2. Enlist the general characteristics of Phylum Chordata. 3. Classify the Phylum Chordata and give characteristics of each class. 4. Explain various adaptations of different categories under Chordata. 5. Identify examples of each class. 		
<p>Learning Outcomes:</p> <p>After the successful completion of the module, the learner will be able to:</p> <ol style="list-style-type: none"> 1. Enumerate the unique characteristics of Hemichordata, Protochordata. 2. Discuss unique features of Protochordates, Agnatha, Gnathostomata- Pisces and Tetrapoda up to Reptilia. 3. Recognize diversity from Hemichordata, Protochordata till Class Reptilia. 		
I.1	Hemichordata	[1L]

1.2	General Characteristics and Classification of Phylum: Chordata	[1L]
1.3	Protochordates – Cephalochordata and Urochordata	[2L]
1.4	Characteristics of Vertebrates	[1L]
1.5	Agnatha- Class Cyclostomata Class Gnathostomata	[2L]
1.6	Pisces (up to class level)	[2L]
1.7	Tetrapoda: 1.7.1 Amphibians (up to order level) 1.7.2 Reptiles (up to order level)	[3L]

References:

- Modern textbook of Zoology – Vertebrates; Professor R.L. Kotpal; Rastogi publication; Third Edition 2012.
- Vertebrate Zoology; V. K. Agarwal; S.Chand Publication; 2012.
- Fundamentals of Zoology, Dr. K.C. Ghosh and Dr. B. Manna, New Central book Agency (P) Ltd.
- Chordate Zoology Volume II, Prof. N. Arumogam. Saras Publication.
- Chordate Anatomy Mohan P. Arora, Himalaya Publishing House, First edition.
- Chordate Zoology, E.L.Jordan, P.S. Verma, S. Chand & Company Ltd.
- The life of Vertebrates; J.Z. Young; ELBS - Oxford University Press Third edition, 2006.
- Textbook of chordate Zoology, Vol. II, G.S. Sandhu, H. Bhaskar Campus Book International, First edition, 2005.
- The Phylum Chordata: Biology of Vertebrates and their Kin, 1987, H. H. Newman, Distributor Satish book enterprise, Agra.

- A text book of Zoology, 1984, R. D. Vidyarthi, S. Chand and Co., New Delhi.
- Comparative Anatomy of the Vertebrates, G. C. Kent, R. K Carr, 9th Edn., 2001, McGraw Hill, Boston, USA.

Module 2	Chordates: Aves and Mammals	[12L]
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Learning Objectives:

This module is intended to:

1. Describe basic classification of Aves and Mammals up to order level.
2. Explain various morphological adaptations evolved in them for better survival.

Learning Outcomes:

After the successful completion of the module, the learner will be able to:

1. Summarize the classification of Aves and Mammals up to order level.
2. Identify various Avian and Mammalian adaptations
3. Compare between Aves and Reptiles.

2.1	<p>Aves –</p> <p>2.1.1 Basic characteristic of Aves</p> <p>2.1.2 Comparison between Aves and Reptiles</p> <p>2.1.3 Classification up to orders</p> <p style="padding-left: 20px;">2.1.3.1 Orders: Archaeopterygiformes, Hesperornithiformes</p> <p style="padding-left: 20px;">2.1.3.2 Orders: Struthioniformes, Rheiformes, Casuariformes, Apterygiformes, Sphenisciformes</p> <p style="padding-left: 20px;">2.1.3.3 Orders: Passeriformes, Piciformes, Columbiformes, Galliformes</p> <p style="padding-left: 20px;">2.1.3.4 Orders: Anseriformes, Ciconiformes, Falconiformes, Strigiformes, Micropodiformes</p>	[6L]
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2.2	Mammals 2.2.1 Basic characteristics of mammals 2.2.2 Classification up to orders with emphasis on Adaptations 2.2.2.1 Orders: Monotremata, Marsupialia 2.2.2.2 Orders: Insectivora, Chiroptera, Primates, Rodentia 2.2.2.3 Orders: Legomorpha, Cetacea, Sirenia 2.2.2.4 Orders: Carnivora, Proboscidea, Perissodactyla	[6L]
References: <ul style="list-style-type: none"> • Chordate zoology: E. L. Jordan and P. S. Verma, S. Chand & Co. • The life of Vertebrates: J. Z. Young, ELBS-Oxford Univ. Press. 		
Module 3	Ethology	[12L]
Learning Objectives: The module is intended to <ol style="list-style-type: none"> 1. Explain ontogeny of Animal behavior along with innate and learned aspects. 2. Introduce the learner to the development of animal behaviour. 3. Discuss various types of animal behaviour. 4. Elaborate on animal behaviour with relevant examples 		
Learning Outcomes: After the successful completion of the module, the learner will be able to: <ol style="list-style-type: none"> 1. Distinguish between innate and learned behaviour. 2. Interpret the reasons for biological and cognitive aspects of behaviour. 3. Relate the changes occurring in the behaviour of animals from juvenile stage to mature stage of development. 		
3.1	Approaches to the study of behaviour	[1L]



3.2	Development of behaviour 3.2.1 Ontogeny of behaviour 3.2.2 Environmental influence on behaviour 3.2.3 Sensitive periods during development, juvenile and innate behaviour	[5L]
3.3	Animal learning: Habituation, Acquisition, Extinction, Classical conditioning, Instrument learning and Operant behaviour 3.3.1 Biological aspects of learning: Learning to avoid enemies, Sickness and Mimicry. 3.3.2 Cognitive aspects of learning: Hidden aspects of conditioning, Nature of cognitive process, Insight learning, Associative learning and representation.	[6L]
References: <ul style="list-style-type: none">• Introduction to Ethology, Klaus Immelman, 2nd Edition, Plenum Press, 1983.• An Introduction to Animal Behaviour, Aubrey Manning, 6th Edition, Cambridge University Press India Pvt. Ltd, January 2016.		



Question Paper Template

F.Y. B. Sc. (ZOOLOGY) SEMESTER II

Core Course- I

COURSE TITLE: Hemichordates, Chordates and Ethology

COURSE CODE: 2IUS2ZOCCIHCE [CREDITS - 02]

Module	Remembering/ Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total marks
I	15	10	5	-	-	-	30
II	15	10	5	-	-	-	30
III	15	10	5	-	-	-	30
Total marks per objective	45	30	15	-	-	-	90
% Weightage	50	34	17	-	-	-	100



F.Y. B. Sc. (ZOOLOGY) SEMESTER II

Core Course- II

COURSE TITLE: Lipids and Nucleic Acids, Applied Biotechnology, Evolution and Biodiversity

COURSE CODE: 2IUS2ZOCC2LAE [CREDITS - 02]

Course Learning Outcomes		
<p>After the successful completion of the Course, the learner will be able to:</p> <ol style="list-style-type: none"> 1. Describe the chemical structure and biological role of lipids and nucleic acids. 2. Define transgenic technology and enlist its applications. 3. Elaborate various practices employed for bioremediation and phytoremediation. 4. Discuss different evidence of evolution. 5. Explain the applications of biodiversity and its conservation strategies. 		
Module I	Lipids and Nucleic Acids	[12L]
<p>Learning Objectives:</p> <p>The module is intended to</p> <ol style="list-style-type: none"> 1. Explain lipids and nucleic acids as biomolecules. 2. Enlist types of lipids, RNA and DNA. 3. Discuss structure of nucleotides and bonds involved in formation of nucleic acids. 4. Enlist biological and commercial uses of lipids. 		
<p>Learning Outcomes:</p> <p>After the successful completion of the module, the learner will be able to:</p> <ol style="list-style-type: none"> 1. Describe the chemical structure and biological role of lipids and nucleic acids. 		

<p>2. Classify lipids and give examples.</p> <p>3. Differentiate between types of RNA and DNA.</p> <p>4. Analyse role of lipids and Nucleic acids in functioning of human body.</p>		
1.1	<p>Lipids</p> <p>1.1.1 Fatty acids: Structure, types and properties</p> <p>1.1.2 Mono-, di- and triglycerides</p> <p>1.1.3 Phospholipids and sphingolipids</p> <p>1.1.4 Sterols and waxes</p> <p>1.1.5 Biological role of lipids and commercially significant Lipids</p>	[6L]
1.2	<p>Nucleic acids</p> <p>1.2.1 Chemical structure of nitrogenous bases, pentoses.</p> <p>1.2.2 Nucleosides and nucleotides</p> <p>1.2.3 Polynucleotides: 3' 5' phosphodiester linkage</p> <p>1.2.4 Watson - Crick Model of DNA</p> <p>1.2.5 Different Forms of DNA</p> <p>1.2.6 Types of RNA: mRNA, t-RNA and r-RNA</p> <p>1.2.7 Differences between DNA and RNA</p>	[6L]
<p>References:</p> <ul style="list-style-type: none"> Biochemistry by U. Satyanarayana. Basics of Biochemistry by J.L. Jain. 		
Module 2	Applied Biotechnology	[12L]
<p>Learning Objectives:</p> <p>This module is intended to:</p>		

<ol style="list-style-type: none"> 1. Explain the methodology involved in creating transgenic animals. 2. Identify applications of biotechnology in various fields such as medical, food, environment and Enzyme industry. 		
<p>Learning Outcomes:</p> <p>After the successful completion of the module, the learner will be able to:</p> <ol style="list-style-type: none"> 1. Define transgenic technology and elaborate on its applications. 2. Interpret cloning and weigh its pros and cons. 3. Explain gene therapy and elaborate its types. 4. Compare between <i>ex vivo</i> and <i>in vivo</i> therapy methods. 5. Comment on environmental remediation strategies with examples. 6. Identify various food products made using biotechnology principles. 7. Demonstrate enzyme immobilization in the laboratory. 		
2.1	<p>Transgenic Technology - Methods</p> <p>2.1.1 Microinjection</p> <p>2.1.2 Embryonic Stem cells</p> <p>2.1.3 Virus mediated transfer</p>	[3L]
2.2	<p>Medical Biotechnology-Gene therapy: Ex vivo and In vitro approach.</p> <p>i. Gene therapy for SCID (severe combined immune deficiency)</p> <p>2.2.2 Cystic fibrosis</p>	[3L]
2.3	<p>Environmental biotechnology</p> <p>2.3.1 Bioremediation: Concepts and applications</p> <p>2.3.2 Phytoremediation: Concepts and applications</p>	[2L]
2.4	<p>Food Biotechnology - Applications of biotechnology in the bread and cheese industry</p>	[2L]

2.5	Enzyme technology – concept of enzyme immobilization, Applications in meat tenderization, fermentation	[2L]
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References:

- Textbook of Biotechnology by H.K.Das, 4th Edition. 2010, Publisher - John Wiley
- A textbook of Biotechnology by R.C.Dubey, 5th edition 2014. Publisher - S.Chand
- Biotechnology by U.Satyanarayana, 1st edition.2005 Publisher - Books and Allied Pvt Ltd.
- Biotechnology: Principles and Applications by S.C.Rastogi 2007. Publisher - alpha Science

Module 3	Evolution and Biodiversity	[12L]
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Learning Objectives:

The module is intended to

1. Describe the classic experiments by Francesco Redi, Luis Pasteur, Miller-Urey that disproved the spontaneous origin of life on Earth.
2. Explain the evidence of evolution with the help of examples.
3. Discuss the concepts in biodiversity and its significance.
4. Demonstrate the use of IUCN red list database.
5. Enlist the IUCN Biodiversity hotspots in India, their animal biodiversity, threats and conservation strategies.

Learning Outcomes:

After the successful completion of the module, the learner will be able to:

1. Sketch the experimental set up of Miller-Urey experiment, Redi's experiment and Pasteur's experiment.
2. Discuss different evidence of evolution.
3. Recall the experiments based on theory of abiogenesis and biogenesis.
4. Analyse the effect of anthropogenic activities on biodiversity.
5. Discuss the applications of biodiversity and its conservation strategies.
6. Elaborate on the IUCN hotspots in India and IUCN red data list
7. Locate the biodiversity hotspots on map of India.
8. Enlist the endemic, endangered and threatened species of biodiversity hotspots in India.
9. Enumerate the benefits of and threats to biodiversity.

3.1	<p>Evolution</p> <p>3.1.1 Origin of life: Miller- Urey Experiment, Oparin Haldane concept.</p> <p>3.1.2 Spontaneous origin of life and experiments that disproved it: Francesco Redi's Experiment and Louis Pasteur's Experiment. 3.1.3 Evidence of Organic Evolution:</p> <p>i) Morphological and Anatomical Evidence- Homologous and Analogous organs, connecting links and vestigial organs</p> <p>ii) Palaeontological Evidence: Fossils, Fossilization</p>	[6L]
3.2	<p>Biodiversity</p> <p>3.2.1 Definition, concepts in biodiversity</p> <p>3.2.2 IUCN Red List</p> <p>3.2.3 Biodiversity hotspots in India - Western Ghats, Andaman and Nicobar Islands, Eastern Himalayas, Indo- Burma Region.</p>	[6L]

	3.2.4 Benefits of biodiversity and strategies for conservation	
	3.2.5 Threats to biodiversity- natural and anthropogenic	
References:		
<ul style="list-style-type: none"> • Strickberger's Evolution by Monroe W. Strickberger (Author), Brian K. Hall (Author), Benedikt Hallgrímsson (Author), Publisher - Jones & Bartlett; 4th edition (6 December 2007). • Textbook of Biodiversity, KV Krishnamurthy, Science Publishers, USA, 2010. 		

F.Y. B. Sc. (ZOOLOGY) SEMESTER I

Core Course- III

COURSE TITLE: MOOC - NPTEL COURSES

COURSE CODE: 2IUS2ZOCC3NPT

[CREDITS - 02]

AS AN OPTIONS FOR CC2

Course Learning Outcomes

After the successful completion of the Course, the learner will be able to

1. Be part of the Largest online repository in the world of courses in engineering, basic sciences and selected humanities and social sciences subjects
2. Learn from teachers at IIT Guwahati and IIT Madras
3. Define all basic terminologies with respect to medical biomaterials
4. Explain the various applications of medical biomaterials
5. Describe the basic concepts of Bioreactor design
6. Elaborate on different designs used in the industry



Credits [O2] SEMESTER	NPTEL COURSE NAME*
SEMESTER - II	MEDICAL BIOMATERIALS https://nptel.ac.in/courses/102/106/102106057/
SEMESTER - II	BIOREACTOR DESIGN AND ANALYSIS https://onlinecourses.nptel.ac.in/noc21_bt13/preview

* The courses can change or vary according to the availability on NPTEL website.

**Students opting for the NPTEL courses have to pay some additional charges in order to avail certificates for the respective course.

***The student can choose any one of these courses as an alternative to 100 marks theory of course-2, in each semester.



Question Paper Template

F.Y. B. Sc. (ZOOLOGY) SEMESTER II

Core Course- II

COURSE TITLE: Applied Biotechnology, Evolution and Biodiversity

COURSE CODE: 2IUS2ZOCC2LAE [CREDITS - 02]

Module	Remembering/ Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total marks
I	15	5	5	5	-	-	30
II	15	5	10	-	-	-	30
III	10	10	10	-	-	-	30
Total marks per objective	45	22	28	-	-	-	90
% Weightage	40	20	25	5	-	-	100



F. Y. B. Sc. (ZOOLOGY)

SEMESTER II - Practical

COURSE CODE: 2IUS2ZOCCP Credit- 02

Learning Objectives:

The practical is intended to

1. Familiarize the learner with vertebrate groups and their adaptations.
2. Make the learner understand excretion and reproduction processes with illustrations.
3. Develop basic laboratory skills in the learner.
4. Hone the analytical and problem-solving skills of the learner

Learning Outcomes:

After the successful completion of the practical, the learner will be able to:

1. Compare between different groups of vertebrates on the basis of their adaptations.
2. Mount septal nephridium from preserved earthworm specimen.
3. Detect lipids, nucleic acids, enzymes, normal and abnormal constituents of urine in given samples.
4. Analyse the quality of milk based on bacterial load in the given sample.
5. Recall fossil examples and correlate to geological timescale

Core Course I

Hemichordates, Chordates and Ethology

1. Types of tail fin in fish
2. Types of scales in fish
3. Comparison of cartilaginous and bony fish
4. Comparative study of morphology of Amphibian orders
5. Neoteny in Salamander
6. Endangered fish, amphibian, reptiles, birds and mammal
7. Comparative morphology of turtle and tortoise.

8. Component of snake venom and its effect
9. Types of feet in birds
10. Types of beaks in birds
11. Types of feathers in birds
12. Mounting of septal nephridium of earthworm, observation of sagittal section of mammalian kidney, Bowman's capsule (under high power)
13. Urine analysis for detection of normal and abnormal constituents.
14. Detection of uric acid from the excreta of bird or cockroach.
15. Detection of Ammonia as an excretory product of fish from water.
16. Study of the human eye and ear.
17. Observation of permanent slide of: Sponge gemmules, Hydra budding, Mammalian sperm, T.S. mammalian testis, T.S. mammalian ovary showing Graffian follicle, Observation of hen's egg with developing embryo at any stage of development.
18. Observation of representative specimens for each phylum and superclass of phylum Chordata

Core Course II

**Lipids and Nucleic Acids, Applied
Biotechnology, Evolution and Biodiversity**

1. Qualitative tests for lipids.
2. Extraction and qualitative detection of nucleic acids: a) DNA (SDS-NaCl extraction) b) RNA (Phenol extraction)
3. Identification with photographs: Methodology for transgenesis –
 - i) By microinjection into egg ii) Transgenesis of embryonic stem cell iii) Methodology for gene therapy for SCID or any human diseases
4. Preparation of beads of calcium alginate for immobilization using yeast cells.

5. Assay of immobilized invertase from immobilised yeast cells by DNSA method (visual observation for comparative colour intensity in test tube)
6. To demonstrate fermentation of grape juice/sugar cane juice or any fruit juice – (Detection of alcohol generated during fermentation by benzoic acid).
7. Effect of Papain (raw papaya extract) as a meat tenderizer.
8. To evaluate the quality of milk by methylene blue reduction method.
9. Study of fossils – Types and Examples Trilobite, Ammonite, Hydrosaur head, Sivatherium- Indian Giraffe, Woolly mammoth skull
10. Problems based on calculation of age of fossils
11. Geological Time Scale

References:

- Chordate Zoology, E.L.Jordan, P.S. Verma, S. Chand & Company Ltd.
- The life of Vertebrates; J.Z. Young; ELBS - Oxford University Press Third edition, 2006.
- Textbook of chordate Zoology, Vol. II, G.S. Sandhu, H. Bhaskar Campus Book International, First edition, 2005.
- Biochemistry by U. Satyanarayana.
- Strickberger's Evolution by Monroe W. Strickberger (Author), Brian K. Hall (Author), Benedikt Hallgrimsson (Author), Publisher - Jones & Bartlett; 4th edition (6 December 2007).
- Laboratory Manual provided by Department of Zoology.

8. Teaching learning process

The pedagogic methods adopted involve direct lectures, tutorial discussions, as well as technology- supported presentations. We believe that education must be interactive and all sessions between students and teachers are based upon reciprocity and respect.

1) The lectures (of fifty minutes duration) are delivered to one class at a time systematically deal with the themes of the syllabus. This constitutes the core of the teaching- learning process. The students are provided with bibliographic references and encouraged to go through at least some readings beforehand so that they could be more interactive and ask relevant questions in the class. This also helps to acquire knowledge beyond the boundaries of the syllabi.

2) Wherever needed, teachers use audio-video based technology devices (e. g. power point, YouTube videos) to make their presentations more effective. Some courses require that students see a documentary, or a video and courses are structured so that discussions of these will further nuance the critical engagement of students with ideas introduced in their textual materials.

3) Remedial coaching is adopted to enhance the learning for special learners. Remedial sessions are conducted to offer assistance on certain advanced topics.

4) Use of collaborative learning strategies, flipped class pedagogy, Research and enquiry-based learning, diagnostic quizzes, classroom seminars, paper reviews are actively practised.

5) The USP of zoology curriculum is the focus on experiential learning, as we strongly believe that zoology can be understood better outdoors. Hence nature trails, field visits, short and long excursions form an integral part of our curriculum.

9. Assessment Methods

Evaluation Pattern: Theory

- Assessments are divided into two parts: Continuous Internal Assessment (CIA) & Semester End Examination.
- The Semester End Examination shall be conducted by the College at the end of each semester.
- Semester End Examination (external) (60 M)- Duration: 2 hours Paper Pattern

Question No	Module	Marks with Option	Marks without Option
1	I	5 M x 6 Q = 30 M	4 M x 5 Q = 20 M
2	II	5 M x 6 Q = 30 M	4 M x 5 Q = 20 M
3	III	5 M x 6 Q = 30 M	4 M x 5 Q = 20 M

Each question will have six sub questions a, b, c, d, e, f and out of which any four should be answered.

- For Internal Evaluation (40 M)
 - Mid Sem Examination 25 M
 - Workshop/Project/Industrial Visit/ Excursion/ Seminar/ Assignment/ Research paper review 15 M

Or

- Project (40 M)

Evaluation pattern: Practical

- Semester-end evaluation: 30 Marks practical examination for each Course at the end of semester.
- Continuous internal evaluation 20 marks as per the following rubrics

Experimental Work	Experimental Report	Quiz	Total
10 M	5M	5M	20M

10. Program and Course Code Format

The course is coded according to following criteria:

1. First two numbers in each course code indicates year of implementation of syllabus (21- year of implementation is 2021-22)
2. Third letter 'U' designates undergraduate
3. Fourth letter 'S' designate Science discipline and the digit followed is for semester number (S1 – 1st Semester)
4. Letter 'ZO' is for Chemistry discipline (ZO - Zoology)
This forms the programme code 2IUSZO. For the further course codes programme code is amended as follows
5. To designate the semester, add the digit (1-6) after S in the programme code.
(Eg: 2IUSIZO- for semester I)



For the further course codes, addition to the program code should be done as per the following instructions.

6. To represent core courses (CC) followed by course number digit (1/2/3/4) and three lettered code representing the title of the course.
7. For Ability enhancement course code, (AE) alphabets followed by a digit (1/2) followed by 'FOC'- Foundation course, , 'EVS'-Environmental science are used.
8. For Skill enhancement courses code (SE) followed by digits (1/2/3) followed by letters 'STP'-Sports training program, 'BCE'-Basic communication in English, ICH'-Indian cultural heritage, followed by digits (1/2/3) representing the levels are used. In case of subject related SEC, (SE) followed by digits (1/2/3) followed by a three lettered code representing the title of the course are used.
9. For Discipline specific elective course (DS) of Semester V and VI, (DS) followed by digits (1/2/3/4) followed by a three lettered code representing the title of the course are used.
10. 'P' followed by digit indicates practical course number. (Practical course number will be added for semesters only where there are more than one course.