VISVA-BHARATI
(A Central University)

Curriculum for
Four-Year Undergraduate Courses in
Zoology

[Learning Outcome-based Curriculum Framework (LOCF) following NEP 2020
With effect from the Academic Session 2023-2024]

2023

Introduction:

Zoology deals with the study of animal kingdom covering a wide range of topics especially animal diversity, principles of ecology, comparative anatomy, developmental biology, cell biology, physiology, biochemistry, genetics and evolutionary biology, animal biotechnology, parasitology, immunology, reproductive biology, endocrinology, applied and economic Zoology etc. The learning outcome-based curriculum framework for the Undergraduate courses in Zoology is designed to cater to the needs of students by providing with in-depth knowledge on the subject as well as developing their skill for employability.

Undergraduate Courses in Zoology

Courses	Duration	Semesters	Credits
Certificate	1 year	I & II	46+ 4 (Voc)
Diploma	2 years	I-IV	88+ 4(Voc)
B.Sc. Degree	3 years	I-VI	120+ 4(Voc)
B.Sc. (Honours)	4 years	I-VIII	160+ 4(Voc)
B.Sc. (Honours with Research)	4 years	I-VIII	160+4 (Voc)

Course Objectives and Outcomes
One-Year Certificate Course in Zoology (Semesters I & II)
● This course is designed to provide a comprehensive knowledge on animal diversities from Protozoa to Mammalia, their systematics, biology and adaptive features, principle of ecology to understand the relationship of environment and animals, cell biology will provide the fundamental knowledge on the functional organization of animals. ● This course is also designed to develop vocational skills of the students by providing theory and practical knowledge in Sericulture, Apiculture and Laboratory instrumentation. ● This course will be the foundation course of Zoology and develop the skill of the students to get placements through bee farming, sericulture insect vector management sector or may start their own entrepreneurship for self-employment and employment generation.
Two-Year Diploma Course in Zoology (Semesters I-IV)
● This course is designed to provide knowledge on the animal diversity, economic Zoology, ecology and cell biology in the first year as stated above and in the second year, students will be taught principles of genetics, biochemistry, physiology, comparative anatomy of

vertebrates, fish biology and fisheries and molecular biology.

- This course will be helpful to develop skills in the laboratory techniques of microscopy, cytology, histology, biochemistry, haematology, and techniques of molecular biology and biotechnology along with skill development in economic zoology and vector management.
- Students may be interested to continue higher studies in Zoology, or get job in research laboratories or start entrepreneurship for self-employment.

Three-Year B.Sc. Degree in Zoology (Semesters I-VI)

- Three-year **B.Sc. (Honours) Degree in Zoology (Semesters I-VI)** is designed to provide a comprehensive knowledge of major concepts, theoretical principles and experimental findings in Zoology and its different subfields including biodiversity, biology, anatomy, physiology, endocrinology, biochemistry, biotechnology, ecology, animal behaviour and chronobiology, evolutionary biology, cell biology, molecular biology, immunology and genetics in addition to some applied areas of study such as wildlife conservation and management, apiculture, sericulture, fish and fisheries sciences and parasitology.
- Students may proceed for higher studies, join research and technical Govt/Private laboratories, education and administrative services.

Four-Year B.Sc. (Honours) Degree in Zoology (Semesters I-VIII)

- Four-year **B.Sc. (Honours) Degree in Zoology** is designed to provide a holistic knowledge of major concepts, theoretical principles and experimental findings in Zoology and its different subfields including biodiversity, systematics, anatomy, cell biology, molecular biology, genetics physiology, endocrinology, developmental biology, biochemistry, biotechnology, ecology, animal behaviour and chronobiology, evolutionary biology, immunology and toxicology.
- Skill will be developed in research methodology, research tools and techniques, computational biology in addition to some applied areas of study such as insect vector management, apiculture, sericulture, fish and fisheries sciences and parasitology.
- Students may proceed for higher studies, join research and technical Govt/Private laboratories, education and administrative services.

Four-Year B.Sc. (Honours with Research) Degree in Zoology (Semesters I-VIII)

- Four-year **B.Sc. (Honours with Research) Degree in Zoology (Semesters I-VIII)** is designed to provide a comprehensive knowledge in Zoology and its different subfields as mentioned in four-year B. Sc. (Hons.) courses as well as to orient students toward research field it includes research dissertation, review of literatures, lab or field-based research project, thesis writing and presentation.
- Students may proceed for higher studies, develop research career, join research and technical Govt./Private laboratories, education and administrative services.

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COURSE STRUCTURE OF FOUR-YEAR UNDERGRADUATE PROGRAMME IN ZOOLOGY

Sem	Major Courses	Minor Courses	Multi Courses	AECC	SEC	CVAC	Research*	Internship	Total Credits	
I	2x4cr=8	1x4cr=4	1x3cr=3	MIL1 1x2cr=2	1x3cr=3	Tagore S 1x3cr=3	---		23	B.Sc. Certificate
II	2x4cr=8	1x4cr=4	1x3cr=3	MIL2 1x2cr=2	1x3cr=3	EVS 1x3cr=3	---		23	
YEAR 1	4x4=16cr	2x4=8cr	2x3=6cr	2x2=4cr	2x3=6cr	2x3=6cr	---	Sum 4cr	46+4	
After successful completion of ONE YEAR Course (Semesters - I & II) securing 46 credits + 4 credits vocational summer internship, students may exit with B.Sc. Certificate in Zoology or continue further.										
III	2x4cr=8	1x4cr=4	1x3cr=3	ENG1 1x2cr=2	1x3Cr=3	---	---		20	B.Sc. Diploma
IV	4x4cr=16	1x4cr=4	---	ENG2 1x2cr=2	---	---	---		22	
YEAR 2	10x4=40cr	4x4=16cr	3x3=9cr	4x2=8cr	3x3=9cr	2x3=6cr	---	Sum 4cr	88+4	
After successful completion of TWO-YEAR Course (Semesters - I to IV) securing 88 credits + 4 credits vocational summer internship, students may exit with B.Sc. Diploma in Zoology or continue further.										
V	3x4cr=12	1x4cr=4	---	---	---	---	---		16	B.Sc. Degree
VI	3x4cr=12	1x4cr=4	---	---	---	---	---		16	
YEAR 3	16x4=64cr	6x4=24cr	3x3=9cr	4x2=8cr	3x3=9cr	2x3=6cr	---	Sum 4cr	120+4	
After successful completion of THREE-YEAR COURSE (Semesters - I to VI) securing 120 credits + 4 credits vocational summer internship, students may exit with B.Sc. Degree in Zoology or continue further.										
VII	4x4cr=16	1x4cr=4	---	---	---	---	----		20	B.Sc. Honours
VIII	4x4cr=16	1x4cr=4	---	---	---	---	----		20	
YEAR 4	24x4=96cr	8x4=32cr	3x3=9cr	4x2=8cr	3x3=9cr	2x3=6cr	----	Sum 4cr	160+4	
VII	3x4cr=12	1xx4cr=4	---	---	---	---	1x4cr=4*		20	B.Sc. Honours (withResearch)
VIII	2x4cr=8	1x4cr=4	---	---	---	---	2x4cr=8*		20	
YEAR 4	21x4=84cr	8x4=32cr	3x3=9cr	4x2=8cr	3x3=9cr	2x3=6cr	3x4=12 cr	Sum 4cr	160+4	

After successful completion of FOUR-YEAR COURSE (Semesters - I to VIII) securing 160 credits + 4 credits vocational summer internship, students may obtain either B.Sc. Honours degree in Zoology or B.Sc. Honours (with Research) degree in Zoology.

Dissertation can be opted by students who attain at least 75% marks in 3 years and desire the Research degree. The students pursuing B.Sc. Honours (with Research) have to secure 12 credits from Research dissertation (4 credits in Semester VII and 8 credits in Semester VIII). However, students pursuing only B.Sc. Honours have to study additional three Major Courses of Zoology securing 12 credits (4 credits in Semester VII and 8 credits in Semester VIII).

Minor Courses and Multidisciplinary Courses in Zoology are offered for the students who opted major courses other than Zoology. Students of Zoology have to opt minor and multidisciplinary courses from other disciplines. Students have to take minor courses (total 8 courses) from two disciplines, one each in alternate Semesters.

Ability Enhancement courses (AECC): Communication skill in English and/or Modern Indian Language (MIL)

Skill Enhancement Courses (SEC) in Zoology are offered for the students of Zoology Major.

Common Value-Added Courses (CVAC): Tagore studies (TS) and Environmental studies (EVS)

Summer Internship: One course of 4 credits is compulsory within the course duration for completion of Certificate, Diploma or Degree.

Learning Outcome-based Curriculum for FOUR-YEAR UNDERGRADUATE PROGRAMME in ZOOLOGY following NEP 2020

MAJOR COURSES in ZOOLOGY [Discipline-Specific Core Courses]

Course Code	Course Type	Course Title	Credits	Full Marks	Theory	Practical	Internal	Contact Hours
SEMESTER I								
MJZO01	Theory	Biology of Non-Chordates	3	75	60	--	15	45
MJZO01	*Practical*	Biology of Non-Chordates	1	25	--	20	05	30
MJZO02	Theory	Principles of Ecology	3	75	60	--	15	45
MJZO02	*Practical*	Principles of Ecology	1	25	--	20	05	30
		Total	**8 credits**	**200**				
SEMESTER II								
MJZO03	Theory	Diversity of Chordates	3	75	60	--	15	45
MJZO03	*Practical*	Diversity of Chordates	1	25	--	20	05	30
MJZO04	Theory	Cell Biology	3	75	60	--	15	45
MJZO04	*Practical*	Cell Biology	1	25	--	20	05	30
		Total	**8 credits**	**200**				
ONE-YEAR CERTIFICATE PROGRAMME TOTAL 4 MAJOR COURSES			**16 credits**	**400**				
SEMESTER III								
MJZO05	Theory	Comparative Anatomy of Vertebrates	3	75	60	--	15	45
MJZO05	*Practical*	Comparative Anatomy of Vertebrates	1	25	--	20	05	30
MJZO06	Theory	Principles of Genetics	3	75	60	--	15	45
MJZO06	*Practical*	Principles of Genetics	1	25	--	20	05	30
		Total	**8 credits**	**200**				
SEMESTER IV								
MJZO07	Theory	Fundamentals of Biochemistry	3	75	60	--	15	45
MJZO07	*Practical*	Fundamentals of Biochemistry	1	25	--	20	05	30
MJZO08	Theory	Physiology: Animal Tissues and Coordinating Systems	3	75	60	--	15	45
MJZO08	Practical	Physiology: Animal Tissues and Coordinating Systems	1	25	--	20	05	30
MJZO09	Theory	Molecular Biology	3	75	60	--	15	45
MJZO09	*Practical*	Molecular Biology	1	25	--	20	05	30
MJZO10	Theory	Fish Biology and Fisheries	3	75	60	--	15	45
MJZO10	*Practical*	Fish Biology and Fisheries	1	25	--	20	05	30
		Total	**16 credits**	**400**				
TWO-YEAR DIPLOMA PROGRAMME TOTAL 10 MAJOR COURSES			**40 credits**	**1000**				

SEMESTER V								
MJZO11	Theory	Physiology: Life Sustaining Systems	3	75	60	--	15	45
MJZO11	*Practical*	Physiology: Life Sustaining Systems	1	25	--	20	05	30
MJZO12	Theory	Metabolic Processes and Regulation	3	75	60	--	15	45
MJZO12	*Practical*	Metabolic Processes and Regulation	1	25	--	20	05	30
MJZO13	Theory	Developmental Biology	3	75	60	--	15	45
MJZO13	*Practical*	Developmental Biology	1	25	--	20	05	30
		Total	**12 credits**	**300**				
SEMESTER VI								
MJZO14	Theory	Parasitology	3	75	60	--	15	45
MJZO14	*Practical*	Parasitology	1	25	--	20	05	30
MJZO15	Theory	Immunology	3	75	60	--	15	45
MJZO15	*Practical*	Immunology	1	25	--	20	05	30
MJZO16	Theory	Evolutionary Biology, Systematics and Taxonomy	3	75	60	--	15	45
MJZO16	*Practical*	Evolutionary Biology, Systematics and Taxonomy	1	25	--	20	05	30
		Total	**12 credits**	**300**				
THREE-YEAR B.Sc. DEGREE PROGRAMME **Total 16 MAJOR COURSES**			**64 credits**	**1600**				
SEMESTER VII For B.Sc. (Honours)								
MJZO17	Theory	Research Methodology and Biostatistics	3	75	60	--	15	45
MJZO17	*Practical*	Research Methodology and Biostatistics	1	25	--	20	05	30
MJZO18	Theory	Methods in Biology- I: Microscopy and Separation Techniques	3	75	60	--	15	45
MJZO18	*Practical*	Methods in Biology- I: Microscopy and Separation Techniques	1	25	--	20	05	30
MJZO19	Theory	Endocrinology	3	75	60	--	15	45
MJZO19	*Practical*	Endocrinology	1	25	--	20	05	30
MJZO20(E)	Theory	Behavioral Biology	3	75	60	--	15	45
MJZO20(E)	*Practical*	Behavioral Biology	1	25	--	20	05	30
		Total	**16 credits**	**400**				
SEMESTER VIII For B.Sc. (Honours)								
MJZO21	Theory	Methods In Biology –II: Molecular Analyses	3	75	60	--	15	45
MJZO21	*Practical*	Methods In Biology- II: Molecular Analyses	1	25	--	20	05	30
MJZO22	Theory	Toxicology	3	75	60	--	15	45
MJZO22	*Practical*	Toxicology	1	25	--	20	05	30
MJZO23(E)	Theory	Animal Cell Biotechnology	3	75	60	--	15	45

MJZO23(E)	*Practical*	Animal Cell Biotechnology	1	25	--	20	05	30
MJZO24(E)	Theory	Biology of Infectious Diseases	3	75	60	--	15	45
MJZO24(E)	*Practical*	Biology of Infectious Diseases	1	25	--	20	05	30
		Total	**16 credits**	**400**				
FOUR-YEAR B.Sc (HONOURS) PROGRAMME Total 24 COURSES			**96 credits**	**2400**				
SEMESTER VII For B.Sc. (Honours with Research)								
MJZO17	Theory	Research Methodology and Biostatistics	3	75	60	--	15	45
MJZO17	*Practical*	Research Methodology and Biostatistics	1	25	--	20	05	30
MJZO18	Theory	Methods in Biology- I: Microscopy and Separation Techniques	3	75	60	--	15	45
MJZO18	*Practical*	Methods in Biology- I: Microscopy and Separation Techniques	1	25	--	20	05	30
MJZO19	Theory	Endocrinology	3	75	60	--	15	45
MJZO19	*Practical*	Endocrinology	1	25	--	20	05	30
MJZORD 01	*Practical*	Research Dissertation	**4**	**100**		80	20	
		Total	**16 Credits**	**400**				
SEMESTER-VIII For B.Sc. (Honours with Research)								
MJZO21	Theory	Methods In Biology –II: Molecular Analyses	3	75	60	--	15	45
MJZO21	*Practical*	Methods In Biology- II: Molecular Analyses	1	25	--	20	05	30
MJZO22	Theory	Toxicology	3	75	60	--	15	45
MJZO22	*Practical*	Toxicology	1	25	--	20	05	30
MJZORD 02	*Practical*	Research Dissertation	8	200		160	40	
		Total	**16 Credits**	**400**				
FOUR-YEAR B.Sc. (HONOURS with RESEARCH) PROGRAMME Total 21 COURSES + DISSERTATION			**84 credits +12 credits**	**2100 + 300 =2400**				

MINOR COURSES in ZOOLOGY [Discipline-Specific Minor Courses]

Course Code	Course Type	Course Title	Credits	Marks				Hours
SEMESTER I								
MNZO01	Theory	Animal Diversity	3	75	60	--	15	45
MNZO01	Practical	Animal Diversity	1	25	--	20	05	30
SEMESTER II								
MNZO01	Theory	Animal Diversity	3	75	60	--	15	45
MNZO01	Practical	Animal Diversity	1	25	--	20	05	30
ONE-YEAR CERTIFICATE PROGRAMME TOTAL 1 MINOR COURSE in ZOOLOGY			**4**	**100**				
SEMESTER III								
MNZO02	Theory	Insect Vectors and Diseases	3	75	60	--	15	45
MNZO02	Practical	Insect Vectors and Diseases	1	25	--	20	05	30
SEMESTER IV								
MNZO02	Theory	Insect Vectors and Diseases	3	75	60	--	15	45
MNZO02	Practical	Insect Vectors and Diseases	1	25	--	20	05	30
TWO-YEAR DIPLOMA PROGRAMME TOTAL 2 MINOR COURSES in ZOOLOGY			**8**	**200**				
SEMESTER V								
MNZO03	Theory	Cytogenetics	3	75	60	--	15	45
MNZO03	*Practical*	Cytogenetics	1	25	--	20	05	30
SEMESTER VI								
MNZO03	Theory	Cytogenetics	3	75	60	--	15	45
MNZO03	*Practical*	Cytogenetics	1	25	--	20	05	30
THREE-YEAR DEGREE PROGRAMME TOTAL 3 MINOR COURSES in ZOOLOGY			**12**	**300**				
SEMESTER VII								
MNZO04	Theory	Reproductive Biology	3	75	60	--	15	45
MNZO04	*Practical*	Reproductive Biology	1	25	--	20	05	30
SEMESTER VIII								
MNZO04	Theory	Reproductive Biology	3	75	60	--	15	45
MNZO04	*Practical*	Reproductive Biology	1	25	--	20	05	30
FOUR-YEAR HONOURS PROGRAMME TOTAL 4 MINOR COURSES in ZOOLOGY			**16**	**400**				

Students of other discipline may opt for minor courses in Zoology, one in each year either in odd or in even semester

SKILL ENHANCEMENT COURSES in ZOOLOGY

Course Code	Course Type	Course title	Credits	Marks	Theory	Practical	Internal	Hours
SEMESTER I								
SEZO01	Theory	Sericulture and Apiculture	2	50	40		10	30
SEZO01	*Experiential Learning*	Sericulture and Apiculture	1	25		20	05	40
TOTAL 1 COURSE			**3 credits**	**75**				
SEMESTER II								
SEZO02	Theory	Laboratory Techniques and Instrumentation	2	50	40		10	30
SEZO02	*Experiential Learning*	Laboratory Techniques and Instrumentation	1	25		20	05	40
TOTAL 2 COURSES			**6 credits**	**150**				
SEMESTER III								
SEZO03	Theory	Wildlife Conservation and Management	2	50	40		10	30
SEZO03	*Experiential Learning*	Wildlife Conservation and Management	1	25		20	05	40-45
TOTAL 3 COURSES			**9 credits**	**225**				

MULTIDISCIPLINARY COURSE in ZOOLOGY

Course Code	Course Type	Course title	Credits	Marks	Theory	Practical	Internal	Hours
SEMESTER I /II/III								
MDZO01	Theory	Applied Zoology	3	75	60	-	15	45

Examination pattern:

Internal assessment: 20% of full marks
End Semester examination: 80% of full marks

Duration of examination:

Theory: 3 hours (Full marks 60 and above); Theory: 2 hours (Full mark below 60)

Practical: 2 hours for 20 marks

Question pattern:

For Theory of 60 marks: 6 questions of 2 marks each out of 8 questions (6x2=12);4 questions of 4 marks each out of 6 questions (4x4=16);4 questions of 8 marks out of 6 questions (4x8=32).

For theory of 40 marks:4 questions of 2 marks each (out of 6 questions) (4x2=8);2 questions of 4 marks each out of 3 questions (2x4=8);3 questions of 8 marks out of 5 questions (3x8=24).

Credit distribution Framework for Three/Four-year Honours/Honours with Research Degree Programme with Multiple Entry and Exits Options

NCrF Credit Level	Semester	Major (Core)	Minor (Electives)	Multi/Inter disciplinary	AEC	SEC/ Internship	VAC/IKS	RP/PM /OJT	Cumulative Credit Per Sem.	Qualification
4.5	**I**	**8**	**4**	**3**	**2**	**3 (SEC)**	**3**	**-**	**23**	UG Certificate
	II	**8**	**4**	**3**	**2**	**3 (SEC)**	**3**	**-**	**23**	
1st Year Cumulative Credits		**16**	**8**	6	4	**6**	**6**	**-**	**46**	

Exit 1: Award of UG certificate in Major with 46 credits with additional 4 credits Summer Internship in core NSQF course OR continue with Major and Minor

5.0	**III**	**8**	**4**	**3**	**2**	**3**	**-**	**-**	**20**	**UG Diploma**
	IV	**16**	**4**	**-**	**2**	**-**	**-**	**-**	**22**	
2nd Year Cumulative Credits		**40**	**16**	**9**	**8**	**9**	**6**		**88**	

Exit 2: Award of UG Diploma in Major with 88 credits with additional 4 credits Summer Internship in core NSQF course OR continue with Major and Minor

5.5	**V**	**12**	**4**	**-**	**-**	**-**	**-**	**-**	**16**	**UG Degree**
	VI	**12**	**4**	**-**	**-**	**4 (Internship)**	**-**	**-**	**16**	
3rd Year Cumulative Credits		**64**	**24**	**9**	**8**	**13**	**6**		**124**	

Exit 3: Award of UG Degree in Major with 124 credits and Internship in same discipline OR continue with Major and Minor

6.0	**VII**	**16**	**4**	**-**	**-**	**-**	**-**	**-**	**20**	**UG Honours Degree**
	VIII	**16**	**4**	-	-	-	-	-	**20**	
4th Year Cumulative Credits		**96**	**32**	**9**	**8**	**13**	**6**	**-**	**164**	

Four-Year UG Honours Degree in Major and Minor with 164 credits

6.0	**VII**	**12**	**4**	**-**	**-**	**-**	**-**	**4**	**20**	**UG Honours with Research Degree**
	VIII	**08**	**4**	**-**	**-**	**-**	**-**	**8**	**20**	
4th Year Cumulative Credits		**84**	**32**	**9**	**8**	**13**	**6**	**12**	**164**	

Four-Year UG (Honours with Research) Degree in Major and Minor with 164 credits

Course Title: Biology of Non-chordates (MJZO01)
Course credit: 3 (Theory); NCrF Level 4.5
Semester-I

Objectives of the Course:

1) **Knowledge and Understanding:** Students will understand taxonomy, development, adaptations, and ecology of non-chordates.

2) **Application of Knowledge and Skills:** Learners will classify species using modern methods; interpret life cycles and parasitic relationships

3) **Technical and Professional Skills:** Students will perform specimen prep, specimen dissection, and lab documentation.

4) **Employability and Job-Ready Skills**: Students will apply zoological knowledge to public health, ecological conservation, and lab-based roles.

Expected outcome from the Course:

After completion of the course, the learners will be able to-

Sl no.	Learning outcome	Attributes
1.	Describe the structural biology, taxonomy, and evolutionary relationships of major non-chordate phyla—from Protista to Echinodermata	Critical thinking
2.	Critically analyze morphological, functional, and ecological traits to classify organisms and predict their roles in ecosystems .	Application of knowledge and skills
3.	Prepare laboratory mounts, dissect representative specimens (e.g., earthworm, prawn, gastropod, echinoderm), and correctly identify anatomical structures	Communication skills/ Research-related skills
4.	Demonstrate transferable lab skills relevant to careers in parasitology, environmental biology, aquaculture, museum curation, and education	Technological skills

Pedagogical approach of teaching:

Following pedagogical approaches will be followed:

Classroom teaching through Chalk and blackboard, Power point presentation, Questionnaires and discussion, Group based learning (collaborative learning, problem solving, debates, focused group discussion), Project based learning (Case studies, brain storming, problem solving.), Experiential learning (hands on training, demonstration, E- tutoring), Technology based learning (Use of PPT, Videos, E-content, etc.).

Continuous assessment:
Quiz/MCQ for each unit will be shared using LMS (Google Classroom or Moodle), Assignment at the end of each week/unit, Viva-voce, assignment and presentation.

Course Title: Principles of Ecology (MJZO02)
Course credit: 3 (Theory); NCrF Level 4.5
Semester-I

Objectives of the Course

1) **Knowledge & Understanding:** To enable learners to know about wildlife habitat and their management

2) **Application of Knowledge & Skills:** Learners will be able to compute population estimation using wild life data.

3) **Technical & professional skills:** Learners will understand the use of e-tools and acquire the skill of free tools like M-Stripes
4) **Employability and job ready Skills:** Learners will be trained in wild life census and data archiving tasks

Expected outcome from the Course:

After completion of the course, the learners will be able to-

Sl no.	Learning outcome	Attributes
1.	Interpret and comment on the outcomes of different estimators of wild life abundance	Critical thinking
2.	Compute, interpret and comment on the outcomes of different population count indices of wild life.	Research related skills
3.	Contribute in wildlife management programme related to data collection	Coordinating/collaborating with others, Research-related skills
4.	Use the e-tools (freely accessible) learned for wild life study	Digital and technological skills, Learning how to learn

Pedagogical approach of teaching:
Following pedagogical approaches will be followed:
Group based learning (Example, computation of estimators and indices in small groups), Project based learning (Collecting local fauna and their habitats, species-specific cover usage etc.), Experiential learning (Fecal matter analysis, hair identification), Technology based learning (Use of DISTANCE, M-sTripes, SMART, GBIF through android/Desktop etc.).

Continuous assessment:
Quiz/MCQ for each unit will be shared using LMS (Google Classroom or Moodle), Assignment at the end of each week/unit.

Course Title: Diversity of Chordates (MJZO03)
Course credit: 3 (Theory); NCrF Level 4.5
Semester-II

Objectives of the Course:

1) **Knowledge and Understanding:** Students will learn about phylum chordata, including its defining characteristics (notochord, dorsal nerve cord, etc.), classification, evolutionary significance, and habitat diversity of chordates.

2) **Application of Knowledge and Skills:** Learners will apply classification skills to identify and categorize different chordates based on morphology and anatomy and compare chordate classes to find out phylogenetic relationships.

3) **Technical and Professional Skills:** Students will acquire knowledge on ethical and safety guidelines in handling biological samples and conducting field/lab studies including dissection, specimen preservation, and observation of anatomical features.

4) **Employability and Job-Ready Skills:** Students will build a foundation for advanced studies or careers in ecology, environmental science, biodiversity research, wildlife conservation, or biological research

Expected outcome from the Course:

After completion of the course, the learners will be able to-

Sl no.	Learning outcome	Attributes
1.	Analyze the evolutionary relationships among chordates and and other animal phyla using morphological and molecular data	Critical thinking
2.	Identify and explain the structural and functional adaptations in major vertebrate classes: fishes, amphibians, reptiles, birds, and mammals	Application of knowledge and skills
3.	Communicate scientific ideas effectively through written reports, oral presentations, and the use of biological terminology	Communication skills/ Research-related skills
4.	Demonstrate basic dissection techniques and microscopic analysis of chordate tissues and organs.	Technological skills

Pedagogical approach of teaching:

Following pedagogical approaches will be followed:

Classroom teaching through Chalk and blackboard, Power point presentation, Questionnaires and discussion, Group based learning (collaborative learning, problem solving, debates, focused group discussion), Project based learning (Case studies, brain storming, problem solving.), Experiential learning (hands on training, demonstration, E- tutoring), Technology based learning (Use of PPT, Videos, E-content, etc.).

Continuous assessment:

Quiz/MCQ for each unit will be shared using LMS (Google Classroom or Moodle), Assignment at the end of each week/unit, Viva-voce, assignment and presentation.

Course Title: Cell Biology (MJZO04)
Course credit: 3 (Theory); NCrF Level 4.5
Semester-II

Objectives of the Course:

1) **Knowledge and Understanding:** Students will gain the foundational knowledge of the structure and function of prokaryotic and eukaryotic cells.

2) **Application of Knowledge and Skills:** Learners will understand molecular mechanisms, signaling pathways, and the dynamic interactions that govern cellular behavior in both normal and pathological conditions.

3) **Technical and Professional Skills:** Students will acquire hands-on experience with laboratory techniques such as cell staining, microscopy, and viability assays.

4) **Employability and Job-Ready Skills:** Students will build a foundation for careers in biomedical research, biotechnology, diagnostics, and pharmaceutical industries

Expected outcome from the Course:

After completion of the course, the learners will be able to-

Sl no.	Learning outcome	Attributes
1.	Describe the structure, function, and dynamics of cellular organelles and membranes.	Critical thinking
2.	Analyze cellular signaling pathways and their roles in growth, development, and disease.	Application of knowledge and skills
3.	Apply cell biology concepts to understand the cellular basis of diseases and genetic disorders	Communication skills/ Research-related skills
4.	Develop critical thinking and problem-solving skills related to cellular mechanisms and experimental design.	Technological skills

Pedagogical approach of teaching:

Following pedagogical approaches will be followed:

Classroom teaching through Chalk and blackboard, Power point presentation, Questionnaires and discussion, Group based learning (collaborative learning, problem solving, debates, focused group discussion), Project based learning (Case studies, brain storming, problem solving.), Experiential learning (hands on training, demonstration, E- tutoring), Technology based learning (Use of PPT, Videos, E-content, etc.).

Continuous assessment:

Quiz/MCQ for each unit will be shared using LMS (Google Classroom or Moodle), Assignment at the end of each week/unit, Viva-voce, assignment and presentation.

Course Title: Comparative Anatomy of Vertebrates (MJZO05)
Course credit: 3 (Theory); NCrF Level 5
Semester-III

Objectives of the Course:

1) **Knowledge and understanding**: Students will learn the functional adaptations of integument, skeletal system, Digestive respiratory, circulatory, excretory and nervous system through vertebrate series.

2) **Application of knowledge**: Students can apply the knowledge to corelate the modifications of organ systems with their physiological functions in particular habitats.

3) **Technical and Professional skill**: Students can acquire the technical skill on critical thinking, observation and analysing the anatomy with physiology and develop research skill.

4) **Employability and job ready Skill and Entrepreneurship skill:** The course enables the students to get job as comparative anatomist and curator in museum.

Expected outcome from the Course:

After completion of the course, the learners will be able to-

Sl no.	Learning outcome	Attributes
1.	Compare the functional anatomy of different organ systems through vertebrate series and their functional adaptations in different habitats	Critical thinking
2.	Understand the evolution of vertebrates by integrating the modifications of different organ systems	Application of knowledge and skills
3.	Prepare laboratory mounts, dissect representative specimens and correctly identify anatomical structures	Communication skills/ Research-related skills
4.	Demonstrate transferable lab skills relevant to careers in herpetology, environmental biology, museum curation, and education	Technological skills

Pedagogical approach of teaching:

Following pedagogical approaches will be followed:

Classroom teaching through Chalk and blackboard, Power point presentation, Questionnaires and discussion, Group based learning (collaborative learning, problem solving, debates, focused group discussion), Project based learning (Case studies, brain storming, problem solving.), Experiential learning (hands on training, demonstration, E- tutoring), Technology based learning (Use of PPT, Videos, E-content, etc.).

Continuous assessment:
Quiz/MCQ for each unit will be shared using LMS (Google Classroom or Moodle), Assignment at the end of each week/unit, Viva-voce, assignment and presentation.

Course Title: Principles of Genetics (MJZO06)
Course credit: 3 (Theory); NCrF Level 4.5
Semester- III

Objectives of the Course:

1. **Knowledge & Understanding:** To enable learners to know about the fundamental principles of genetics: Structure and function of DNA, genes, and chromosomes.

2. **Application of Knowledge & Skills:** Learners will be able to gain knowledge of Mendelian laws of inheritance and their application.

3. **Technical & professional skills:** Learners will understand the importance of genetic variation, mutation, and inheritance. e-tools and acquire the skill of free tools like M-Stripes

4. **Employability and job ready skills:** Learners will apply genetic concepts to real-world problems: Disease diagnosis, treatment, and prevention. Analyze genetic data: Predict inheritance patterns, identify genetic disorders.

Expected outcome from the Course:

After completion of the course, the learners will be able to-

Sl no.	Learning outcome	Attributes
1.	Understand the structure and function of DNA, genes, and chromosomes	Critical thinking
2.	Learn about Mendelian laws of inheritance and their application	Research related skills
3.	Understand the principles of genetic variation, mutation, and inheritance	Coordinating/collaborating with others, Research-related skills

Pedagogical approaches

Following pedagogical approaches will be followed:

1. Lectures: Delivering foundational knowledge through lectures.
2. Textbooks: Using textbooks as a primary resource.
3. Class discussions: Encouraging discussions to clarify concepts.

Continuous assessment:

Continuous assessment in genetics study involves regularly evaluating student understanding and progress throughout the course. Here are some methods:

1. Quizzes: Regular quizzes to assess understanding of key concepts.
2. Classwork: Evaluating student participation and engagement in class activities.
3. Group discussions: Assessing student ability to apply genetic concepts in group discussions.
4. Problem-solving exercises: Evaluating student ability to solve genetic problems.

Course Title: Fundamentals of Biochemistry (MJZO07)
Course credit: 3 (Theory); NCrF Level 5
Semester-IV

Objectives of the Course:

1) **Knowledge and understanding:** Learners will be able to gather knowledge about the structures of major biomolecules.

2) **Application of knowledge and skills:** Learners will understand how structural features determine biological functions of biomolecules.

3) **Technical & professional skills:** Learners will be able to determine structures, prepare reagents, samples and buffers, and execute biochemical analyses.

4) **Employability and job ready skills**: To enable learners to perform qualitative and quantitative estimations of carbohydrates and proteins, and enzyme assays.

Expected outcome from the Course:

After completion of the course, the learners will be able to-

Sl no.	Learning outcome	Attributes
1.	Interpret experimental data/findings and establish logical thinking by applying correct technical language related to biochemistry.	Critical thinking
2.	Apply the acquired theoretical knowledge, and a variety of practical skills to gather quantitative and qualitative data on biomolecules	Application of knowledge and skills

3.	Present complex information of various biochemical reactions, nuclic acids and enzymes and the findings of the	Communication skills/ Research-related skills
4.	Execute hands on practical experiments and lab work related to professional employment in the field of teaching and public service.	Technological skills

Pedagogical approach of teaching:

Following pedagogical approaches will be followed:

Classroom teaching through Chalk and blackboard, Power point presentation, Questionnaires and discussion, Group based learning (collaborative learning, problem solving, debates, focused group discussion), Project based learning (Case studies, brain storming, problem solving.), Experiential learning (hands on training, demonstration, E- tutoring), Technology based learning (Use of PPT, Videos, E-content, etc.).

Continuous assessment:
Quiz/MCQ for each unit will be shared using LMS (Google Classroom or Moodle), Assignment at the end of each week/unit.

Course Title: Animal Tissues and Coordinating Systems (MJZO08)
Course credit: 3 (Theory); NCrF Level 5
Semester-IV

Objectives of the Course:

1) **Knowledge and Understanding:** Students will able to describe the organization and function of the **coordinating systems** in animals, especially the nervous system and endocrine system.

2) **Application of Knowledge and Skills:** Students will Identify different tissue types and relate their structure to their specific physiological functions.

3) **Technical and Professional Skills:** Students will perform basic laboratory techniques, including tissue preparation, staining, observations under microscope and slide interpretation.

4) **Employability and Job-Ready Skills**: Students will build foundational skills required for careers in biomedical sciences**,** anatomy**,** physiology**,** health sciences, and laboratory diagnostics.

Expected outcome from the Course:

After completion of the course, the learners will be able to-

Sl no.	Learning outcome	Attributes
1.	Classify and explain the structure, function, and location of epithelial, connective, muscular, and nervous tissues.	Critical thinking
2.	Correlate tissue structure with specific physiological roles and understand how coordination systems maintain homeostasis.	Application of knowledge and skills
3.	Interpret histological slides and anatomical models of tissues and coordinating systems.	Communication skills/ Research-related skills
4.	Gain foundational knowledge and practical experience necessary for careers or higher education in physiology, anatomy, pathology, and health sciences.	Technological skills

Pedagogical approach of teaching:

Following pedagogical approaches will be followed:

Classroom teaching through Chalk and blackboard, Power point presentation, Questionnaires and discussion, Group based learning (collaborative learning, problem solving, debates, focused group discussion), Project based learning (Case studies, brain storming, problem solving.), Experiential learning (hands on training, demonstration, E- tutoring), Technology based learning (Use of PPT, Videos, E-content, etc.).

Continuous assessment:
Quiz/MCQ for each unit will be shared using LMS (Google Classroom or Moodle), Assignment at the end of each week/unit, Viva-voce, assignment and presentation.

Course Title: Molecular Biology (MJZO09)
Course credit: 3 (Theory); NCrF Level: 5
Semester-IV

Objectives of the Course:

1) **Knowledge & Understanding:** To enable learners to know about the molecular basis of life processes.

2) **Application of Knowledge & Skills:** Learners will be able to analyze and manipulate genetic material for purposes such as disease diagnosis and understanding cellular functions

3) **Technical & professional skills:** Learners will understand the technical skills in DNA/RNA isolation and quantification. Along with, professional skills in critical thinking, data interpretation, laboratory documentation and collaborative research.

4) **Employability and job ready skills:** Molecular biology equips learners with job-ready skills in DNA/RNA analysis, PCR, and data interpretation, making them employable in biotechnology, healthcare, research and pharmaceutical industries.

Expected outcome from the Course:

After completion of the course, the learners will be able to-

Sl No.	Learning outcome	Attributes
1	Understanding the concept regarding the molecular basis of various biological processes.	Critical thinking
2	Studying molecular biology will equip the learner with a diverse set of research-related skills that are highly valuable in scientific, medical, and biotechnological fields	Research related skills
3	Various group discussions and team-based approach regarding the understanding of the subject matter will drive the learner to be able to work efficiently in a collaborative scientific environment.	Coordinating/collaborating with others, Research-related skills
4	Learners will be able to acquire various skills such as primer designing, conducting in-silico PCR, etc.	Digital and technological skills, Learning how to learn

Pedagogical approach of teaching:

Following pedagogical approaches will be followed:

Group based learning (Collaborative instructional strategy where learners will work together to explore complex biological processes at the molecular level.), Project based learning (Learners will gain knowledge and skills by working on real-world, hands-on projects over an extended period of time), Experimental learning (Learners will be able to construct methodologies as well as conduct experiments for various molecular techniques).

Continuous assessment:

Quiz/MCQ for each unit will be shared using LMS (Google Classroom or Moodle), Assignment at the end of each week/unit.

Course Title: Fish Biology and Fisheries (MJZO10)
Course credit: 3 (Theory); NCrF Level 5
Semester-IV

Objectives of the Course:

1) **Knowledge and understanding**: Students will learn about fish diversity, habitat and habits; anatomy and physiology; fishing crafts and gears, capture fisheries status of India; Fish and Prawn farming systems.

2) **Application of knowledge**: Students can apply the knowledge in fisheries and aquaculture management.

3) **Technical and Professional skill**: Students can apply the knowledge in Fisheries and aquaculture management.

4) **Employability and job ready Skill and Entrepreneurship skill:** Students will be trained for employability or entrepreneurship in aquaculture farming.

Expected outcome from the Course:

After completion of the course, the learners will be able to-

Sl no.	Learning outcome	Attributes
1.	Diversity, habit and habitats, biology, anatomy and physiology of fish	Critical thinking
2.	Marine fishery status of India and its problems and remedies, crafts and gears, preservation and processing	Application of knowledge and skills
3.	Different aquaculture practices, induced breeding, water quality, feeding and disease management in farming system	Communication skills/ Research-related skills
4.	Demonstrate the strategies for fish conservation	Technological skills

Pedagogical approach of teaching:

Following pedagogical approaches will be followed:

Classroom teaching through Chalk and blackboard, Power point presentation, Questionnaires and discussion, Group based learning (collaborative learning, problem solving, debates, focused group discussion), Project based learning (Case studies, brain storming, problem solving.), Experiential learning (hands on training, demonstration, E- tutoring), Technology based learning (Use of PPT, Videos, E-content, etc.).

Continuous assessment:

Quiz/MCQ for each unit will be shared using LMS (Google Classroom or Moodle), Assignment at the end of each week/unit, Viva-voce, assignment and presentation.

Course Title: Physiology: Life Sustaining System (MJZO11)
Course credit: 3 (Theory); NCrF Level 5.5
Semester-V

Objectives of the Course:

1) **Knowledge and understanding:** Learners will be able to understand basic physiological concepts like principles of physiology, homeostasis, feedback mechanisms, etc.

2) **Application of knowledge and skills:** Learners will understand functions of major organ systems.

3) **Technical & professional skills:** Learners will be able to collect and analyze physiological data from laboratory experiments

4) **Employability and job ready skills**: To enable learners to develop expertise for biomedical sciences, healthcare, and clinical diagnostics

Expected outcome from the Course:

After completion of the course, the learners will be able to-

Sl no.	Learning outcome	Attributes
1.	Describe the structure and function of major organ systems responsible for sustaining life, including the cardiovascular, respiratory, renal, digestive, and nervous systems	Critical thinking
2.	Analyze how deviations in physiological functions can lead to disorders or diseases	Application of knowledge and skills
3.	Collect, analyze, and interpret physiological data from laboratory experiments	Communication skills/ Research-related skills
4.	Gain a foundational understanding necessary for careers in biomedical sciences, healthcare, clinical diagnostics, or postgraduate education in physiology and allied fields	chnological skills

Pedagogical approach of teaching:

Following pedagogical approaches will be followed:

Classroom teaching through Chalk and blackboard, Power point presentation, Questionnaires and discussion, Group based learning (collaborative learning, problem solving, debates, focused group discussion), Project based learning (Case studies, brain storming, problem solving.), Experiential learning (hands on training, demonstration, E- tutoring), Technology based learning (Use of PPT, Videos, E-content, etc.).

Continuous assessment:
Quiz/MCQ for each unit will be shared using LMS (Google Classroom or Moodle), Assignment at the end of each week/unit, Viva-voce, assignment and presentation.

Course Title: Metabolic Processes and Regulation (MJZO12)
Course credit: 3 (Theory); NCrF Level 5.5
Semester-V

Objectives of the Course:

1) **Knowledge and Understanding:** Students will grasp the fundamental principles of metabolic pathways (e.g., glycolysis, TCA cycle, β-oxidation, gluconeogenesis).

2) **Application of Knowledge and Skills:** Students will be able to analyze biochemical assay data (e.g., metabolite levels, enzyme kinetics) to assess metabolic regulation.

3) **Technical and Professional Skills:** Students will execute biochemical laboratory techniques: enzyme assays, spectrophotometry, substrate/product quantification

4) **Employability and Job-Ready Skills**: Students will collaborate effectively in multidisciplinary teams, communicating with peers from biology, chemistry, medicine, and computational fields.

Expected outcome from the Course:

After completion of the course, the learners will be able to-

Sl no.	Learning outcome	Attributes
1.	Explain the metabolic processes and understand the mechanism of actions of enzymes and coenzymes; appreciate the integration of metabolic processes	Critical thinking
2.	Use lab techniques such as enzyme assays and spectrophotometry to generate, interpret, and present biochemical data	Application of knowledge and skills
3.	Design and execute experiments to explore enzymatic activity, signal pathways, or metabolic regulation	Communication skills/ Research-related skills
4.	Translate complex metabolic knowledge into practical uses—e.g., biotech, clinical nutrition, or pharmaceutical development	Technological skills

Pedagogical approach of teaching:

Following pedagogical approaches will be followed:

Classroom teaching through Chalk and blackboard, Power point presentation, Questionnaires and discussion, Group based learning (collaborative learning, problem solving, debates, focused group discussion), Project based learning (Case studies, brain storming, problem solving.), Experiential learning (hands on training, demonstration, E- tutoring), Technology based learning (Use of PPT, Videos, E-content, etc.).

Continuous assessment:
Quiz/MCQ for each unit will be shared using LMS (Google Classroom or Moodle), Assignment at the end of each week/unit, Viva-voce, assignment and presentation.

Course Title: Developmental Biology (MJZO13)
Course credit: 3 (Theory); NCrF Level 5.5
Semester-IV

Objectives of the Course:

1) **Knowledge and Understanding:** Students will acquire knowledge on the molecular, genetic, and cellular mechanisms governing embryonic development, morphogenesis, and differentiation

2) **Application of Knowledge and Skills:** Students will analyze developmental processes and apply concepts to interpret experimental outcomes in embryology

3) **Technical and Professional Skills:** Students will perform laboratory techniques such as slide preparation of developmental stages and microscopic examination of embryos.

4) **Employability and Job-Ready Skills**: Students will build foundational skills for employment in academic research, IVF labs, biotech companies, or for pursuing higher studies in life sciences and health-related fields.

Expected outcome from the Course:

After completion of the course, the learners will be able to-

Sl no.	Learning outcome	Attributes
1.	Describe key developmental stages including gametogenesis, fertilization, cleavage, gastrulation, neurulation, and organogenesis	Critical thinking
2.	Explain the roles of genes, signaling pathways, and morphogens in cell differentiation and embryonic patterning	Application of knowledge and skills
3.	Analyze developmental biology data and experiments to understand mechanisms underlying normal development and congenital anomalies	Communication skills/ Research-related skills
4.	Acquire foundational knowledge and technical skills relevant for careers in embryology, developmental genetics, IVF technology, and biomedical research.	Technological skills

Pedagogical approach of teaching:

Following pedagogical approaches will be followed:

Classroom teaching through Chalk and blackboard, Power point presentation, Questionnaires and discussion, Group based learning (collaborative learning, problem solving, debates, focused group discussion), Project based learning (Case studies, brain storming, problem solving.), Experiential learning (hands on training, demonstration, E- tutoring), Technology based learning (Use of PPT, Videos, E-content, etc.).

Continuous assessment:
Quiz/MCQ for each unit will be shared using LMS (Google Classroom or Moodle), Assignment at the end of each week/unit, Viva-voce, assignment and presentation.

Course Title: Parasitology (MJZO14)
Course credit: 3 (Theory); NCrF Level: 5.5
Semester-VI

Objectives of the Course:

1) **Knowledge and Understanding:** To enable learners to know about host-parasite interactions, life cycles, morphology, and disease mechanisms of protozoan, helminth, arthropod, and vertebrate parasites.

2) **Application of Knowledge and Skills:** Learners will be able apply parasitological principles to diagnose parasitic diseases, interpret epidemiological data, and understand prevention and treatment strategies relevant to public and veterinary health.

3) **Technical and Professional Skills:** Learners will develop skills in microscopic identification, life cycle analysis, and parasite classification, preparing them for research or diagnostic settings.

4) **Employability and Job-Ready Skills**: Parasitology equips learners with skills relevant for roles in public health, diagnostics, epidemiology, vector control, and pest management.

Expected outcome from the Course:

After completion of the course, the learners will be able to-

Sl No.	Learning outcome	Attributes
1	Analyzing complex parasite-host interactions, evaluate pathogenic mechanisms, and assess control strategies in real-world epidemiological contexts.	Critical thinking
2	To develop skills in parasite identification, life cycle documentation, review, and formulation of research questions in parasitology.	Research related skills
3	Collaborative projects and discussions on vector-borne diseases and parasite control to promote teamwork in scientific inquiry and field/laboratory studies.	Coordinating/collaborating with others, Research-related skills
4	Using of microscopy tools and databases for parasite taxonomy in parasitological research and diagnostics.	Digital and technological skills, Learning how to learn

Pedagogical approach of teaching:

Following pedagogical approaches will be followed:

Group based learning (Collaborative instructional strategy where learners will work together to explore different parasites), Project based learning (Learners will gain knowledge and skills by working on real-world, hands-on projects over an extended period of time), Experimental learning (Learners will be able to construct methodologies as well as conduct experiments for parasite identification and pathogenesis), Technology based learning (use of digital microscopy tools and online slide banks for examining parasite morphology and life stages remotely, access to WHO parasite databases, CDC parasite image library, and diagnostic keys for identification and epidemiology research).

Continuous assessment:

Quiz/MCQ for each unit will be shared using LMS (Google Classroom or Moodle), Assignment at the end of each week/unit.

Course Title: Immunology (MJZO15)
Course credit: 3 (Theory); NCrF Level 5.5
Semester-VI

Objectives of the Course:

1) **Knowledge and Understanding:** Students willunderstand the fundamental concepts of the immune system, including innate and adaptive immunity.
2) **Application of Knowledge and Skills:** Students will be able to apply immunological principles to explain pathological conditions and responses to infections.
3) **Technical and Professional Skills:** Students will learn basic laboratory techniques practices, data analysis, and safe handling of biological samples.
4) **Employability and Job-Ready Skills:** Students will build competencies relevant to careers in biomedical research, diagnostics, vaccine development, and pharmaceutical industries.

Expected outcome from the Course:

After completion of the course, the learners will be able to-

Sl no.	Learning outcome	Attributes
1.	Explain the components and functions of the innate and adaptive immune systems.	Critical thinking
2.	Analyze immune responses in infections, vaccination, allergies, autoimmune diseases, and cancer.	Application of knowledge and skills
3.	Handle biological specimens safely and maintain laboratory protocols for immunoassays.	Communication skills/ Research-related skills
4.	Demonstrate problem-solving skills and teamwork in laboratory and clinical settings	Technological skills

Pedagogical approach of teaching:

Following pedagogical approaches will be followed:

Classroom teaching through Chalk and blackboard, Power point presentation, Questionnaires and discussion, Group based learning (collaborative learning, problem solving, debates, focused group discussion), Project based learning (Case studies, brain storming, problem solving.), Experiential learning (hands on training, demonstration, E- tutoring), Technology based learning (Use of PPT, Videos, E-content, etc.).

Continuous assessment:
Quiz/MCQ for each unit will be shared using LMS (Google Classroom or Moodle), Assignment at the end of each week/unit, Viva-voce, assignment and presentation.

Course Title: Evolutionary biology, Systematics and Taxonomy (MJZO16)
Course credit: 3 (Theory); NCrF Level: 5.5
Semester-VI

Objectives of the course:

1) **Generic learning outcomes**: To enable learners to get knowledge on how organisms evolved on Earth.

2) **Application of knowledge and skills**: Learners will be able to gather information (direct/allele/genetic) based on different evidences of evolution and interpret the outcomes.

3) **Knowledge and understanding**: The learners will understand mechanisms like genetic drift, gene flow, and mutation.

4) **Application of knowledge and skills**: The learners will synthesize evidence and reasoning to support or refute evolutionary claim.

Expected outcome from the Course:

After completion of the course, the learners will be able to-

Sl No.	Learning outcome	Attributes
1	Define, explain and interpret various evidences and phenomena related to evolutionary process-Critical thinking	Critical thinking
2	Critically evaluate and correlate scientific evidence for evolution from various sources, including fossil records, comparative anatomy, molecular biology- Digital and technological skills- Analytical reasoning/thinking	Research related skills
3	Conduct basic research in the area using concepts and methods used in the evolutionary biology - Research-related skills	Coordinating/collaborating with others, Research-related skills

Pedagogical approach of teaching:

Following pedagogical approaches will be followed:

Lecture method, ICT based (Power point), Group based learning (Collection of evidence, Classification),Blended learning (using Youtube and other videos).

Continuous assessment:

Quiz/MCQ will be shared using Google Classroom, Assignment at the end of the course.

Course Title: Research methodology and Biostatistics (MJZO17)
Credit: 3 (Theory); NCrF Level: 6
Semester-VII

Objectives of the Course:

1) **Generic learning outcomes**: To enable learners to acquire knowledge on the application of statistics in research.
2) **Application of knowledge and skills**: To enable learners to compute statistical analysis using e-tool and IT devices.
3) **Knowledge and understanding**: The learners will collect data and analysis them.

Expected outcome from the Course:

After completion of the course, the learners will be able to-

Sl No.	Learning outcome	Attributes
1	Use of statistical knowledge to analyze-Learning how to learn skills	Critical thinking
2	Analyze data using statistical tool online/offline- Digital and technological skills- Analytical reasoning/thinking	Research related skills
3	Conduct basic research in biology related subjects using any data set and statistical knowhow- Research-related skills	Coordinating/collaborating with others, Research-related skills

Pedagogical approach of teaching:

Following pedagogical approaches will be followed:
Lecture method, ICT based (Power point), Group based learning, Integrative learning,

Continuous assessment:

Quiz/MCQ will be shared using Google Classroom.

Course Title: Methods in Biology–I: Microscopy and Separation Techniques (MJZO18)
Course credit: 3 (Theory); NCrF Level: 6

Objectives of the Course:

1) **Knowledge & Understanding:** To enable learners to gain a foundational understanding of biological tools and principles used in microscopy, separation, spectroscopy, and radioisotope techniques essential for studying cellular and molecular biology.

2) **Application of Knowledge & Skills:** Learners will be able apply analytical and experimental approaches like centrifugation, chromatography, and electrophoresis to isolate and analyze biomolecules in research or diagnostic labs.

3) **Technical & professional skills:** Learners will develop skills handling laboratory instruments and techniques such as TEM, HPLC, SDS-PAGE etc.

4) **Employability and job ready skills:** Microscopy and separation techniques equips learners with skills relevant for careers in biotechnology, pharmaceuticals, diagnostics, and academic research.

Sl No.	Learning outcome	Attributes
1	Ability to choose and evaluate appropriate biological techniques based on experimental needs.	Critical thinking
2	Competence in designing, conducting, and analyzing biological experiments using standard lab methods.	Research related skills
3	Working effectively in teams to carry out complex lab protocols safely and efficiently.	Coordinating/collaborating with others, Research-related skills
4	Proficiency in using lab instruments and software for data acquisition, analysis, and documentation. Developing the ability to independently understand and apply new scientific tools and concepts.	Digital and technological skills, Learning how to learn

Pedagogical approach of teaching:

Following pedagogical approaches will be followed:

Group based learning (Collaborative instructional strategy where learners will work together to explore microscopy and separation techniques), Project based learning (Learners will gain knowledge and skills by working on real-world, hands-on projects over an extended period of time), Experimental learning (Learners will be able to construct methodologies as well as conduct experiments for various microscopy and separation techniques), Technology based learning (use of virtual microscopy simulations, interactive chromatography and centrifugation tools, and online lab demonstrations to enhance conceptual and practical understanding).

Continuous assessment:

Quiz/MCQ for each unit will be shared using LMS (Google Classroom or Moodle), Assignment at the end of each week/unit.

Course Title: Endocrinology (MJZO19)
Course credit: 3 (Theory); NCrF Level 6
Semester-VII

Objectives of the Course:

1) Knowledge and Understanding: Students will acquire knowledge inthe structure, functions, inter-relationships of endocrine glands in vertebrates along with synthesis, secretion, transport, and mechanism of action of hormones.

2) Application of Knowledge and Skills: Students will analyze hormonal control of biological functions in normal and pathological conditions.

3) **Technical and Professional Skills:** Students will perform laboratory techniques such as hormone assays (ELISA, RIA), tissue staining, and microscopy. **They will learn to** handle and interpret physiological data related to hormone levels and endocrine gland function.

1) **Employability and Job-Ready Skills: Students will** gain foundational knowledge useful in the field of endocrinology such as clinical diagnostics, pharmaceutical industries, biomedical research, and health sciences.

Expected outcome from the Course:

After completion of the course, the learners will be able to-

Sl no.	Learning outcome	Attributes
1.	Demonstrate an in-depth understanding of endocrine glands, hormone synthesis, secretion, and their physiological roles. animal phyla using morphological and molecular data	Critical thinking
2.	Integrate knowledge of hormonal regulation in contexts such as reproductive health, stress management, aging, and metabolic diseases	Application of knowledge and skills
3.	Present and explain complex endocrinological processes using correct scientific terminology in written and oral formats	Communication skills/ Research-related skills
4.	Be prepared for advanced studies in physiology, biomedical sciences, endocrinology, or employment in clinical labs, research centers, and the healthcare industry.	Technological skills

Pedagogical approach of teaching:

Following pedagogical approaches will be followed:

Classroom teaching through Chalk and blackboard, Power point presentation, Questionnaires and discussion, Group based learning (collaborative learning, problem solving, debates, focused group discussion), Project based learning (Case studies, brain storming, problem solving.), Experiential learning (hands on training, demonstration, E- tutoring), Technology based learning (Use of PPT, Videos, E-content, etc.).

Continuous assessment:

Quiz/MCQ for each unit will be shared using LMS (Google Classroom or Moodle), Assignment at the end of each week/unit, Viva-voce, assignment and presentation.

Course Title: Behavioral Biology (MJZO20 (E))
Course credit: 3 (Theory); NCrF Level 6
Semester-VII

Objectives of the Course:

1) **Knowledge and Understanding:** Students will learn the principles and evolutionary basis of animal behaviour.

2) **Application of Knowledge and Skills:** Students will use behavioural knowledge to address real-world problems such as human-wildlife conflict or captive animal welfare

3) **Technical and Professional Skills:** Learners will interpret animal behaviour through video analysis, fieldwork, and lab-based exercises

4) **Employability and Job-Ready Skills: Students will** develop observation, critical thinking, and data analysis skills essential for behavioral research and field studies.

Expected outcome from the Course:

After completion of the course, the learners will be able to-

Sl no.	Learning outcome	Attributes
1.	Explain the biological basis, evolution, and adaptive significance of animal behavior	Critical thinking
2.	Describe the roles of neural, hormonal, genetic, and environmental factors in shaping behavior	Application of knowledge and skills
3.	Design small-scale behavior studies, apply ethical guidelines in behavioral observation, and maintain accurate records.	Communication skills/ Research-related skills
4.	Acquire practical and analytical skills valuable for careers in wildlife research, environmental consultancy, zoological parks, NGOs, and animal care sectors	Technological skills

Pedagogical approach of teaching:

Following pedagogical approaches will be followed:

Classroom teaching through Chalk and blackboard, Power point presentation, Questionnaires and discussion, Group based learning (collaborative learning, problem solving, debates, focused group discussion), Project based learning (Case studies, brain storming, problem solving.), Experiential learning (hands on training, demonstration, E- tutoring), Technology based learning (Use of PPT, Videos, E-content, etc.).

Continuous assessment:
Quiz/MCQ for each unit will be shared using LMS (Google Classroom or Moodle), Assignment at the end of each week/unit, Viva-voce, assignment and presentation.

Course Title: Methods in Biology-II: Molecular Biology (MJZO21)
Course credit: 4 (Theory); NCrF Level:6

Objectives of the Course:

1. **Knowledge & Understanding**: Learners will understand the basis and working principle of various molecular techniques.

2. **Application of Knowledge & Skills**: Learners will be able to learn advanced molecular analytical techniques.

3. **Technical & professional skills**: Learners will be able to conduct immunoassays, gene amplification, protein identification and quantification.

4. **Employability and job ready skills**: Learners will have the opportunity as a research scientist in biomedical research diagnostics and therapeutics.

Expected outcome from the Course:

After completion of the course, the learners will be able to-

Sl No.	Learning outcome	Attributes
1	Understanding about inter-connection of molecular biology, immunology and proteomics to draw a meaningful conclusion.	Critical thinking
2	Ability to design, conduct and analyze experiment using molecular, immune and proteomics techniques.	Research related skills
3	Team-based laboratory work like collaborating with peers to conduct experiments (PCR, gel electrophoresis, immunoassays)	Coordinating/collaborating with others, Research-related skills
4	Use of various open-access biological databases like NCBI, DDBJ, EMBL, etc.	Digital and technological skills, Learning how to learn

Pedagogical approach of teaching:

Following pedagogical approaches will be followed:

Group based learning (Group projects and discussions for better understanding of various molecular techniques), Inquiry-based learning (Encouraging the learners to *ask questions* and maintain a good interaction for circulation of appropriate knowledge of the subject matter), Experimental learning (Emphasizing on experimental methodology, formulate hypotheses and design suitable experiments), Technology based learning (Use of DNA/RNA extraction, PCR, gel electrophoresis, western blotting technology, etc).

Continuous assessment:

Quiz/MCQ for each unit will be shared using LMS (Google Classroom or Moodle), Assignment at the end of each week/unit.

Course Title: Toxicology (MJZO22)
Course credit: 3 (Theory); NCrF Level 6.0
Semester VIII

Objectives of the Course:

1. **Knowledge & Understanding:** To enable learners to know about the adverse effects of chemicals on living organisms.

2. **Application of Knowledge & Skills:** Learners will be able to gain knowledge of identifying toxic substances.

3. **Technical & professional skills:** Learners will evaluate the potential risks associated with exposure to toxic substances importance of genetic variation, mutation, and inheritance. e-tools and acquire the skill of free tools like M-Stripes

4. **Employability and job ready skills:** Learners will determine the toxicity of various substances, including chemicals, drugs, and environmental pollutants.

Expected outcome from the Course:

After completion of the course, the learners will be able to-

Sl no.	Learning outcome	Attributes
1.	Recognize the adverse effects of chemicals on living organisms.	Critical thinking
2.	Understand how toxic substances cause harm at the molecular, cellular, and organismal levels.	Research related skills
3.	Assess the risk of evaluate the potential risks associated with exposure to toxic substances Understand the principles of genetic variation, mutation, and inheritance	Coordinating/collaborating with others, Research-related skills

Pedagogical approaches

Following pedagogical approaches will be followed:

1. Lectures: Delivering foundational knowledge through lectures.
2. Textbooks: Using textbooks as a primary resource.
3. Class discussions: Encouraging discussions to clarify concepts.

Continuous assessment:

Continuous assessment in genetics study involves regularly evaluating student understanding and progress throughout the course. Here are some methods:

1. Quizzes: Regular quizzes to assess understanding of key concepts.
2. Classwork: Evaluating student participation and engagement in class activities.
3. Group discussions: Assessing student ability to apply genetic concepts in group discussions.
4. Problem-solving exercises: Evaluating student ability to solve genetic problems.

Course Title: Animal Cell Biotechnology (MJZO23(E))

Course credit:4 (Theory); NCrF Level: 6

Objectives of the Course:

1. **Knowledge & Understanding**: Learners will gain knowledge regarding animal cell culture; microbial, plants and animals transformation techniques as well as cloning in mammalian cells. Moreover, they will also be able to grasp an overview of genetic manipulation and recombinant DNA technology.

2. **Application of Knowledge & Skills**: Learners will be able apply the knowledge acquired in this course in various health sectors by understanding the development of recombinant vaccines, gene therapy as well as production of insulin and growth hormones.

3. **Technical & professional skills**: Learners will acquire technical skills related to the cell culture like preserving aseptic conditions and controlling contamination, maintaining primary and continuous cell lines, preparation of growth media as well as nutrient profiling and supplementation. Moreover, learners will also gain skills regarding usage of restriction enzymes as well as plasmid DNA isolation and transformation of *Escherichia coli* with plasmid DNA using $CaCl_2$.

4. **Employability and job ready skills**:Learners will be equipped with biotechnology industry relevant skills with hands on experience on animal cell culture and proper utilization of molecular biology tools like PCR and ELISA. They will be competent in using aseptic techniques and data recording of various experiments held in a day-to-day basis and will also excel in usage of statistical methods.

Expected outcome from the Course:

After completion of the course, the learners will be able to-

Sl No.	Learning outcome	Attributes
1	Developing an ability for diagnosis of low cell yield as well as testing new formulations of media and exploring new techniques for cell transformation.	Critical thinking
2	Learners will be able to acquire research ready skills in cell culture techniques, troubleshooting of standard protocols and accurate data collection.	Research related skills
3	Collaborating with other individuals will boost the learners to gain more knowledge regarding the subject matter and techniques associated with it. Moreover, it will also allow the learners to develop a research-ready mindset.	Coordinating/collaborating with others, Research-related skills
4	Learners will be able to use tools like UGENE, MEGA, BLAST and KEGG for improving productivity of research.	Digital and technological skills, Learning how to learn

Pedagogical approach of teaching:

Following pedagogical approaches will be followed:

Group based learning (Working in small groups will drive the curiosity of learners to develop core biotechnological concepts and building an appropriate knowledge base through collective interaction and experience), Project based learning (Simulating a group based project will enhance the learners to develop industry relevant skills and will also drive them to understand laboratory work ethics), Experimental learning (Learning by conducting various experiments will allow the learners to gain experience in thorough interpretation of results as well as refining various standard biotechnological procedures to suite their individual experimental settings), Technology based learning (Employing various tools like Labster, Visible body, GraphPad and ImageJ that simulate a laboratory environment as well as also allow the learner to develop a proper understanding of data visualization and analysis).

Continuous assessment:

Quiz/MCQ for each unit will be shared using LMS (Google Classroom or Moodle), Assignment at the end of each week/unit.

Course Title: Biology of Infectious Diseases (MJZO24(E))
Course credit: 3 (Theory); NCrF Level 6
Semester-VIII

Objectives of the Course:

1) **Knowledge and Understanding:** Students will learn the biology, classification, life cycles, and pathogenic mechanisms of major infectious agents (bacteria, viruses, fungi, parasites).

2) **Application of Knowledge and Skills:** Learners will apply clinical and laboratory diagnostic techniques to identify pathogens, including serology, culture, molecular methods, and point-of-care tests.

3) **Technical and Professional Skills:** Students will demonstrate competence in infection prevention and control best practices.

4) Employability and Job-Ready Skills: Students will apply knowledge to roles in clinical microbiology, epidemiology, public health, and infection control.

Expected outcome from the Course:

After completion of the course, the learners will be able to-

Sl no.	Learning outcome	Attributes
1.	Understand molecular and cellular mechanisms underlying infection, host–pathogen interactions, virulence factors, and immune evasion strategies	Critical thinking
2.	Critically evaluate and integrate scientific research to formulate hypotheses and rationales in infectious disease contexts	Application of knowledge and skills
3.	Communicate findings effectively through written reports, presentations, and oral briefings; demonstrate self-management, teamwork, and reflective skills	Communication skills/ Research-related skills
4.	Work effectively in multidisciplinary teams—clinical, public health, research; advise on diagnostics, antimicrobial use, and prevention strategies	Technological skills

Pedagogical approach of teaching:

Following pedagogical approaches will be followed:

Classroom teaching through Chalk and blackboard, Power point presentation, Questionnaires and discussion, Group based learning (collaborative learning, problem solving, debates, focused group discussion), Project based learning (Case studies, brain storming, problem solving.), Experiential learning (hands on training, demonstration, E- tutoring), Technology based learning (Use of PPT, Videos, E-content, etc.).

Continuous assessment:
Quiz/MCQ for each unit will be shared using LMS (Google Classroom or Moodle), Assignment at the end of each week/unit, Viva-voce, assignment and presentation.

Course Title: Animal diversity (MNZO01)
Course credit: 3 (Theory); NCrF Level: 4.5
Semester-I/II

Objectives of the Course:

1. **Knowledge & Understanding:** To enable learners to gain foundational knowledge of invertebrate diversity, structure, and classification, with insight into evolutionary relationships and functional adaptations across protozoan to mammals.

2. **Application of Knowledge & Skills:** Learners apply taxonomic principles, and life cycle knowledge to analyze invertebrate and vertebrate adaptations, ecological roles, and evolutionary significance in practical and research contexts.

3. **Technical & professional skills:** Learners will develop dissection, slide preparation, and microscopic observation skills, along with classification techniques essential for zoological lab work and biodiversity assessment.

4. **Employability and job ready skills:** The course builds a foundation for careers in wildlife biology, environmental consultancy, academia, and research through skills in taxonomy, species identification, and understanding of ecological interactions.

Expected outcome from the Course:

After completion of the course, the learners will be able to-

Sl No.	Learning outcome	Attributes
1	Analyze and compare anatomical and physiological adaptations to evaluate evolutionary relationships among invertebrates and vertebrate.	Critical thinking
2	Learn develop abilities in species classification, literature review, and data interpretation to support zoological research.	Research related skills
3	Perform group work and discuss foster teamwork and collaborative problem-solving in identifying and analyzing invertebrate and vertebrate specimens.	Coordinating/collaborating with others, Research-related skills
4	Students utilize digital taxonomic databases, microscopy tools, and online zoological resources for classification and research.	Digital and technological skills, Learning how to learn

Pedagogical approach of teaching:

Following pedagogical approaches will be followed:

Group based learning (Collaborative instructional strategy where learners will work together to explore biology of different animals), Project based learning (Learners will gain knowledge and skills by working on real-world, hands-on projects over an extended period of time), Experimental learning (Learners will be able to construct methodologies as well as conduct experiments on invertebrate and vertebrate specimens), Technology based learning (use of virtual dissections, and interactive taxonomy platforms to enhance understanding of animal diversity).

Continuous assessment:

Quiz/MCQ for each unit will be shared using LMS (Google Classroom or Moodle), Assignment at the end of each week/unit.

Course Title: Insect Vectors and Diseases (MNZO02)
Course credit: 3 (Theory); NCrF Level: 5
Semester-III/IV

Objectives of the Course:

1. **Knowledge & Understanding:** To enable learners to gain foundational and in-depth knowledge of insect morphology, feeding mechanisms and their role as disease vectors, including biological and mechanical transmission.

2. **Application of Knowledge & Skills:** Learners will apply entomological principles to identify vector species and relate insect behavior and adaptations to disease transmission and control strategies.

3. **Technical & professional skills:** Learners will develop skills in vector identification, understanding host-vector relationships, and methods of vector control, relevant to public health and entomology labs.

4. **Employability and job ready skills:** This paper **e**quips students for careers in medical entomology, vector control programs, public health agencies, and research institutions dealing with vector-borne diseases.

Expected outcome from the Course:

After completion of the course, the learners will be able to-

Sl No.	Learning outcome	Attributes
1	Ability to critically analyze the life cycles, adaptations, and epidemiological roles of insect vectors to evaluate their impact on disease spread and control effectiveness.	Critical thinking
2	Competence in developing abilities to gather, interpret, and synthesize entomological and epidemiological data from scientific literature and case studies on vector-borne diseases.	Research related skills
3	Working in groups to investigate outbreaks, design control strategies, or conduct case-based analyses of vector management programs.	Coordinating/collaborating with others, Research-related skills
4	Proficiency in using digital tools for insect identification, disease surveillance databases, GIS mapping for vector distribution, and accessing scientific repositories.	Digital and technological skills, Learning how to learn

Pedagogical approach of teaching:

Following pedagogical approaches will be followed:

Group based learning (Collaborative instructional strategy where learners will work together to explore Insect Vectors and Diseases), Project based learning (Learners will gain knowledge and skills by working on real-world, hands-on projects over an extended period of time), Experimental learning (Learners will be able to construct methodologies as well as conduct experiments for Insect Vectors and Diseases), Technology based learning (use of virtual labs, digital microscopy, vector identification apps, and online disease surveillance platforms).

Continuous assessment:

Quiz/MCQ for each unit will be shared using LMS (Google Classroom or Moodle), Assignment at the end of each week/unit.

Course Title: Cytogenetics (MNZO03)
Course credit: 3 (Theory); NCrF Level 5.5
Semester V/VI

Objectives of the Course:

1. **Knowledge & Understanding:** To enable learners to understand chromosome structure and function of chromosomes.

2. **Application of Knowledge & Skills:** To enable students toidentify chromosomal abnormalities.

3. **Technical & professional skills:** Learners will understand the relationship between chromosomal abnormalities and human disease, including genetic disorders and cancer.

4. **Employability and job ready skills: L**earners will determine the abnormalities, such as aneuploidy, translocations, and deletions.

Expected outcome from the Course:

After completion of the course, the learners will be able to-

Sl no.	Learning outcome	Attributes
1.	Recognize the structure, behavior, and function of chromosomes.	Critical thinking
2.	Detect and characterize chromosomal abnormalities, such as aneuploidy, translocations, and deletions	Research related skills
3.	Understand the clinical significance of chromosomal abnormalities and their role in human disease	Coordinating/collaborating with others, Research-related skills

Pedagogical approaches

Following pedagogical approaches will be followed:

1. Lectures: Delivering foundational knowledge through lectures.
2. Textbooks: Using textbooks as a primary resource.
3. Class discussions: Encouraging discussions to clarify concepts.

Continuous assessment:

Continuous assessment in genetics study involves regularly evaluating student understanding and progress throughout the course. Here are some methods:

1. Quizzes: Regular quizzes to assess understanding of key concepts.
2. Classwork: Evaluating student participation and engagement in class activities.
3. Group discussions: Assessing student ability to apply genetic concepts in group discussions.
4. Problem-solving exercises: Evaluating student ability to solve genetic problems.

Course Title: Reproductive Biology (MNZO04)
Course credit: 3 (Theory); NCrF Level 6
Semester-VII/VIII

Objectives of the Course:

1) **Knowledge and Understanding:** Students will understand the fundamental principles of reproductive systems in both males and females across various species.

2) **Application of Knowledge and Skills:** Students will be able to apply knowledge to interpret reproductive physiology and pathophysiology in humans and animals.

3) **Technical and Professional Skills:** Students will perform basic laboratory techniques such as sperm analysis, hormone detection (e.g., ELISA), and microscopic examination of reproductive tissues

4) **Employability and Job-Ready Skills**: Students will prepare for careers in reproductive health clinics, fertility centers, veterinary sciences, pharmaceuticals, and research institutions

Expected outcome from the Course:

After completion of the course, the learners will be able to-

Sl no.	Learning outcome	Attributes
1.	Gain in-depth knowledge of the anatomical, physiological, hormonal, and molecular aspects of the reproductive systems in humans and other animals	Critical thinking
2.	Apply theoretical concepts to practical scenarios, including the diagnosis of reproductive disorders, understanding contraceptive strategies, and the use of assisted reproductive technologies (ART).	Application of knowledge and skills
3.	Develop hands-on experience with laboratory techniques such as hormone assays, gamete handling, and reproductive tissue staining.	Communication skills/ Research-related skills
4.	Acquire job-ready skills for roles in fertility clinics, diagnostic laboratories, reproductive health NGOs, veterinary services, and biopharma industries focusing on reproductive health.	Technological skills

Pedagogical approach of teaching:

Following pedagogical approaches will be followed:

Classroom teaching through Chalk and blackboard, Power point presentation, Questionnaires and discussion, Group based learning (collaborative learning, problem solving, debates, focused group discussion), Project based learning (Case studies, brain storming, problem solving.), Experiential learning (hands on training, demonstration, E- tutoring), Technology based learning (Use of PPT, Videos, E-content, etc.).

Continuous assessment:
Quiz/MCQ for each unit will be shared using LMS (Google Classroom or Moodle), Assignment at the end of each week/unit, Viva-voce, assignment and presentation.

Course Title: Sericulture and Apiculture (SEZO01)
Course credit: 3 (Theory); NCrF Level: 4.5
Semester-I

Objectives of the Course:

1. **Knowledge & Understanding:** Learners will be able to understand and gain knowledge regarding the sericulture and apiculture industries and other related indigenous traditional practices about rearing of silkworms as well as culturing of bees.

2. **Application of Knowledge & Skills:** Learners will be able to apply the knowledge and skills of sericulture and apiculture to enhance rural livelihoods, promote sustainable agriculture, and support the production of silk and honey through management of silkworms and honeybees.

3. **Technical & professional skills:** Learners will understand the use of insect rearing, disease management, product processing (silk and honey).

4. **Employability and job ready skills:** Learning sericulture and apiculture equips students with job-ready skills in insect rearing, farm management, insect disease control, product processing and

entrepreneurship. These skills will further make them desirable for employment in agro-based industries, research, and rural development sectors.

Expected outcome from the Course:

After completion of the course, the learners will be able to-

Sl No.	Learning outcome	Attributes
1	Developing learners' ability to analyse, evaluate, and apply knowledge to solve real-world problems in the sericulture and apiculture fields.	Critical thinking
2	Acquisition of real-world skills applicable in agricultural science, entomology, environmental studies, as well as commercial farming	Research related skills
3	Learners will be able to collaborate with each other for formulation of solutions as well as working as team to tackle various situation that arises during silkworm and bee culture.	Coordinating/collaborating with others, Research-related skills
4	Learners will be able to access various online silkworm and api-culture databases for more in-depth learning of the subject matter.	Digital and technological skills, Learning how to learn

Pedagogical approach of teaching:

Following pedagogical approaches will be followed:

Group based learning (Students simulate managing a bee colony as well as silkworm cultures, thereby assigning roles like beekeeper, rearers, environmental analyst, and disease specialist.), Project based learning (Initiating various hands-on project such as bee-keeping, management of host plants for silkworm culturing, bee hive monitoring, etc.), Experimental learning (Learning through various experimental activities such as identification of sexual characters of bees and silk moths, Cocoon yield measurement, etc.), Technology based learning (Employing various modern tools for increasing the yield of the culture).

Continuous assessment:

Quiz/MCQ for each unit will be shared using LMS (Google Classroom or Moodle), Assignment at the end of each week/unit.

Course Title: Lab Techniques and Instrumentation (SEZO02)
Course credit: 3 (Theory); NCrF Level: 5
Semester-II

Objectives of the Course:

1. **Knowledge & Understanding:** Understands core principles of laboratory techniques including sterilization, centrifugation, microscopy, spectrophotometry, and chromatography.

2. **Application of Knowledge & Skills:** Applies scientific concepts to prepare reagents, operate lab instruments, and perform analytical procedures accurately.

3. **Technical & professional skills:** Demonstrates proficiency in handling laboratory equipment, preparing chemical solutions, and following safety protocols.

4. **Employability and job ready skills:** Equipped with practical lab competencies and technical know-how required for entry-level roles in biological and chemical laboratories.

Expected outcome from the Course:

After completion of the course, the learners will be able to-

Sl No.	Learning outcome	Attributes
1	Students will develop the ability to analyze and evaluate experimental techniques and scientific data related to sterilization, centrifugation, microscopy, spectrophotometry, and chromatography.	Critical thinking
2	Students will acquire practical skills in preparing laboratory reagents, conducting scientific experiments, and applying research methodologies using modern laboratory instruments.	Research related skills
3	Students will enhance their ability to work effectively in teams to plan, execute, and troubleshoot experiments while maintaining accurate and collaborative documentation.	Coordinating/collaborating with others, Research-related skills
4	Students will learn to operate and maintain laboratory instruments (e.g., centrifuges, microscopes, spectrophotometers) and utilize digital tools for data analysis and research.	Digital and technological skills, Learning how to learn

Pedagogical approach of teaching:

Following pedagogical approaches will be followed:

Group based learning (Collaborative instructional strategy where learners will work together to explore different lab techniques and instrumentation), Project based learning (Learners will gain knowledge and skills by working on real-world, hands-on projects over an extended period of time), Experimental learning (Learners will be able to know about multiple lab techniques and instrumentation), Technology based learning (students will engage in technology-based learning through the use of digital simulations, virtual labs, and instrument-based software to understand and apply core laboratory techniques and analytical methods.).

Continuous assessment:

Quiz/MCQ for each unit will be shared using LMS (Google Classroom or Moodle), Assignment at the end of each week/unit.

Course Title: Wildlife conservation and management (SEZO03)
Course Credit: 2 (Theory); NCrF Level: 5.5
Semester-III

Objectives of the Course:

1) **Application of Knowledge & Skills**: Learners will be able to collect and compute population estimation using appropriate method.
2) **Technical & professional skills**: Learners will understand the use ofe-tools (e.g. M-Stripes) in wild life studies
3) **Employability and job ready skills**: Learners will be able to exercise the methods used in wild life census.

Expected outcome from the Course:

After completion of the course, the learners will be able to-

Sl No.	Learning outcome	Attributes
1	Interpret and comment on the outcomes of different estimators of wild life abundance-Critical thinking	Critical thinking
2	Compute, interpret and comment on the outcomes of different population count indices of wild life	Research related skills
3	Contribute in wildlife management programme related to data collection - Coordinating/collaborating with others	Coordinating/collaborating with others, Research-related skills
4	Use the e-tools (freely accessible) learned for wild life study -Digital and technological skills, Learning how to learn	Digital and technological skills, Learning how to learn

Pedagogical approach of teaching

Following pedagogical approaches will be followed:

Group based learning (Example, computation of estimators and indices in small groups), Project based learning (Collecting local fauna and their habitats, species-specific cover usage etc.), Experiential learning (Fecal matter analysis, hair identification), Technology based learning (Use of DISTANCE, M-sTripes, SMART, GBIF through android/Desktop etc.).

Continuous assessment:

Quiz/MCQ for each unit will be shared using LMS (Google Classroom or Moodle), Assignment at the end of each week/unit.

Course Title: Applied Zoology (MDZO01)
Course credit: 3 (Theory); NCrF Level: 4.5
Semester-I/II/III

Objectives of the Course:

1. **Knowledge & Understanding**: Learners will be able to gain knowledge regarding the apiculture, sericulture, aquaculture, management of insect vectors and pest and also understanding the biodiversity of wildlife.

2. **Application of Knowledge & Skills**: Learners will be able to understand the workings of honey production, silk production, fish production as well as vector control and insect control.

3. **Technical & professional skills**: Learners will be able to acquire a well-defined skill set regarding livestock management, aquaculture, silkworm batch maintenance, etc.

4. **Employability and job ready skills**: Learners will be able to apply their culturing skills to increase their employability in any departments that deals with aquaculture, sericulture, etc.

Expected outcome from the Course:

After completion of the course, the learners will be able to-

Sl No.	Learning outcome	Attributes
1	Learners will develop a definite mindset for solving various issues regarding insect and fish culture, etc.	Critical thinking
2	Developing foundational skills for empowering students in fields of research such as animal pathology, culture maintenance, etc.	Research related skills
3	Working in teams and collaboration will result into the in-depth understanding of observational skills, keeping up a clean environment for culture of various animal species.	Coordinating/collaborating with others, Research-related skills
4	Learners will learn the use of various tools and software for proper maintenance of data records.	Digital and technological skills, Learning how to learn

Pedagogical approach of teaching:

Following pedagogical approaches will be followed:

Group based learning (Collaborative learning where students work in small teams to explore, analyse, and solve biological problems related to animals and their applications in real-world industries like sericulture, apiculture, aquaculture, and animal husbandry), Project based learning (Learners will have to deal with real-world tasks where they research, design, execute, and present projects related to animal science and its practical applications), Experimental learning (Formulation various experimental designs formonitoring honeybee behaviour and hive health, mini aquaculture setups, sustainable insect culturing, etc.), Technology based learning (Incorporating data-driven research, virtual as well as field experiences using various modern tool sets).

Continuous assessment:

Quiz/MCQ for each unit will be shared using LMS (Google Classroom or Moodle), Assignment at the end of each week/unit.

Indian Knowledge System (IKS) incorporated in the Syllabus

Semester	Paper & Code	Unit	Credit
Sem I	MJZO02: Principles of Ecology (Theory)	Unit 5: Applied Ecology, Principles of Ecology in Wildlife Management	0.3
	SEZO02: Sericulture and Apiculture (Theory)	Unit 1: Introduction to Sericulture & Biology of Silkworm Unit 2: Rearing of Silkworms Unit 3: Introduction to Apiculture & Biology of Bees Unit 4: Rearing of Bees Unit 5: Pests and Diseases	2
	SEZO01: Sericulture and Apiculture (Experiential learning)	Practical	1
Sem I/II/III	MDZO01: Applied Zoology	Unit 1: Apiculture and Sericulture Unit 2: Insect Pest Management Unit 3: Insect Vectors and Parasitic Diseases Unit 4: Aquaculture Unit 5: Biodiversity and Wildlife Management	3
Sem III	SEZO03: Wildlife Conservation and Management	Unit 1: Introduction to Wildlife Management	2
Sem VI	MJZO14: Parasitology (Theory)	Unit 1: Introduction Unit 2: Parasitic Protista- *Plasmodium*, *Leishmania*, *Giardia* Unit 5: Arthropoda	1
Sem V	MJZO012: Metabolic Processes and Regulation (Theory)	Unit 1: Overview of Bioenergetics and Metabolism	1
Sem VIII	MJZO22: Toxicology (Theory)	Unit 4: Pesticides	0.2
	MJZO24: Biology of Infectious Disease (Theory)	Unit 1: Mosquitoes as Vectors and related diseases Unit 3: Leprosy Unit 4:Food and Water-borne Diseases	0.8
Total Credits			**11.3**

OUTLINE OF THE CERTIFICATE COURSE IN ZOOLOGY

[1st YEAR OF FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUP) UNDER NEP 2020]

SEMESTERS	MAJOR CORE COURSES	MINOR COURSES	MULTI COURSES	AECC	SECZ	CVAC	INTERN-SHIP	TOTAL CREDITS
I	**MJZO01 (4 credits)** [Biology of Non-Chordates] **MJZO02 (4 credits)** [Principles of Ecology]	**MNZO01 (4 credits)** [Animal Diversity]	**MDZO01 (3 credits)**	**MIL-1 (2 credits)**	**SEZO01 (3 credits)** [Sericulture and Apiculture]	**CVAC-1 (3 credits)** [Tagore Studies]	**Vocational Summer Internship (4 credits)**	**23**
II	**MJZO03 (4 credits)** [Diversity of Chordates] **MJZO04 (4 credits)** [Cell Biology]	**MNZO01 (4 credits)** [Animal Diversity]	**MDZO01 (3 credits)**	**MIL-2 (2credits)**	**SEZO02 (3 credits)** [Laboratory Techniques and Instrumentation]	**CVAC-2 (3 credits)** (Environmental Studies)		**23**
YEAR - 1	**4x4=16 cr**	**2x4=8 cr**	**2x3=6cr**	**2x2=4 cr**	**2x3=6cr**	**2x3=6cr**	**1x4=4cr**	**46 (+4)**

[*After successful completion of ONE YEAR Course (Semesters -I & II) securing 46 Credits plus 4 Credits Vocational Summer Internship, students may exit with Certificate in Zoology or continue further.*]

Note:

*The students can opt for the Minor Course **MNZO01** and the Multidisciplinary course **MDZO01** only once in a year. The students cannot opt for same Paper code twice.*

DISCIPLINE-SPECIFIC MAJOR (CORE) COURSES IN ZOOLOGY

SEMESTER - I

MJZO01: BIOLOGY OF NON-CHORDATES (4 Credits; 100 Marks)

About the Course:The course presents a detailed comparison of the different taxa of non-chordates from Protozoa to the Coelomates. It highlights the increasing complexity of structure and function in the taxonomic hierarchy. The course gives an overview of the intricate life processes in non-chordates.

Learning Outcomes: After successful completion of this course, the students will be able to

- Know the characteristics used to classify the organisms belonging to different taxa;
- Appreciate the diversity among non-chordates and understand distinctive features of the various phyla;
- Have hands-on experience of specimens demonstrating diversity of Protozoa to Coelomates;
- Get a flavor of animal diversity through local field visits.

MJZO01: BIOLOGY OF NON-CHORDATES [THEORY] (3 Credits; 75 Marks)

	No. of lectures
Unit1:Protozoa	
General characteristics and Classification upto sub-phylum (according to Levine,1982); Locomotion and Reproduction in Protozoa	8
Unit 2:Acoelomates and Pseudocoelomates	
General characteristics and Classification of major phyla upto class; Canal system in Porifera; Polymorphism and Metagenesis in Cnidaria; Corals and coral reef; Parasitic adaptations in helminths; Evolutionary significance of Ctenophora	10
Unit3: Coelomate Invertebrates	8
General characteristics and Classification of major phyla uptoclass; Evolution of Coelom; Metamerism in Annelida; Characteristics and affinities of *Peripatus*	
Unit 4: Arthropoda and Mollusca	12
Arthropoda: Digestive, Circulatory and Respiratory systems (with reference to *Periplaneta*); Compound eyes; Metamorphosis in insects. Mollusca: Torsion and detorsion in Gastropoda; Evolutionary significance of Trocophore larva; Pearl formation	7
Unit 5: Echinodermata	
Water vascular system in Asteroidea; Larval forms; Affinities with Chordates	

Note: Classification to be followed from —Ruppert and Barnes (2006) *Invertebrate Zoology,* 8th edition, Holt Saunders International Edition.

MJZO01: BIOLOGY OF NON-CHORDATES [PRACTICAL](1 Credit; 25 Marks)

1. Study of whole mounts of *Euglena, Amoeba, Paramecium;* Conjugation in *Paramecium; Sycon* (T.S. and L.S.); Study of the specimens of *Spongilla, Obelia, Physalia, Aurelia, Metridium, Pennatula, Fasciola hepatica, Taenia solium and Ascaris lumbricoides*
2. Study of the following specimens of:
   Annelida - *Aphrodite,Neanthes,*Heteronereis stage*, Pheretima,Hirudinaria*
   Arthropoda -*Limulus,Palaemon,Balanus,Eupagurus, Scolopendra,*Onychophora– *Peripatus*
   Mollusca-*Chiton,Pila,Doris,Pinctada,Sepia,Loligo, Octopus*
   Echinodermata -*Asterias,Ophiura,Echinus,Cucumaria, Antedon*
3. Study of digestive system and septal nephridia of earthworm.
4. Study of mouth parts, dissection of digestive system and nervous system of Cockroach/Prawn.
5. Submission of a Project Report on field visit.

Suggested Readings:

- Ruppert and Barnes, R.D. (2006). *Invertebrate Zoology,* VIII Edition. Holt Saunders International Edition.
- Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2002). *The Invertebrates: A New Synthesis,* III Edition, Blackwell Science.
- Barrington, E.J.W. (1979). *Invertebrate Structure and Functions.* II Edition, E.L.B.S

MJZO02: PRINCIPLES OF ECOLOGY (4 Credits; 100 Marks)

About the Course:The course will enlighten the students about the interactions between species and their environments. It highlights the important ecological aspects of growth and survival of populations and communities in different habitats, energy flow in the ecosystems, interactions between the communities, exclusion of niches and consequences of changing environment on the biodiversity.

Prelude for IKS-The principles of ecology in wildlife management are deeply interwoven with India's traditional knowledge systems—through sacred values, community oversight, and sustainable ecosystem stewardship that align with modern ecological science

Learning Outcomes: After successful completion of this course, the students will be able to

- Understand the evolutionary and functional basis of animal ecology;
- Learn the scientific study of animal ecology as an exciting endeavor;
- Know about the important aspects of populations, communities and ecosystems;
- Engage in field-based research activities to learn techniques of collecting data in the field.

MJZO02: PRINCIPLES OF ECOLOGY [THEORY](3 Credits; 75 Marks)

No. of lectures

Unit1: IntroductiontoEcology

History of ecology, Autecology and Synecology, Levels of organization, Laws of limiting factors — 6

Unit2: Population

Unitary and Modular populations; Uniqueandgroupattributesofpopulation: Density, natality, mortality, life tables, fecundity tables, survivorship curves, age ratio, sex ratio, dispersal and dispersion; Exponential and logistic growth, equation and patterns, r and K strategies; Population regulation-density-dependent and independent factors. Population interactions
Gause'sPrinciple,Lotka-VolterraequationforcompetitionandPredation — 14

Unit3:Community

Communitycharacteristics:speciesrichness,dominance,diversity,abundance,vertical stratification, Ecotone and Edge effect; Ecological succession, Climax community — 10

Unit4:Ecosystem

Types of Food chains and Food web; Energy flow through ecosystem,Ecological pyramids and Ecological efficiencies; Nitrogen cycle; Carbon cycle — 10

Unit5:AppliedEcology

Principles of ecology, Wildlife Management, Indian traditional knowledge system and advancements — 5

MJZO02: PRINCIPLES OF ECOLOGY [PRACTICAL] (1 Credit; 25 Marks)

1. Study of life-tables and plotting of survivorship curves of different types from the hypothetical/realdata provided.
2. Determination of population density in a natural/hypothetical community by quadrate method and calculation of Shannon-Wiener diversity index for the same community.
3. Study of an aquatic ecosystem: Phytoplankton and Zooplankton, Measurement of area, temperature,

turbidity/penetration of light, determination of pH, and Dissolved Oxygen content (Winkler's method), Chemical Oxygen Demand and free CO_2.

Suggested Readings:

- Gottelli, N.J. (1995). A Primer of Ecology. Sinauer Associates, Inc. Sunderland, Massachusetts
- Rockwood L.L. (2014). Introduction to Population Ecology. Willey Blackwell.
- Krebs, C.J. (2016). Ecology: The Experimental Analysis of Distribution and Abundance. Pearson Education Limited.
- Hutchinson, G.E. (1979). An Introduction to Population Ecology. Yale University Press.

DISCIPLINE-SPECIFIC MAJOR (CORE) COURSES IN ZOOLOGY

SEMESTER - II

MJZO03: DIVERSITY OF CHORDATES (4 Credits; 100 Marks)

About the Course: The course provides detailed information of the amazing diversity of Chordates from proto-chordates to mammals. It enlightens how each group of chordates arose in the course of evolution and how did they establish themselves in the environment with their special characteristics. It also deals with the differences and similarities between organisms of different groups and discusses their unique features.

Learning Outcomes: After successful completion of this course, the students will be able to

- **Develop an understanding of the diversity of life with regard to protochordates and chordates;**
- **Group animals on the basis of their morphological characteristics/structural features;**
- **Understand how morphological changes occurring due to changes in environment can drive evolution.**

MJZO03: DIVERSITY OF CHORDATES [THEORY] (3 Credits; 75 Marks)

	No. of lectures
Unit 1:Introduction to Chordates General characteristics and outline classification; Dipleurula concept and the Echinoderm theory of origin of chordates	5
Unit 2: Protochordata General characteristics of Hemichordata; Urochordata and Cephalochordata; Filter feeding; Retrogressive metamorphosis in Urochordata	4
Unit 3: Agnatha andPisces General characteristics and classification of Cyclostomata up to order; Comparative morpho-anatomy of *Petromyzon*and*Myxine* General characteristics and classification of Pisces up to subclass; Digestive, Respiratory and Reproductive systems in fish; characteristics and affinities of Dipnoi.	10
Unit 4: Amphibia Origin of Tetrapoda (Evolution of terrestrial ectotherms); General characteristics and Classification up to order; Parental care in Amphibia; Neoteny and Paedogenesis	6
Unit 5: Reptilia and Aves General characteristics and Classification of Reptilia up to order; Reptilian skull; Affinities of *Sphenodon;* Poison apparatus and Biting mechanism in snakes. General characteristics and Classification of Aves up to order; *Archaeopteryx*-- a connecting link; Principles and aerodynamics of flight, Flight adaptations and Migration in birds	10
Unit-6: Mammalia	10

General characteristic and classification upto order; Affinities of Prototheria; Distinctive characters of Cetacea, Sirenia, Carnivora and Primates; Ecolocation in Bat and Sirenia; Adaptive radiation in marsupials; Dentition in mammals.

MJZO03: DIVERSITY OF CHORDATES [PRACTICAL] (1 Credit; 25 Marks)

1. Study of the following specimens:
   Protochordata: *Balanoglossus, Ascidia, Salpa, Doliolum, Branchiostoma*
   Agnatha: *Petromyzon, Myxine*
   Fishes: *Scoliodon, Pristis, Torpedo, Mystus, Heteropneustes, Labeo, Exocoetus, Echeneis, Hippocampus, Tetrodon/ Diodon, Anabas, Cyanoglossus*
   Amphibia:*Ichthyophis/Ureotyphlus, Necturus, Bufo, Hyla, Alytes, Tylototriton,*
   Reptilia:*Chelone, Trionyx, Hemidactylus, Varanus, Uromastix, Chamaeleon,Draco, Bungarus, Vipera, Naja, Hydrophis, Crocodylus*
   Aves: *Corvus*, *Psittacula*, *Bubo*, *Gallus*, *Columba*, *Pycnonotus*; Types of beaks, claws and feathers
   Mammalia: Bat (Insectivorous and Frugivorous), *Funambulus, Loris.*
2. Mount of Weberian ossicles of carp; pecten from fowl head
   Note: Classification from Young, J.Z. (2004) to be followed

Suggested Readings:

- Young, J. Z. (2004). The Life of Vertebrates. III Edition. Oxford University Press.
- Pough H. Vertebrate life, VIII Edition, Pearson International.
- Darlington P.J. The Geographical Distribution of Animals, R.E. Krieger Pub Co.
- Hall B.K. and Hallgrimsson B. (2008). Strickberger's Evolution. IV Edition. Jones and Bartlett Publishers Inc.

MJZO04: CELL BIOLOGY (4 Credits; 100 Marks)

About the Course:The course provides a detailed insight into the basic concepts of cellular structure and function. It also gives an account of the complex regulatory mechanisms that control cell function.

Learning Outcomes:After successfulcompletion of this course, the students will be able to

- **Learn different types of cells, microorganisms and viruses;**
- **Understand the functioning of nucleus and extra-nuclear organelles;**
- **Acquire knowledge of different pathways related to cell signaling and apoptosis, regulation of cell division and cell cycle, thus enabling them to understand the anomalies in cancer;**
- **Develop an understanding of cell as the fundamental structural and functional unit**

MJZO04: CELL BIOLOGY [THEORY] (3 Credits; 75 Marks)

No. of lectures

Unit 1:Overview of cells 3

Prokaryotic and Eukaryotic cells, Virus, Viroids, Mycoplasma

Unit 2:Plasma Membrane 8

Various models of plasma membrane structure,
Transport across membranes: Active and Passive transport, Facilitated transport; Cell junctions: Tight junctions, Desmosomes, Gap junctions

Unit3:EndomembraneSystem 8

Structure and Functions: Endoplasmic Reticulum, Golgi Apparatus,Lysosomes

Unit4:MitochondriaandPeroxisomes Structure and Functions of Mitochondria; Semi-autonomous nature, Endosymbiotic hypothesis; Basic idea of Mitochondrial Respiratory Chain; Structure and Functions of Peroxisomes	6
Unit5:Cytoskeleton Structure and Functions: Microtubules, Microfilaments and Intermediate filaments	4
Unit6:Nucleus Structure of Nucleus: Nuclear envelope, Nuclear pore complex, Nucleolus, Chromatin: Euchromatin and Heterochromatin; Nucleosome	6
Unit7:CellDivision Mitosis, Meiosis, Cell cycle and its regulation	6
Unit8:CellSignaling GPCRs and Role of second messenger(cAMP)	4

MJZO04: CELL BIOLOGY [PRACTICAL] (1 Credit; 25 Marks)

1. Preparation of temporary stained squash of onion root tip to study various stages of mitosis.
2. Study of the various stages of meiosis.
3. Preparation of permanent slide to show the presence of Barr body in human female blood cells/cheek cells.

Suggested Readings:

- Karp, G. (2010). *Cell and Molecular Biology: Concepts and Experiments.* VI Edition.John Wiley and Sons. Inc.
- De Robertis, E.D.P. and De Robertis, E.M.F. (2006). *Cell and Molecular Biology.* VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
- Cooper, G.M. and Hausman, R.E. (2009). *The Cell: A Molecular Approach.* V Edition. ASM Press and Sunderland, Washington, D.C.; Sinauer Associates, MA.
- Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). *The World of the Cell.* VIIEdition. Pearson Benjamin Cummings Publishing, San Francisco.
- Bruce Albert, Bray Dennis, Levis Julian, Raff Martin, Roberts Keith and Watson James (2008). *Molecular Biology of the Cell,* V Edition, Garland publishing Inc., New York and London.

MINOR COURSES IN ZOOLOGY

SEMESTER – I/II

MNZO01: ANIMAL DIVERSITY (4 Credits; 100 Marks)

About the Course:The course highlights the amazing diversity of living forms from simple to complex one. It enlightens about the differences and similarities of the varied organisms on the basis of their morphology and anatomy which led to their grouping into taxa and clades.

Learning Outcomes: After successful completion of this course, the students will be able to

- Appreciate the amazing diversity of life forms with regard to protists, non-chordates and chordates;
- Group animals on the basis of their morphological characteristics/ structures;
- Understand how the simple organisms have evolved into complex multicellular forms.

MNZO01: ANIMAL DIVERSITY [THEORY] (3 Credits; 75 Marks)

	No. of lectures of lectures	
Unit1: Protozoa General characteristics and Classification up to sub-phyla (according to Lavine); Locomotion in Protozoa.	4	5
Unit 2: Acoelomate and Pseudocoelomates General characteristics and Scheme of classification of the Phyla Porifera, Cnidaria, Ctenophora, Platyheminthes and Nemathelminthes up to class; Canal system in Porifera; Polymorphism in Cnidaria; Parasitic adaptations in helminths	8 12	4 4 4
Unit 3: Coelomate Invertebrates General characteristics and Scheme of classification of the phyla Annelida, Onychophora, Arthropoda, Mollusca and Echinodermata up to class; Metamerism in Annelids; Respiratory systems in Arthropods; Social life in insects; Torsion in Gastropods; Water-vascular system in Starfish		
Unit 4: Protochordata Salient features and Classification up to sub-phyla; Retrogressive metamorphosis in *Ascidia*	5	
Unit 5: Agnatha and Pisces General characteristics of Cyclostomes and Pisces; Classification of Pisces upto Subclass; Gill respiration.	4	
Unit 6: Amphibia and Reptilia General characteristics and Classification upto order; Adaptations for terrestrial life; Parental carein Amphibia; Biting mechanism of snakes	6	
Unit 7: Aves and Mammalia General characteristics of Aves and Distinctive features upto superorder; Flight adaptations in birds; Migration of birds; General characteristics and classification of Mammalia upto order; Echolocation in bat	6	

MNZO01: ANIMAL DIVERSITY [PRACTICAL] (1 Credit; 25 Marks)

1. Study of the following specimens of:
   Non-chordates: Whole mounts of *Euglena and Paramecium; Sycon* (T.S. and L.S.); *Physalia, Metridium, Taenia solium, Ascaris lumbricoides, Aphrodite, Neanthes,* Heteronereis stage, Leech,Hermit crab, Millipede, Centipede, Beetle,*Chiton*, *Octopus*, *Asteria*
   Chordates: *Balanoglossus*,*Branchiostama*, *Petromyzon, Pristis, Hippocampus, Labeo, Ichthyophis/Ureotyphlus, Salamander, Rhacophorus, Draco, Naja,* Viper, *Corvus*, *Bubo*, *Psittacula*,

Funambulus, Microchiroptera.

2. Preparation of temporary mounts of:Placoid, cycloid and ctenoid scales
3. Study of the following mouthparts ofPrawn, *Anopheles/Culex*, *Periplaneta*

Suggested Readings:

- Ruppert and Barnes, R.D. (2006). *Invertebrate Zoology,* VIII Edition. Holt Saunders International Edition.
- Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2002). *The Invertebrates: A New Synthesis,* III Edition, Blackwell Science.
- Young, J. Z. (2004). The Life of Vertebrates. III Edition. Oxford University Press.
- Pough H. Vertebrate life, VIII Edition, Pearson International.
- Campbell&Reece(2005).Biology,PearsonEducation,(Singapore)Pvt.Ltd.
- Kardong, K. V. (2002). Vertebrates Comparative Anatomy. Function and Evolution. TataMcGrawHillPublishingCompany, NewDelhi.
- Raven,P.H.andJohnson,G.B.(2004).Biology,6th edition,TataMcGrawHillPublications, NewDelhi.

DISCIPLINE-SPECIFIC SKILL ENHANCEMENT COURSES IN ZOOLOGY

SEMESTER - I

SEZO01: SERICULTURE ANDAPICULTURE (3 Credits; 75 Marks)

About the Course:The course provides an insight into the principles of sustainable sericulture and apiculture, and how these principles can guide silk moth rearing and bee-keeping into enduring practices.

Prelude for IKS- Sericulture (silk production)**and** Apiculture (beekeeping) **in line with** India's traditional knowledge systems**, blending ancient heritage, community practices, livelihoods, ecological wisdom and economic importance.**

Learning Outcomes: After successful completion of this course, the students will be able to

- Know the technical aspects of sericulture and apiculture practices;
- Acquire skill and requisite expertise in these fields that might provide employment opportunities;
- Gain exposure from field visits to sericulture and apiculture centres;
- Develop entrepreneurship skills.

SEZO01: SERICULTURE AND APICULTURE [THEORY] (2 Credits; 50 Marks)

No. of lectures

Unit 1: Introduction to Sericulture & Biology of Silkworm

History of sericulture in Indian traditional knowledge system; Present status in India — 4

Types of silk worms; Life cycle of *Bombyx mori*; Structure of silk gland; Secretion of silk

Unit 2: Rearing of Silkworms — 8

Selection of mulberry variety and establishment of mulberry garden; Rearing house and rearing appliances; Silkworm rearing technology: Early age and Late age rearing; Types of mountages; Selection of cocoons; Spinning, harvesting and storage of cocoons

Unit 3: Introduction to Apiculture & Biology of Bees

Legacy of bee rearing in ancient India; Present status in India — 4

Types of honey bees; Social organization of bee colony

Unit 4: Rearing of Bees — 8

Artificial bee rearing (Apiary); Beehives – Newton and Langstroth; Bee pasturage; Bee keeping equipment; Methods of extraction of honey (Indigenous and Modern)

Unit 5: Pests and Diseases

Pests of silkworm: Uzi fly, dermestid beetles and vertebrates; Pathogenesis of silkworm diseases: Protozoan, viral, fungal and bacterial; Control and prevention of pests and diseases; — 6

Bee diseases and enemies; Control and preventive measures

NSQF Ref:NCO 6123.0101; NCO 6123.0201; NCO 6123.9900

SEZO01: SERICULTURE AND APICULTURE [EXPERIENTIAL LEARNING] (1 Credit; 25 Marks)

Prelude for IKS- Here's how experimental work in sericulture and apiculture ties into India's traditional knowledge systems—blending indigenous wisdom with scientific research to enhance productivity, conservation, and livelihoods.

1. Knowledge of prospects of Sericulture in India; employment potential in sericulture.
2. Knowledge of Bee Keeping Industry – Recent Efforts, Modern Methods in employing artificial Beehives for cross pollination in horticultural gardens.
3. Developingtechnical know-how and entrepreneurship skills.
4. Visits to sericulture/apiculture units; Submission of Field Reports.

Suggested Readings:

- Handbook of Practical Sericulture: S.R. Ullal and M.N. Narasimhanna CSB,Bangalore.
- Appropriate Sericultural Techniques; Ed. M. S. Jolly, Director, CSR & TI, Mysore.
- Bisht D.S., Apiculture, ICAR Publication.
- Singh S., Beekeeping in India, Indian Council of Agricultural Research, NewDelhi.

DISCIPLINE-SPECIFIC SKILL ENHANCEMENT COURSES IN ZOOLOGY

SEMESTER - II

SEZO02: LABORATORY TECHNIQUES AND INSTRUMENTATION (3 Credits; 75 Marks)

About the Course:The course provides an insight into the basic laboratory practices and techniques. It also includes principles and applications of some commonly used laboratory instruments.

Learning Outcomes: After successful completion of this course, the students will be able to

- Know the technical aspects of standard laboratory practices;
- Acquire skill and requisite expertise in basic laboratory techniques and instrumentation that might provide employment opportunities;
- Gain exposure from research laboratory visits.

SEZO02: LABORATORY TECHNIQUES AND INSTRUMENTATION [THEORY] (2 Credits; 50 Marks)

	No. of lectures
Unit 1: Sterilization Practices and Preparation of Laboratory Reagents Different laboratory sterilization processes; Weighing balance; Concept of molarity, molality and normality; Preparation of solutions (percentage, molar, normal); Concept of pH; Preparation of buffers (acidic, basic, neutral)	6
Unit 2: Centrifugation Introduction, Basic principle of sedimentation, different types of centrifugation processes (preparatory and analytical), Safety aspects of centrifuges	6
Unit 3: Microscopy Introduction and instrumentation of light microscope, Maintenance of microscopes	4
Unit 4: Spectrophotometry Concept of electromagnetic spectrum, Principle, Instrumentation and applications of UV-VIS Spectrophotometry	6
Unit 5: Chromatography Principle of chromatography, Adsorption and Partition Chromatography, Paper and Thin Layer Chromatography, Molecular (size) exclusion chromatography	8

NSQF Ref: NCO 3141.0100

SEZO02: LABORATORY TECHNIQUES ANDINSTRUMENTATION[EXPERIENTIAL LEARNING] (1 Credit; 25 Marks)

1. Sterilization of different laboratory glasswares and plastic wares; Pipetting.

2. Visualization of stained and unstained specimen under light microscope.
3. Preparation of buffer and adjustment of pH.
4. Use of centrifuge for sample preparation.
5. Estimation of samples using UV-VIS Spectrophotometer.
6. Visit to research laboratory; Submission of Report.

Suggested Readings:

- Principles and Techniques of Biochemistry and Molecular Biology by Wilson andWalkers.
- Biochemistry Laboratory: Modern Theory and Techniques by Rodney F. Boyer.
- Biophysical Chemistry: Principles and Techniques by Upadhyay, Nath.

MULTIDISCIPLINARY COURSE IN ZOOLOGY

SEMESTER –I/II

MDZO01: APPLIED ZOOLOGY (3 Credits; 75 Marks)

About the Course:The course aims to impart knowledge on the economical, ecological, and medical importance of different animals and on their rearing or control techniques for the welfare of human.

Prelude for IKS- Apiculture**,** Sericulture**,** Insect Pest & Vector Management**,** Aquaculture**,** Biodiversity**, and** Wildlife Management **each embody Indigenous Knowledge Systems (IKS) in India**

Learning Outcomes:After successful completion of this course, the students will be able to

- **Learn the economically important techniques of apiculture, sericulture, aquaculture;**
- **Become aware about the insect pests and vectors and their control methods;**
- **Know the causative agents and management of parasitic diseases;**
- **Understand the importance of biodiversity and wildlife management.**

MDZO01: APPLIED ZOOLOGY [THEORY] (3 Credits; 75 Marks)

No. of lectures

Unit 1: Apiculture and Sericulture — 10

Apiculture: Common species of honey of bees, Colony and social organization, structure and composition of hive, rearing methods and economic importance; Traditional Indigenous hive designs and seasonal sustainable honey-harvesting protocols with reference to IKS.

Sericulture: Culturable silkworms in India, rearing methods, silkworm diseases and their control, economic importance; Indigenous host-plant knowledge and traditional rearing of wild silks (eri, muga, tasar) as in local IKS-driven silk traditions.

Unit 2: Insect Pest Management — 8

Common insect pests; Types of pesticides; Pest control methods (natural, chemical and biological controls); Integrated pest management. Traditional techniques—using botanical repellents, crop-rotation timing, biological controls, and pest-life-cycle disruption

Unit 3: Insect Vectors and Parasitic Diseases — 9

Common insect vectors (mosquitoes, Sand fly and Tse-Tse fly); Vector control methods; Causative agents, clinical symptoms, prevention and control measures of Malaria, Leishmaniasis, Amoebiasis, and Filariasis

Unit 4: Aquaculture — 8

Important cultivable fishes and prawns; Composite fish culture, pearl culture and prawn farming; Induced breeding techniques in fish**;** Traditional IKS integrated wetland systems—such as rice–fish and community-managed fish ponds.

Unit 5: Biodiversity and Wildlife Management — 10

Basic idea on biodiversity, biodiversity hotspot; species richness, Sorensen's index and Shannon-Wiener index. Wildlife: value of wild life;human-animal conflicts; Causes of depletion; Importance of conservation; Wildlife management; *in situ* and *ex situ* conservation strategies; Traditional practices like sacred groves and community forest guardianship—supported by legal frameworks such as the Biological Diversity Act and community reserves

Suggested Readings:

- Jhingran, V. G. (2002). Fish and Fisheries of India. Hindustan Publishing Corporation, Delhi, India.
- Kumar, A., Desmukh, N. Z., Kumar, D., and Goswami, R. (2020). Applied and Economic Zoology. Daya Publishing House.
- Mathur, R. (2019). Wildlife Conservation and Management. Rastogi Publications, Meerut, India.
- Upadhyay, V. B., Shukla, G. S. (2014). Applied and Economic Zoology. Rastogi Publications, Meerut, India.
- Winter, M. (2016). Wildlife Biology. Syrawood Publishing House

OUTLINE OF THE 2ND YEAR COURSES FORDIPLOMA IN ZOOLOGY

[2ndYEAR OF FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUP) UNDER NEP 2020]

SEMESTERS	MAJOR CORE COURSES	MINOR COURSES	MULTI COURSES	AECC	SECZ	INTERN-SHIP	TOTAL CREDITS
III	**MJZO05 (4 credits)** [Comparative Anatomy of Vertebrates] **MJZO06 (4 credits)** [Principles of Genetics]	**MNZO02 (4 credits)** [Insect Vectors and Diseases]	**MDZO01 (3 credits)**	**ENG-1 (2 credits)**	**SEZO03 (3 credits)** [Wildlife Conservation and Management]	**Vocational Summer Internship (4 credits)**	**20**
IV	**MJZO07 (4 credits)** [Fundamentals of Biochemistry] **MJZO08 (4 credits)** [Physiology: Animal Tissues and Coordinating Systems] **MJZO09 (4 credits)** [Molecular Biology] **MJZO10 (4 credits)** [Fish Biology and Fisheries]	**MNZO02 (4 credits)** [Insect Vectors and Diseases]	---	**ENG-2 (2 credits)**	---		**22**
YEAR –2	**6x4= 24cr**	**2x4=8 cr**	**1x3= 3 cr**	**2x2 = 4 cr**	**1x3= 3 cr**	**1x4=4cr**	**42 (+4)**

[After successful completion of TWO-YEAR Course (Semesters - I to IV) securing 88 Credits plus 4 Credits Vocational Summer Internship, students may exit with B.Sc. Diploma in Zoology or continue further.]

Note: *The students can opt for the Minor Course* ***MNZO02 only once in a year****.*
The students cannot opt for same Paper code twice.

DISCIPLINE-SPECIFIC CORE COURSES

SEMESTER - III

MJZO05: COMPARATIVE ANATOMY OF VERTEBRATES [THEORY] (3 Credits; 75 Marks)

About the Course:The course offers insight into the comparative account of chordates anatomy with respect to their functional adaptation in diverse habitats. This course also explores evolution of different organ systems through vertebrate series.

Learning Outcomes: After successfully completing this course, the students will be able to

- Develop an understanding of the evolution of vertebrates thus integrating structure, function and development.
- Have an overview of the evolutionary concepts.
- Understand comparisons of major organ systems in vertebrates.
- Study skeleton of representative types, and know the skeletal modifications.

	No. of lectures
Unit 1: Integumentary System Structure, functions and derivatives of integument	3
Unit 2: Skeletal System Overview of skull and Jaw suspensorium, Visceral arches	4
Unit 3: Digestive System Alimentary canal and associated glands, dentition	4
Unit 4: Respiratory System Skin, gills, lungs and air sacs; Accessory respiratory organs	6
Unit 5: Circulatory System General plan of circulation, evolution of heart and aortic arches	6
Unit 6: Urinogenital System Succession of kidney, Evolution of urinogenital ducts, Types of mammalian uteri	6
Unit 7: Nervous System Comparative account of brain, Autonomic nervous system, Cranial nerves in mammals	8
Unit 8: Sense Organs Classification of receptors, Brief account of visual and auditory receptors	8

MJZO05: COMPARATIVE ANATOMY OF VERTEBRATES [PRACTICAL] (1 Credit; 25 Marks)

1. Study of placoid, cycloid and ctenoid scales.
2. DisarticulatedskeletonofFrog,*Varanus,*Fowl,Rabbit.
3. Mammalianskulls:Oneherbivorousandonecarnivorousanimal
4. Dissection and display of afferent and efferent arterial system, IX and X cranial nerves in fish

5. Project on skeletal modifications in vertebrates (if dissection is not permitted)

Suggested Readings:

- Kardong, K.V. (2005) *Vertebrates' Comparative Anatomy, Function andEvolution.*IVEdition.McGraw-HillHigher Education.
- Kent, G.C. and Carr R.K. (2000). *ComparativeAnatomy of the Vertebrates.* IXEdition.The McGraw-HillCompanies.
- Hilderbrand, M and Gaslow G.E. *Analysis of Vertebrate Structure,* John Wiley andSons.
- Walter,H.E. andSayles,L.P.;*BiologyofVertebrates,* KhoslaPublishingHouse.

MJZO06: PRINCIPLES OF GENETICS (4 Credits; 100 Marks)

About the Course:The course is designed to revise basic concepts of Genetics and then move on to advanced concepts. Some key aspects include the mechanism of inheritance, gene structure and function, sex chromosomal and autosomal anomalies, aspects of human genetics, etc. will be covered.

Learning Outcomes: After successfully completing this course, the students will be able to

- Apply the principles of Mendelian inheritance.
- Understand the cause and effects of alterations in chromosome number and structure.
- Learn about extra-chromosomal inheritance and polygenic inheritance.
- Know human karyotype and perform pedigree analyses.

MJZO06: PRINCIPLES OF GENETICS [THEORY] (3 Credits; 75 Marks)

	No. of lectures
Unit 1: Mendelian Genetics and its Extension Principles of inheritance, Incomplete dominance and co-dominance, Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Sex-linked, sex- influenced and sex-limited characters inheritance.	6
Unit 2: Linkage, Crossing Over and Chromosomal Mapping Linkage and crossing over, Cytological basis of crossing over, Molecular mechanisms of crossing over including models of recombination, Recombination frequency as a measure of linkage intensity, Two factor and three factor crosses, Interference and coincidence, Somatic cell hybridization.	6
6Unit 3: Mutations Types of gene mutations (Classification), Types of chromosomal aberrations (Classification, figures and with one suitable example of each), Molecular basis of mutations in relation to UV light and chemical mutagens; Detection of mutations: CLB method, attached *X* method.	8 4
Unit 4: Sex determination Chromosomal mechanisms of sex determination in Drosophila and Man	
Unit 5: Extra-chromosomal Inheritance Criteria for extra-chromosomal inheritance, Antibiotic resistance in *Chlamydomonas,* Mitochondrial mutations in *Saccharomyces,* Infective heredity in *Paramecium* and Maternal effects.	10

Unit 6: Polygenic Inheritance 6

Polygenic inheritance with suitable examples; simple numericals based on it.

Unit 7:Recombination in Bacteria and Viruses 6

Conjugation, Transformation, Transduction, Complementation test in Bacteriophage

MJZO06: PRINCIPLES OF GENETICS [PRACTICAL] (1 Credit; 25 Marks)

1. Chi-square analyses using seeds/beads/Drosophila.
2. Study of human karyotype (normal and abnormal).
3. Pedigree analysis of some human inherited traits.

Suggested Readings:

- Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). *Principles of Genetics.* VIII Edition. Wiley India.
- Snustad, D.P., Simmons, M.J. (2009). *Principles of Genetics.* V Edition. John Wiley and Sons Inc.
- Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). *Concepts of Genetics.* X Edition. Benjamin Cummings.
- Russell, P. J. (2009). *Genetics- A Molecular Approach.III*Edition. Benjamin Cummings.
- Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B.*Introduction to Genetic Analysis.* IX Edition. W. H. Freeman and Co.
- Fletcher H. and Hickey I. (2015). *Genetics.* IV Edition. GS, Taylor and Francis Group, New York and London.

DISCIPLINE-SPECIFIC CORE COURSES

SEMESTER - IV

MJZO07: FUNDAMENTALS OF BIOCHEMISTRY (4 Credits; 100 Marks)

About the Course:The course provides an introduction to the structure of biomolecules with emphasis on the techniques used for structure determination and analysis. The course covers basic aspects of sample preparation for analysis and aims to enlighten the students how structural information can be utilized for better understanding of biological processes.

Learning Outcomes: After successfully completing this course, the students will be able to

- Understand the importance and scope of biochemistry.
- Know the structure and biological significance of carbohydrates, proteins, lipids and nucleic acids.
- Learn about enzymes, the mechanism of catalysis, and enzyme kinetics.
- Perform biochemical tests for identification of sugars and amino acids.

MJZO07: FUNDAMENTALS OF BIOCHEMISTRY [THEORY] (3 Credits; 75 Marks)

	No. of lectures
Unit 1: Basic concepts Concept of pH and buffers; Biological buffer systems; Water as biological solvent	4
Unit 2: Carbohydrates Structure and significance: Monosaccharides, Disaccharides,Polysaccharides, Glycoconjugates, Reducing sugars	8
Unit 3: Lipids Structure and significance: Saturated and unsaturated fatty acids, Triacylglycerols, Phospholipids, Steroids	6
Unit 4: Proteins Structure, Classification and General properties of α-amino acids; Concept of pKa and pI; Titration curve of Glycine; Bonds stabilizing protein structure; Levels of organization in proteins; Denaturation of proteins; Introduction to simple and conjugate proteins	8
Unit 5: Nucleic Acids Structure of purines and pyrimidines, Nucleosides, Nucleotides; Nucleic acids: Types of DNA and RNA; Double helical structure of DNA; Structure of tRNA; Denaturation and Renaturation of DNA; Hypo- and Hyperchromicity of DNA	9
Unit 6: Enzymes Nomenclature and classification; Cofactors; Specificity of enzyme action; Isozymes; Mechanism of enzyme action; Enzyme kinetics; Factors affecting rate of enzyme-catalyzed reactions; Derivation of Michaelis-Menten equation, Concept of Km and Vmax, Lineweaver-Burk plot; Multi-substrate reactions; Enzyme inhibition	10

MJZO07: FUNDAMENTALS OF BIOCHEMISTRY [PRACTICAL](1 Credit; 25 Marks)

1. Qualitative tests of carbohydrates
2. Estimation of Hyperchromic or Hypochromic effect in DNA sample.
3. Biuret and Ninhydrin test of amino acids.
4. Demonstration of Paper chromatography of amino acids.
5. Quantitative estimation of Protein using Lowry's method.

6. Action of salivary amylase under optimum conditions, and effect of pH, temperature on enzyme activity.

Suggested Readings:

- Cox, M.M and Nelson, D.L. (2008). *Lehninger's Principles of Biochemistry,* V Edition, W.H. Freeman and Co., New York.
- Berg, J.M., Tymoczko, J.L. and Stryer, L. (2007). *Biochemistry,* VI Edition,W.H. Freeman and Co., New York.
- Murray, R.K., Bender, D.A., Botham, K.M., Kennelly, P.J., Rodwell, V.W. and Well, P.A. (2009). *Harper's Illustrated Biochemistry,* XXVIII Edition, International Edition, The McGraw- Hill Companies Inc.
- Hames, B.D. and Hooper, N.M. (2000). *Instant Notes in Biochemistry,* II Edition, BIOS Scientific Publishers Ltd., U.K.
- Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R. (2008). *Molecular Biology of the Gene,* VI Edition, Cold Spring Harbor Lab. Press, Pearson Pub.

MJZO08: ANIMAL TISSUES AND COORDINATING SYSTEMS (4 Credits; 100 Marks)

About the Course:The course provides an insight into the structure and function of organ systems in humans and their involvement in body metabolism towards maintenance of homeostasis.

Learning Outcomes: After successfully completing this course, the students will be able to

- Know the different types of tissues in detail
- Understand the mechanisms of neurotransmissionand muscle contraction
- Learn the reproductive physiology in males and females
- Know different endocrine glands, their secretions andhormonal disorders.

MJZO08: ANIMAL TISSUES AND COORDINATING SYSTEMS [THEORY] (3 Credits; 75 Marks)

	No. of lectures
Unit 1: Tissues Structure, location, classification and functions of epithelial tissue, connective tissue, muscular tissue and nervous tissue	6
Unit 2: Bone and Cartilage Structure and types of bones and cartilages	4
Unit 3: Nervous System Structure of neuron, autonomic and sympathetic nervous system; resting membrane potential, Origin of action potential and its propagation across the myelinated and unmyelinated nerve fibers; Types of synapse, Synaptic transmission	8
Unit 4: Muscle Histology of different types of muscle; Ultrastructure of skeletal muscle; Molecular and chemical basis of muscle contraction	8
Unit 5: Reproductive System Histology of testis and ovary; Physiology of male and female reproduction; Puberty	9
Unit 6: Endocrine System Histology of endocrine glands - pineal, pituitary, thyroid, parathyroid, pancreas, adrenal and the hormones secreted by these glands; Classification of hormones	10

MJZO08: ANIMAL TISSUES AND COORDINATING SYSTEMS [PRACTICAL] (1 Credit; 25 Marks)

1. Demonstration of the unconditioned reflex action (Deep tendon reflex such as knee jerk reflex).
2. Preparation of temporary mounts: Squamous epithelium,Striated muscle fibresand nerve cells.
3. Study of permanent slides of Mammalian skin, Cartilage, Bone, Spinal cord, Nerve cell, Pituitary, Pancreas, Testis, Ovary, Adrenal, Thyroid and Parathyroid.
4. Microtomy: Preparation of permanent slides

Suggested Readings:

- Guyton,A.C.&Hall,J.E.(2006).TextbookofMedicalPhysiology.XIEdition.HercourtAsiaPTELtd. /W.B.Saunders Company.
- Tortora,G.J.&Grabowski,S.(2006).Principles of Anatomy&Physiology.XIEdition JohnWiley& Sons.
- Victor P. Eroschenko. (2008). DiFiore's Atlas of Histology with Functional correlations. XIIEdition.Lippincott W. &Wilkins.

MJZO09: MOLECULAR BIOLOGY (4 Credits; 100 Marks)

About the Course:The course provides an insight into the life processes at the molecular levels. The course also covers the fundamental aspects of regulation of gene expression in prokaryotes and eukaryotes.

Learning Outcomes: After successfully completing this course, the students will be able to

- Develop concepts of genes and how genes are expressed.
- Learn the mechanisms of replication, transcription and translation in prokaryotes and eukaryotes.
- Know the differences between prokaryotic and eukaryotic regulation of gene expression.
- Perform the techniques of quantification of DNA and RNA.

MJZO09: MOLECULAR BIOLOGY [THEORY] (3 Credits; 75 Marks)

No. of lectures

Unit 1: DNA Replication — 8

DNA Replication in prokaryotes and eukaryotes; Semi-conservative, bidirectional and semi-discontinuous replication, RNA priming. Replication of circular and linear ds-DNA, Replication of telomeres

Unit 2: Transcription — 8

RNA polymerase, Promoter and Mechanism of transcription in prokaryotes;

RNA polymerases, Promoter elements, Enhancers, Transcription factors in eukaryotes — 8

Unit 3: Post-Transcriptional Modifications and Processing of Eukaryotic RNA

Modifications of eukaryotic RNA; Structure of globin mRNA; Split genes: concept of introns and exons; Splicing mechanism, Alternative splicing, Exon shuffling

Unit 4: Genetic Code — 4

Genetic code and its salient features; Wobble Hypothesis

Unit 5: Translation — 7

Process of translation in prokaryotes: Ribosome structure and assembly, fidelity of protein synthesis, aminoacyl tRNA synthetases and charging of tRNA; Inhibitors of protein synthesis; Difference between prokaryotic and eukaryotic translation

Unit 6: Concept of Genes and Regulation of gene expression — 10

Gene arrangements in prokaryotes; Activators, Repressors, Operon model of transcriptional regulation in prokaryotes with examples of *lac* operon and *trp* operon.

DNA packaging in eukaryotes; Principles of Transcription regulation in eukaryotes: Basic

concept of Chromatin remodeling, Histone modifications

MJZO09: MOLECULAR BIOLOGY [PRACTICAL] (1 Credit; 25 Marks)

1. Quantitative estimation of DNA using Diphenylamine reagent.
2. Quantitative estimation of RNA using Orcinol reaction.
3. Quantitative estimation and purity of DNA/RNA using UV spectrophotometer.
4. Study and interpretation of electron micrographs showing (a) DNA replication (b) Transcription (c) Split genes

Suggested Readings:

- Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). *The Worldof the Cell.* VII Edition. Pearson Benjamin Cummings Publishing, SanFrancisco.
- BruceAlberts,AlexanderJohnson,JulianLewis,MartinRaff,KeithRoberts,Peter Walter:*MolecularBiologyoftheCell,*IVEdition.
- Cooper G. M. and Robert E. Hausman R. E. *The Cell: A Molecular Approach,* VEdition,ASMPressandSinauerAssociates.
- De Robertis, E.D.P. and De Robertis, E.M.F. (2006). *Cell and MolecularBiology.*VIIIEdition.LippincottWilliamsandWilkins,Philadelphia.
- Karp, G. (2010) *Cell and Molecular Biology: Concepts and Experiments.* VIEdition.JohnWileyandSons.Inc.
- LewinB.(2008).*GeneXI,*Jonesand Bartlett

MJZO010: FISH BIOLOGY AND FISHERIES (4 Credits; 100 Marks)

About the Course:This course will give the students an understanding of the principles of fish and fisheries, including production systems, water quality, nutrition, spawning, larval culture and culture methodologies. The course will include an opportunity to conduct hands-on activities related to pisciculture.

Learning Outcomes: After successfully completing this course, the students will be able to

- Learn the classification, morphological features and physiological aspects of fishes.
- Understand the fisheries systems.
- Know the conditioning factors and how they can be manipulated.
- Learn about aquaculture practices.

MJZO010: FISH BIOLOGY AND FISHERIES [THEORY] (3 Credits; 75 Marks)

No. of lectures

Unit 1: Introduction and Classification — 4

Classification based on feeding habit, habitat and manner of reproduction

Unit 2: Morphology and Physiology — 12

Types of fins and their modifications; Locomotion in fishes; Hydrodynamics; Types of Scales, Use of scales in Classification and determination of age of fish; Gills and gas exchange; SwimBladder, Reproductive strategies (special reference to Indian fishes); Electric organs; Bioluminescence; Mechanoreceptors; Migration

Unit 3: Fisheries — 10

Scope and prospects of fisheries in India; Marine Fisheries: scope, status, problem and management strategies Fishing crafts and Gears, Preservation and processing of harvested fish,Fishery by-products

Unit 4: Aquaculture — 20

Types of Aquacultures, Three-tier fish pond management; Role of water quality in aquaculture; Composite fish culture, Integrated fish farming, pearl culture, Prawn farming, Induced breeding of fish; Management of finfish hatcheries, Preparation and maintenance of fish aquarium; Preparation of compound diets for fish; Fish diseases: Bacterial, viral and parasitic; Prevention and control of fish diseases.

MJZO010: FISH BIOLOGY AND FISHERIES [PRACTICAL] (1 Credit; 25 Marks)

1. Study of Morphometric and meristic characters of fishes.
2. Identification of *Scoliodon, Torpedo, Trigon*, *Pristis, Hippocampus,Gambusia,Labeo, Heteropneustes, Mystus, Anabas,Lates calcarifer, Liza parsia, Polynemus, Pampus argentius, Penaeus monodon, Macrobrachium rosenbergii*
3. Water quality Assessment: pH, dissolved oxygen, water alkalinity
4. Study of air breathing organs in *Channa, Heteropneustes, Anabas* and *Clarias.*

Suggested Readings:

- QBoneandRMoore,BiologyofFishes,TalyorandFrancisGroup,CRCPress,U.K.
- D. H. Evans and J. D. Claiborne, The Physiology of Fishes, Taylor and Francis Group, CRC Press, U KvonderEmde, R.J. Mogdans and B.G. Kapoor. TheSenses of Fish: Adaptations for the Reception of Natural Stimuli, Springer, Netherlands.
- C. B. L. Srivastava, Fish Biology, Narendra Publishing House.
- J. R. Norman, A history of Fishes, Hill and Wang Publishers.
- S. S. Khanna and H. R. Singh, A textbook of Fish Biology and Fisheries, Narendra Publishing House.

MINOR COURSES IN ZOOLOGY

SEMESTER – III/IV

MNZO02: INSECT VECTOR AND DISEASES (4 Credits; 100 Marks)

About the Course:This course will enable students gain knowledge various insect vectors and the insect-borne diseases. The course begins with an introduction covering the distinctive features of insects and then explains the concept of vectors. It lays emphasis on the study of insect vectors in detail and the control measures.

Learning Outcomes: After successful completion of this course, the students will be able to

- Understand the role of insects as vectors.
- Gain knowledge about various insect-borne diseases.
- Know effective control and preventive measures.

MNZO02: INSECT VECTORS AND DISEASES [THEORY] (3 Credits; 75 Marks)

	No. of lectures	No. of lectures
Unit1: Introduction to Insects	6	5
General and Morphological features, Mouth parts with respect to feeding habits	6	4
Unit 2: Concept of Vectors		
Brief introduction of Carrier and Vectors (mechanical and biological vectors), Reservoirs, Host-vector relationship, Vectorial capacity, Adaptations as vectors, Host Specificity	4	4
Unit 3: Dipterans as Disease Vectors	4	4
Dipterans as important insect vectors – Mosquitoes, Sand fly, Houseflies; Study of mosquito-borne diseases – Malaria, Dengue; Control of mosquitoes; Study of sand fly-borne diseases – Visceral Leishmaniasis; Control of Sand fly Study of house fly as important mechanical vector, Control of house fly	6	
Unit 4: Siphonaptera as Disease Vectors		
Fleas as important insect vectors; Study of Flea-borne diseases – Plague; Control of fleas	4	
Unit 5: Siphunculata as Disease Vectors		
Human louse (Head, Body and Pubic louse) as important insect vectors; Study of louse-borne diseases –Typhus fever, Relapsing fever; Control of human louse		
Unit 6: Hemiptera as Disease Vectors	6	
Bugs as insect vectors; Study of bug-borne diseases – Chagas disease; Control and prevention measures		

MNZO02: INSECT VECTOR AND DISEASES [PRACTICAL] (1 Credit; 25 Marks)

1. Study of different kinds of mouth parts of insects.
2. Study of following insect vectors through permanent slides/photographs: *Aedes*,*Culex*,*Anopheles*,*Pediculus humanus capitis*,*Pediculus humanus corporis*, *Phithirus pubis*, *Xenopsylla cheopis*, *Cimex lectularius*,*Phlebotomus argentipes*,*Musca domestica*.
3. Study of different diseases transmitted by the above insect vectors.

Suggested Readings:

- Imms,A.D.(1977).*A General Text Book of Entomology.* Chapman&Hall,UK.
- Chapman, R.F. (1998). *The Insects: Structure and Function.* IV Edition, CambridgeUniversityPress, UK.
- PedigoL.P.(2002).*EntomologyandPestManagement.*PrenticeHallPublication.
- Mathews, G. (2011). *Integrated Vector Management: Controlling Vectors of Malaria and Other Insect Vector*

Borne Diseases. Wiley-Blackwell.

DISCIPLINE-SPECIFIC SKILL ENHANCEMENT COURSES IN ZOOLOGY

SEMESTER - III

SEZO03: WILDLIFE CONSERVATION AND MANAGEMENT (3 Credits; 75 Marks)

About the Course:The course provides an insight into the wildlife conservation strategies and management practices. It also includes tools and techniques for wildlife management and monitoring.

Prelude for IKS- Wildlife Conservation and Management in India is inextricably linked to Indigenous Knowledge Systems **— through spiritual traditions, community stewardship, practical ecological understanding, and adaptive governance. These systems form the foundation of sustainable, culturally resonant, and community-led conservation models.**

Learning Outcomes: After successful completion of this course, the students will be able to

- Know the principles of wildlife management;
- Develop understanding about habitat;
- Learn the tools and techniques used to monitor wildlife which may generate employment opportunities.

SEZO03: WILDLIFE CONSERVATION AND MANAGEMENT [THEORY] (2 Credits; 50 Marks)

No. of lectures

Unit 1: Introduction to Wildlife Management: 7
Definition and importance of Wild life (with reference to IKS and modern concepts); Causes of depletion of Wild life, Conservation strategies, Principles of Wildlife Management, Disturbance Ecology and management, Legal provisions of wild life Conservation

Unit 2: Management of Habitats: 6
Determination of Territory and Home range, species-area relationship, Grazing and grazing types, logging and logging types, Management of fire, Cover construction

Unit 3: Population Estimation and census: 8
Estimation of growth, Age structured growth, Density and Abundance, Direct and Indirect population estimation methods, Fecal samples analysis of ungulates and carnivores, and study of Pug marks, DNA analysis, Description of common population count indices

Unit 4: Tools and Techniques used in Wildlife Management and Monitoring: 5
Hair identification, Camera traps, Wild life Telemetry (Radio Telemetry, Satellite Telemetry, GPS telemetry), Remote Sensing, GIS, Thermal imaging

Unit 5: Introduction to e-Technology in wild life management: 5
e-management tools (M-STrIPES, DISTANCE, Earthranger, SMART, Trailguard AI, Cybertracker), GBIF, BIODIVERSE

NSQF Ref: NCO: 2131.9900 (Biologists, Botanists, Zoologists and Related Professionals, Other)

SEZO03: WILDLIFE CONSERVATION AND MANAGEMENT [EXPERIENTIAL LEARNING] (1 Credit; 25 Marks)

1. Demonstration of basic equipment needed in wildlife studies use, care and maintenance (Compass, Binoculars, Spotting scope, Range Finders, Global Positioning System, Various types of Cameras and lenses)
2. Identification of pugmarks, hoofmarks, scats, pellet groups, nest, antlers etc.
3. Demonstration of use of hand net, snake tong, mist net, dive in trap.
4. PCQ, Ten tree method, Circular, Square & rectangular plots for ground cover assessment.
5. Trail/transect monitoring for abundance and diversity estimation of mammals (direct and indirect evidences).

Suggested Readings:

- John R. Skalski, Kristen E. Ryding and Joshua J. Millspaug (2005) Wildlife Demography: Analysis of Sex, Age, and Count Data.978-0-12-088773-6, Academic Press, Elsevier.
- G.K. Saha and S, Mazumder (2022). Wildlife Biology-An Indian Perspective. PHI Learning Private Limited, Delhi.
- Anthony R.E. Sinclair, John M. Fryxell, Graeme Caughley (2006) Wildlife Ecology and Conservation, 978-1-4051-0737-2, Blackwell Publishing.
- John M. Fryxell, Anthony R.E. Sinclair, Graeme Caughley (2006) Wildlife Ecology, Conservation, and Management. 978-1-118-29107-8, Blackwell Publishing
- Online sources**:** https://www.gbif.org/, https://smartconservationtools.org/en-us/, https://www.earthranger.com/, https://www.nightjar.tech/, https://cybertracker.org/, https://shawnlaffan.github.io/biodiverse/, https://wii.gov.in/mstripes_mobile_app

OUTLINE OF THE 3rd YEAR COURSES FOR B.Sc. DEGREE IN ZOOLOGY

[3rd YEAR OF FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUP) UNDER NEP 2020]

SEMESTERS	MAJOR CORE COURSES	MINOR COURSES	INTERNSHIP	TOTAL CREDITS
V	**MJZO11** **(4 credits)** [Physiology: Life Sustaining Systems] **MJZO12** **(4 credits)** [Metabolic Processes and Regulation] **MJZO13** **(4 credits)** [Developmental Biology]	**MNZO03** **(4 credits)** [Cytogenetics]	**Vocational Summer Internship (4 credits)**	**16**
VI	**MJZO14** **(4 credits)** [Parasitology] **MJZO15** **(4 credits)** [Immunology] **MJZO16** **(4 credits)** [Evolutionary Biology, Systematics and Taxonomy]	**MNZO03** **(4 credits)** [Cytogenetics]		**16**
YEAR –3	**6x4= 24cr**	**2x4=8 cr**	**1x4=4cr**	**32 (+4)**

[*After successful completion of THREE YEAR COURSE (Semesters - I to VI) securing 120 credits + 4 credits vocational summer internship, students may exit with B.Sc. Degree in Zoology or continue further*.]

DISCIPLINE-SPECIFIC MAJOR COURSES

SEMESTER - V

MJZO11: PHYSIOLOGY: LIFE SUSTAINING SYSTEMS (4 Credits; 100 Marks)

About the Course:The course deals with various physiological functions in mammals. It covers the structural and functional aspects in detail with special emphasis on the mechanisms involved in these processes.

Learning Outcomes: After successfully completing this course, the students will be able to

- Understand the processes of digestion and respiration;
- Know the ultrastructure of nephron and the mechanism of urine formation;
- Learn aboutblood components, structure of heart and its functioning;
- Determine blood group and hemoglobin, and measure blood pressure.

MJZO11: PHYSIOLOGY: LIFE SUSTAINING SYSTEMS [THEORY] (3 Credits; 75 Marks)

	No. of lectures
Unit 1: Physiology of Digestion Structuralorganizationandfunctionsofgastrointestinaltractandassociatedglands; Mechanical and chemical digestion of food; Absorption of carbohydrates, lipids and proteins, Hormonal control of secretion of enzymes in gastrointestinal tract	10
Unit 2: Physiology of Respiration Transport of oxygen and carbon dioxide in blood; Respiratory pigments, Dissociation curves and the factors influencing it; Carbon monoxide poisoning	8
Unit 3: Renal Physiology Structure of kidney and its functional unit; Mechanism of urine formation	6
Unit 4: Blood Components of blood and their functions; Structure and functions of haemoglobin. Haemostasis:Blood clotting system, Kallikrein-Kinninogen system, Fibrinolytic system,Haematopoiesis; Blood groups: ABO and MN, Rh factor	9
Unit 5: Physiology of Heart Structure of mammalian heart; Coronary circulation; Structure and working of conducting myocardial fibres. Origin and conduction of cardiac impulses. Cardiac cycle; Cardiac output and its regulation. Frank-Starling Law of the heart, nervous and chemical regulation of heart rate; Electrocardiogram, Blood pressure and its regulation	12

MJZO11: PHYSIOLOGY: LIFE SUSTAINING SYSTEMS [PRACTICAL](1 Credit; 25 Marks)

1. Determination of ABO Blood group.
2. Enumeration of red blood cells and white blood cells using haemocytometer.
3. Estimation of haemoglobin using Sahli's haemoglobinometer.
4. Preparation of haemin and haemochromogen crystals.
5. Recording of blood pressure using a sphygmomanometer.
6. Identification of sections of mammalian oesophagus, stomach, ileum, liver, lung, kidney.

Suggested Readings:

- Guyton,A.C.&Hall,J.E.(2006).TextbookofMedicalPhysiology.XIEdition.HercourtAsiaPTELtd. /W.B.Saunders Company.
- Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition John Wiley & Sons.
- Victor P. Eroschenko. (2008).Di Fiore's Atlas of Histology with Functional correlations. XII Edition. Lippincott W. & Wilkins.
- VanderA,ShermanJ.andLucianoD.(2014).Vander'sHumanPhysiology:TheMechanismofBodyFunction.XIIIEdition, McGrawHills

MJZO12: METABOLIC PROCESSES AND REGULATION (4 Credits; 100 Marks)

About the Course:The course focuses on various metabolic processes operating in the cell for harnessing energy from biomolecules or storing them into polymeric form. The course covers biochemical pathways related to carbohydrate, lipid, protein and nucleotide metabolism, and delves into aspects of metabolic regulation.

Prelude to IKS: The concept of metabolism in Ayurveda is not simply a biochemical process but a holistic system It is governed by *agni* (digestive fire), *doshas* (biological energies) and *dhatu poshana* (tissue nourishment). The Charaka Samhita emphasizes the role of *Agni*, digestive fire, as the primary force of digestion, absorption and energy metabolism. It is regarded as the foundation of life and health. Its proper functioning is crucial for maintaining metabolic homeostasis.

Learning Outcomes: After successfully completing this course, the students will be able to

- Develop basic concepts of bioenergetics and metabolism.
- Know the biochemical pathways of carbohydrate, lipid, protein and nucleotide metabolism.
- Understand the regulation of enzyme action, allosteric enzymes and their kinetics.
- Appreciate how metabolic processes are coordinately regulated to maintain homeostasis.
- Know about mitochondrial electron transport and oxidative phosphorylation.

i. Perform enzyme assays and also learn to trace fate of C atoms in metabolic cycles as TCA cycle.

MJZO12: METABOLIC PROCESSES AND REGULATION [THEORY] (3 Credits; 75 Marks)

	No. of lectures
Unit 1: Overview of Bioenergetics and Metabolism Concept of metabolism and metabolic disorders as in Indian Traditional Knowledge Systems (Charaka Samhita, Ayurveda); Laws of thermodynamics; Types of systems; Concept of Free energy, Enthalpy, Entropy, Reduction potential; ATP as 'energy currency' of the cell; Metabolism: Anabolism and Catabolism; Fermentations: Alcoholic fermentation and Lactic acid fermentation	6
Unit 2: Carbohydrate Metabolism Pathways of Glycolysis, Pyruvate oxidation, TCA cycle, Pentose phosphate pathway, Gluconeogenesis. Metabolism of Glycogen: Glycogenesis and Glycogenolysis	12
Unit 3: Lipid Metabolism Fatty acid activation, Carnitine shuttle, β-oxidation of saturated fatty acids with even number of carbon atoms; Fatty acid biosynthesis; Ketogenesis	6
Unit 4: Protein and Nucleotide Metabolism Transamination, Deamination, Urea Cycle; Fate of carbon skeleton of Glucogenic and Ketogenic amino acids; Biosynthesis of Nucleotides: *de novo* and salvage pathways	8
Unit 5: Metabolic Regulation	

Regulation of enzyme activity with examples; Allosteric enzymes and their kinetics; Regulation of Glycolysis; Coordinate metabolic regulation taking the example of Glycolysis and Gluconeogenesis — 8

Unit 6: Oxidative Phosphorylation

Electron carriers; Mitochondrial electron transport chain; ATP synthase; Concept of Chemi-osmotic model; Inhibitors and Uncouplers of oxidative phosphorylation — 5

MJZO12: METABOLIC PROCESSES AND REGULATION [PRACTICAL] (1 Credit; 25 Marks)

1. Determination of Aspartate aminotransferase/Alanine aminotransferase levels in a serum sample.
2. Assay of Alkaline Phosphatase in serum.
3. Assay of Lactate Dehydrogenase
4. Dry Lab: To trace the labelled C atoms of Acetyl-CoA till they evolve as CO_2 in the TCA cycle.

Suggested Readings:

- Cox, M.M and Nelson, D.L. (2008). *Lehninger's Principles of Biochemistry,* V Edition, W.H. Freeman and Co., New York.
- Berg, J.M., Tymoczko, J.L. and Stryer, L. (2007). *Biochemistry,* VI Edition,W.H. Freeman and Co., New York.
- Murray, R.K., Bender, D.A., Botham, K.M., Kennelly, P.J., Rodwell, V.W. and Well, P.A. (2009). *Harper's Illustrated Biochemistry,* XXVIII Edition, International Edition, The McGraw- Hill Companies Inc.
- Hames, B.D. and Hooper, N.M. (2000). *Instant Notes in Biochemistry,* II Edition, BIOS Scientific Publishers Ltd., U.K.

MJZO13: DEVELOPMENTAL BIOLOGY (4 Credits; 100 Marks)

About the Course:The course offers insight into the physiology of chordates while giving an account of their anatomy. This course also explores vertebrate morphology with the aim of understanding major events in the history of vertebrate evolution and integrating the morphology of vertebrates with their ecology, behaviour and physiological adaptation in diverse habitats.

Learning Outcomes: After successfully completing this course, the students will be able to

- Develop an understanding of the evolution of vertebrates thus integrating structure, function and development.
- Have an overview of the evolutionary concepts.
- Understand comparisons of major organ systems in vertebrates.
- Study skeleton of representative types, and know the skeletal modifications.

MJZO13: DEVELOPMENTAL BIOLOGY [THEORY] (3 Credits; 75 Marks)

No. of lectures

Unit 1: Introduction

General introduction to embryonic and post-embryonic development — 2

Unit 2: Gametogenesis

Gametogenic meiosis and gamete specification; gamete structure

Unit 3: Fertilization	6
External fertilization of sea urchin, Internal fertilization of mammal, Fertilization *in vitro*	
Unit 4: Cleavage	6
Cytoskeletal basis of cleavage; pattern of cleavage; cleavage in frog, chick and mammal.	
Mid-blastula transition	6
Unit 5: Gastrulation	
Gastrulation in frog and chick	4
Unit 6: Morphogenesis	6
Cell to cell communication and mechanism of morphogenesis	
Unit 7: Organogenesis	
Development of brain, eye, kidney and heart	
Unit 8: Membranes of Amniotes	6
Extra-embryonic membranes, placentation in mammal (human), types of placentae	
Unit 9: Hormonal reactivation in Development	4
Metamorphosis in insect and amphibian	
	5

MJZO13: DEVELOPMENTAL BIOLOGY [PRACTICAL] (1 Credit; 25 Marks)

1. Whole mount preparation of chick embryo (24 h, 33 h, 48 h, 72 h, 96 h)
2. Identification of section of chick embryo

Suggested Readings:

- Gilbert, S. F. (2006). Developmental Biology, VIII Edition, Sinauer Associates, Inc.,Publishers, Sunderland, Massachusetts, USA.
- Balinsky, B.I. (2008). An introduction to Embryology, International Thomson ComputerPress.
- Carlson, Bruce M (1996). Patten's Foundations of Embryology, McGraw Hill, Inc.

DISCIPLINE-SPECIFIC MAJOR CORE COURSES

SEMESTER - VI

MJZO14: PARASITOLOGY (4 Credits; 100 Marks)

About the Course:This course provides detailed information related to parasites andparasitism, emphasizing the influence of parasites on the ecology and evolution of free-living species, and the role of parasites in publichealth.

Prelude for IKS- Parasitic diseases caused by **parasitic** Protista**like *Plasmodium*, *Leishmania*, *Giardia*,and parasitic arthropods are found in India's** Indigenous Knowledge Systems (IKS)**—through traditional disease observations, traditional ethnopharmacological treatments, and culturally embedded preventive practices.**

Learning Outcomes: After successfully completing this course, the students will be able to

- Understand parasitism, host-parasite relationship.
- Learn the morphology and life cycle of parasites from different invertebrate and vertebrate groups.
- Diagnose the causative agents, describe pathogenesis and treatment for important diseases like malaria, leishmaniasis, trypanosomiasis, toxoplasmosis, schistosomiasis, cysticercosis, filariasis etc.

ii. Learn the incidence, prevalence and epidemiology of different parasitic infections.

MJZO14: PARASITOLOGY [THEORY] (3 Credits; 75 Marks)

	No. of lectures
Unit 1: Introduction Brief introduction of Parasitism, and Vectors (mechanical and biological vector); Host parasite relationship**;** Parasitic diseases caused by parasitic Protista like *Plasmodium*, *Leishmania*, *Giardia*, and parasitic arthropods with reference to IKS	6
Unit 2: Parasitic Protista Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of *Entamoeba histolytica*, *Giardia intestinalis*, *Trypanosoma gambiense*, *Leishmania donovani*, *Plasmodium vivax*	10 8
Unit 3: Parasitic Platyhelminthes Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of *Fasciola hepatica, Schistosoma haematobium* and *Hymenolepis nana*	10
Unit 4: Parasitic Nematoda Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of *Ascaris lumbricoides*, *Ancylostoma duodenale*, *Wuchereria bancrofti* and *Trichinella spiralis*. Study of structure, life cycle and importance of *Meloidogyne* (root knot nematode).	8
Unit 5: Parasitic Arthropoda Biology, importance and control of ticks, lice and fleas **Unit 6: Parasitic Vertebrates** Morphology, structure and feeding of Vampire bat	3

MJZO14: PARASITOLOGY [PRACTICAL] (1 Credit; 25 Marks)

1. Study of life stages of *Entamoeba histolytica, Giardia intestinalis,Trypanosoma gambiense, Leishmania donovani* and *Plasmodium vivax* through permanent slides/microphotographs.
2. Study of adult and life stages of *Fasciola hepatoca, Schistoma sp* and *Hymenolepis nana* through permanent slides/microphotographs.

3. Study of adult and life stages of *Ascaris lumbricoides, Ancylostomaduodenale, Wuchereriabancrofti*and *Trichinella spiralis* throughpermanentslides/microphotographs.
4. Study of plant parasitic root knot nematodefrom the soilsample.
5. Study of *Pediculus humanus*(Head louse and Body louse),*Xenopsyllacheopis*throughpermanentslides/photographs.
6. Study of nematode/cestode parasites from the intestines of Poultry bird[Intestinecanbeprocured frompoultry/market asaby-product].

Suggested Readings:

- Arora,D.Rand Arora,B.(2001) *MedicalParasitology.* IIEdition.CBSPublicationsand Distributors.
- E.R.Nobleand G.A.Noble(1982)Parasitology:Thebiologyofanimalparasites.VEdition,Lea&Febiger.
- Ahmed,N.,Dawson,M.,Smith,C.andWood,Ed.(2007)*BiologyofDisease.*Taylorand FrancisGroup.
- Parija, S. C. Textbook of medical parasitology, protozoology & helminthology(TextandcolourAtlas),IIEdition,AllIndiaPublishers&Distributers,MedicalBooksPublishers, Chennai,Delhi.
- RattanLalIchhpujaniandRajeshBhatia.MedicalParasitology,IIIEdition,JaypeeBrothersMedicalPublishers (P)Ltd., NewDelhi.
- Meyer,Olsen&Schmidt'sEssentialsofParasitology,Murray,D.Dailey,W.C.Brown Publishers.
- K. D. Chatterjee (2009). Parasitology: Protozoology and Helminthology.

MJZO15: IMMUNOLOGY (4 Credits; 100 Marks)

About the Course:This course provides the students fundamental knowledge of the immune system and its protective roles against diseases. The course covers the detailed structure and function of the antigens,immunoglobulin, major histocompatibility complex, complement system and hypersensitivity.

Learning Outcomes: After successfully completing this course, the students will be able to

- Identify the major cellular and tissue components which comprise the innate and adaptive immune systems;
- Understand how are immune responses by CD4 and CD8 T cells, and B cells, initiated and regulated;
- Learn how does the immune system distinguish self from non-self;
- Understand the structure function relationship, mechanism of action of antigens and immunoglobulins.

MJZO15: IMMUNOLOGY [THEORY] (3 Credits; 75 Marks)

	No. of lectures
Unit 1: Overview of Immune System Cells and organs of the Immune system	6
Unit 2: Innate and adaptive Immunity Anatomical barriers, Inflammation, Cell and molecules involved in innateimmunity,Adaptiveimmunity(Cell-mediatedandhumoral),Passive:Artificialand natural Immunity, Active: Artificial and natural Immunity	4 8
Unit 3: Antigens Antigenicity and immunogenicity, Immunogens, Adjuvants and haptens, Factors influencing immunogenicity	

Unit 4: Immunoglobulins 8

Structure and functions of different classes of immunoglobulins, Antigen-antibody interactions, Immunoassays (ELISA and RIA), Polyclonal sera, Hybridoma technology and Monoclonal antibodies

Unit 5: Major Histocompatibility Complex 9

Structure and functions of MHC molecules. Endogenous and exogenous pathways of antigen processing andpresentation 10

Unit 6: Complement System

Components and pathways of complement activation

Unit 7: Hypersensitivity

Gell and Coombs' classification and brief description of various types of hypersensitivities

MJZO15: IMMUNOLOGY [PRACTICAL] (1 Credit; 25 Marks)

1. Histological study of spleen, thymus and lymph nodes through slides/ photographs.
2. Ouchterlony's double immuno-diffusion method.
3. WIDAL Test.
4. Demonstration of ELISA for any cytokine.

Suggested Readings:

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

MJZO16: EVOLUTIONARY BIOLOGY, SYSTEMATICS AND TAXONOMY (4 Credits; 100 Marks)

About the Course:The course gives insight into the origin of life and the related evolutionary processes. It covers the evolutionary theories and the process of species formation.

Learning Outcomes: After successfully completing this course, the students will be able to

- Develop a holistic appreciation on the phylogeny and adaptations in animals.
- Understandthe process and theories in evolutionary biology.
- Learn the uses and limitations of phylogenetic trees.
- Appreciate the complexities and difficulties of various species concepts.
- Learn the rules and philosophy of nomenclature.

MJZO16: EVOLUTIONARY BIOLOGY, SYSTEMATICS AND TAXONOMY [THEORY] (3 Credits; 75 Marks)

No. of lectures

Unit 1: Origin of Life 3

Chemogeny, RNA world, Biogeny, Evolution of eukaryotes

Unit 2: Evolutionary Theories	4
Lamarckism, Darwinism, Neo-Darwinism	
Unit 3: Evolutionary Palaeontology	6
Geological timescale; Zoogeographical realms, fossil record (types of fossils, transitional forms, Evolution of Horse)	3
Unit 4: Molecular Evolution	
Molecular clock with example of globingene family	10
Unit 5: Population Genetics	
Hardy-Weinberg Law (statement and derivation of equation**;** application of law); Evolutionary forces upsetting H-W equilibrium; Natural selection (concept of fitness, selection coefficient, Types of selection, density-dependent selection, heterozygous superiority, kin selection, adaptive resemblances, sexual selection. Genetic Drift (mechanism, founder's effect, bottleneck phenomenon)	8
Unit 6: Product of Evolution	
Microevolutionary changes (inter-population variations, clines, races ,Species concept (Biological Species Concept) Isolating mechanisms, modes of speciation—allopatric,sympatric, Adaptive radiation/macroevolution(exemplified by Galapagosfinches)	7
Unit 7: Systematics and Taxonomy	
Definition of Systematics and Taxonomy, role of Systematics and Taxonomy in Biology, sub-taxonomical themes, taxonomic categories, infraspecific ranks, general properties of scientific name, basic rule of binomial nomenclature, trinomial nomenclature, regulatory bodies for species nomenclature	4
Unit 8: Phylogenetic Trees	
Multiple sequence alignment, Construction and interpretation of phylogenetic trees	

MJZO16: EVOLUTIONARY BIOLOGY, SYSTEMATICS AND TAXONOMY [PRACTICAL] (1 Credit; 25 Marks)

1. Study of fossils from models/pictures.
2. Study of homology and analogy from suitable specimens.
3. Demonstration of role of natural selection and genetic drift in changing allele frequencies using simulation studies.
4. Graphical representation and interpretation of data of height/ weight of a sample of 100 humans in relation to their age and sex.
5. Construction of phylogenetic trees with the help of bioinformatics tools (ClustalX, Phylip, NJ) and its interpretation.

Suggested Readings:

- Ridley,M(2004)EvolutionIIIEditionBlackwell Publishing.
- Hall,B.K.andHallgrimson,B(2008).EvolutionIVEdition.JonesandBarlettPublishers.
- Campbell,N.A.andReeceJ.B(2011).Biology.IXEdition.Pearson,Benjamin,Cummings.
- Douglas,J.Futuyma(1997).EvolutionaryBiology.SinauerAssociates.
- Pevsner, J (2009). Bioinformatics and Functional Genomics. II Edition Wiley-Blackwell.

MINOR COURSES IN ZOOLOGY

SEMESTER –V/VI

MNZO03: CYTOGENETICS (4 Credits; 100 Marks)

About the Course:The course covers basic aspects of cells, cellular organelles and chromosomes. It will provide insight into the laws governing Mendelian inheritance and principles of crossing over.

Learning Outcomes: After successful completion of this course, the students will be able to

- Understand the structure and functions of cellular organelles;
- Know about the chromosomes, linkage and crossing-over;
- Learn Mendelian Genetics;
- Understand the transmission of genes.

MNZO03: CYTOGENETICS [THEORY] (3 Credits; 75 Marks)

	No. of lectures	No. of lectures
Unit 1: Overview of Cells Prokaryotic and Eukaryotic cells, Virus, Viroids, Mycoplasma	6	5
Unit 2: Cell Membrane and Cellular Organelles Plasma Membrane, Endoplasmic Reticulum, Golgi Apparatus, Lysosomes, Mitochondria	6	4
Unit 3: Cell Division Mitosis; Meiosis	8	4
Unit 4: Mendelian Genetics Principles of inheritance, Incomplete dominance and co-dominance, Sex-linked, sex-influenced and sex-limited characters inheritance	10	4
Unit 5: Linkage and Crossing Over Linkage and crossing over, Molecular mechanisms of crossing over	8	
Unit 6: Mutations Types of mutations; Mutagens	7	

MNZO03: CYTOGENETICS [PRACTICAL] (1 Credit; 25 Marks)

1. Preparation of temporary stained squash of onion root tip to study various stages of mitosis.
2. Study of various stages of meiosis.
3. Pedigree analysis of human inherited traits.

Suggested Readings:

- Cooper, G.M. and Hausman, R.E. (2009). *The Cell: A Molecular Approach.* V Edition. ASM Press and Sunderland, Washington, D.C.; Sinauer Associates, MA.
- Bruce Albert, Bray Dennis, Levis Julian, Raff Martin, Roberts Keith and Watson James (2008). *Molecular Biology of the Cell,* V Edition, Garland publishing Inc., New York and London.
- Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). *Concepts of Genetics.* X Edition. Benjamin Cummings
- Strickberger Monroe, W. (2006). *Genetics*. Prentice-Hall of India Private Limited.

• Russell, P. J. (2006). iGenetics: A Molecular Approach. ed. *B. Cummings*.

OUTLINE OF THE 4TH YEAR COURSES FOR B.Sc.HONOURS IN ZOOLOGY

[4thYEAR OF FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUP) UNDER NEP 2020]

SEMESTERS	MAJOR CORE COURSES	MINOR COURSES	INTERNSHIP	TOTAL CREDITS
VII	**MJZO17** **(4 credits)** [Research Methodology and Biostatistics] **MJZO18** **(4 credits)** [Methods in Biology- I: Microscopy and Separation Techniques] **MJZO19** **(4 credits)** [Endocrinology] **MJZO20(E)** **(4 credits)** [Behavioral Biology]	**MNZO04** **(4 credits)** [Reproductive Biology]	**Vocational Summer Internship (4 credits)**	**20**
VIII	**MJZO21** **(4 credits)** [Methods In Biology –II: Molecular Analyses] **MJZO22** **(4 credits)** [Toxicology] **MJZO23(E)** **(4 credits)** [Animal Cell Biotechnology] **MJZO24(E)** **(4 credits)** [Biology of Infectious Diseases]	**MNZO04** **(4 credits)** [Reproductive Biology]		**20**
YEAR –4	**8x4= 32cr**	**1x4= 4cr**	**1x4=4cr**	**40 (+4)**
[*After successful completion of FOUR YEAR COURSE (Semesters - I to VIII) securing 160 credits + 4 credits vocational summer interns-ip, students may obtain B.Sc. Honours Degree in Zoology*]				

OUTLINE OF THE 4th YEAR COURSES FOR B.Sc.(HONOURS with RESEARCH)IN ZOOLOGY

[4thYEAR OF FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUP) UNDER NEP 2020]

SEMESTERS	MAJOR CORE COURSES	MINOR COURSES	RESEARCH	INTERNSHIP	TOTAL CREDITS
VII	**MJZO17** **(4 credits)** [Research Methodology and Biostatistics] **MJZO18** **(4 credits)** [Methods in Biology- I: Microscopy and Separation Techniques] **MJZO19** **(4 credits)** [Endocrinology]	**MNZO04** **(4 credits)** [Reproductive Biology]	**MJZORD01** **(4 credits)** [Research Dissertation]	**Vocational Summer Internship (4 credits)**	**20**
VIII	**MJZO21** **(4 credits)** [Methods In Biology –II: Molecular Analyses] **MJZO22** **(4 credits)** [Toxicology]	**MNZO04** **(4 credits)** [Reproductive Biology]	**MJZORD02** **(8 credits)** [Research Dissertation]		**20**
YEAR –4	**5x4= 20cr**	**2x4= 8cr**	**4+8 = 12 cr**	**1x4=4cr**	**40 (+4)**

[*After successful completion of FOUR-YEAR COURSE (Semesters - I to VIII) securing 160 credits + 4 credits vocational summer internship and having done Research Dissertation, students may obtain B.Sc. Honours with Research Degree in Zoology*]

DISCIPLINE-SPECIFIC CORE COURSES

SEMESTER - VII

MJZO17: RESEARCH METHODOLOGY AND BIOSTATISTICS (4 Credits; 100 Marks)

About the Course:The aim of the course is to familiarize students with basics of research and the research process, provide an introduction to research methods, various kinds research design and sampling.

Learning Outcomes: After successfully completing this course, the students will be able to

- Understand the concept of research;
- Have basic awareness of data analysis-and hypothesis testing procedures;
- Have basic knowledge on biostatistics;
- Develop competence on data collection and process of scientific documentation;
- Evaluate the different methods of scientific writing and reporting.

MJZO17: RESEARCH METHODOLOGY AND BIOSTATISTICS [THEORY] (3 Credits; 75 Marks)

	No. of lectures
Unit 1: Foundation of Research Meaning, Objectives, Motivation: Research Methods vs Methodology, Types of Research: Analytical vs Descriptive, Quantitative *vs* Qualitative, Basic vs Applied	5
Unit 2: Research Design Need for research design: Features of good design, Important concepts related to good design- Observation and Facts, Prediction and Explanation, Development of Models. Developing a research plan: Problem identification, Experimentation, Determining experimental and sample designs	10
Unit 3: Data Collection, Analysis and Report Writing Observation and Collection of Data-Methods of data collection- Sampling Methods, Data Processing and Analysis Strategies, Technical Reports and Thesis writing, Preparation of Tables and Bibliography. Data Presentation using digital technology	10
Unit 4: Ethical Issues Intellectual Property Rights, Commercialization, Copy Right, Royalty, Patent law, Plagiarism, Citation, Acknowledgement	8
Unit 5: Biostatistics Applications of statistics in biology; Measure of central tendency: mean, median and mode; Dispersion: standard deviation, confidence interval, standard error; Probability and distribution: normal, binomial and poisson distribution; Tests of significance: t-test, Chi-square test, ANOVA; Simple correlation and regression analysis	12

MJZO17: RESEARCH METHODOLOGY AND BIOSTATISTICS [PRACTICAL](1 Credit; 25 Marks)

1. Calculation of mean, standard deviation and standard error. Data collection on daily weather (temperature, rainfall etc) and estimation of mean, standard deviation and standard error. Interpretation of data based on mean, standard deviation and standard error.
2. Calculation of correlation coefficient between height and weight of male and female groups

3. Calculation of coefficient of determination using data generated from any laboratory activity.
4. Problems based on moments, skewness and kurtosis. Interpretation.
5. Application of MS Excel in solving statistical problems.
6. Use of R-programming in statistical analysis (Introductory)
7. Graphical representation of data.
8. Determination of pulse rate of human body. Difference between pulse rate of male and female students (use 95% confidence intervals, p-value 0.05). Comparison of means of pulse rate of students' groups using t-test and ANOVA.
9. Collection of data on a local problem and preparation of a research report (introduction, method, results, discussion and bibliography) within 3000 words.

Suggested Readings:

- Anthony, M, Graziano, A.M. and Raulin, M.L. 2009. Research Methods: A Process of Inquiry, Allyn and Bacon.
- Walliman, N. 2011.Research Methods- The Basics. Taylor and Francis, London, New York.
- Wadhera, B.L.: Law Relating to Patents, Trade Marks, Copyright Designs and Geographical Indications, 2002, Universal Law publishing
- C.R.Kothari: Research Methodology, New Age International, 2009
- Coley, S.M. and Scheinberg, C.A. 1990, —Proposal writing‖. Stage Publications

MJZO18: METHODS IN BIOLOGY –I: MICROSCOPY AND SEPARATION TECHNIQUES (4 Credits; 100 Marks)

About the Course:This course provides fundamental knowledge on usage of microscopy and various techniques for the separation of biomolecules.

Learning Outcomes: After successfully completing this course, the students will be able to

- Learn the principles of microscopy and different types of microscopes;
- Learn the principles of centrifugation and different types of centrifugations;
- Know the principle and types of chromatography;
- Understand basics of spectroscopy, electrophoresis and radioisotope techniques.

MJZO18: METHODS IN BIOLOGY – I: MICROSCOPY AND SEPARATION TECHNIQUES [THEORY] (3 Credits; 75 Marks)

No. of lectures

Unit 1: Microscopy — 7

Light microscopy, phase contrast microscopy, fluorescence microscopy, electron microscope- TEM and SEM, confocal microscopy

Unit 2: Cell Disruption and Centrifugation — 10

Cell disruption techniques, Basic principles of sedimentation, Types of centrifuges and their uses, Preparative centrifugation- differential and density gradient separation, Analytical ultracentrifuges and their applications

Unit 3: Chromatography — 6

Paper chromatography, TLC, Column chromatography, Size exclusion chromatography, Ion exchange chromatography, Affinity chromatography, HPLC

Unit 4: Spectroscopy — 6

UV and visible light spectroscopy, NMR, Spectrofluorimetry, Luminometry, Atomic absorption spectroscopy, X-ray diffraction

Unit 5: Electrophoresis

Native gels, SDS-PAGE, Agarose gel electrophoresis, Pulse field gel electrophoresis (PFGE) 8

Unit 6: Radioisotope Techniques

Nature of radioactivity, detection and measurement, GM counter, scintillation counting, autoradiography, Safety aspects and applications of radioisotopes in biology 8

MJZO18: METHODS IN BIOLOGY – I: MICROSCOPY AND SEPARATION TECHNIQUES [PRACTICAL] (1 Credit; 25 Marks)

1. Sub-cellular fractionation using differential/density gradient centrifugation.
2. TLC of amino acids (1D and 2D); Column chromatography.
3. Gel electrophoresis- native and SDS-PAGE and estimation of molecular weight of proteins.
4. Demonstration of various microscopes (Light and Electron Microscope).
5. Demonstration of HPLC.

Suggested Readings:

- Modern Experimental Biochemistry by Rodney F. Boyer, 3rd Edition, Pearson
- Tools and Techniques in Biomolecular Science by Aysha Divan & Janice Royds, 1st Edition, Oxford University Press
- An Introduction to Practical Biochemistry by David T Plummer, 3rd Edition, McGraw Hill
- Practical Biochemistry: Principles and Techniques by Keith Wilson and John Walker, 5th Edition, Cambridge Low-Price Edition
- Electron Microscopy: Principle and Technique for Biologist by Bozzola, John J and Russell, Lonnie D. 2nd Edition Jones and Barlett

MJZO19: ENDOCRINOLOGY (4 Credits; 100 Marks)

About the Course:The course envisages information on endocrine system with emphasis on the structure and function of various endocrine glands. The associated hormones and the related disorders will be explained.

Learning Outcomes: After successfully completing this course, the students will be able to

- Understand neurohormones and neurosecretions;
- Learn about hypothalamo and hypapophysial axis;
- Understand about different endocrine glands and their disorders;
- Understand the mechanism of hormone action.

MJZO19: ENDOCRINOLOGY [THEORY] (3 Credits; 75 Marks)

No. of lectures

Unit 1: Introduction 10

Characteristic and Transport of Hormones

Unit 2: Epiphysis, Hypothalamo-Hypophysial Axis 12

Structure of pineal gland, Secretions and their functions in biological rhythms and reproduction; Neurosecretions and Neurohormones, peripheral regulation of neuroendocrine glands, Pituitaryhormones and their functions, Hypothalamo-hypophysial portal system; Endocrine disorders

Unit 3: Peripheral Endocrine Glands 12

Functions and Regulation of Thyroid gland,Adrenal, Pancreas

Unit 4: Regulation of Hormone Action 15

Hormone action at Cellular level: Hormone receptors, transduction and regulationof

hormone action at molecular level: Second messengers, cAMP/PKA; Nitric oxide (NO)/ cGMP; Ca++ calmodulin, IP_3-DAG

MJZO19: ENDOCRINOLOGY [PRACTICAL] (1 Credit; 25 Marks)

1.Study of the permanent slides of all the endocrine glands.
2. Estimation of plasma level of any hormone using ELISA.
3.Designing of primers of any peptide hormone.

Suggested Readings:

- General Endocrinology C. Donnell Turner Pub- Saunders Toppan.
- Basic Medical Endocrinology by H. Maurice Goodman, 4th Edition, Elsevier
- Hadley, M.E. and Levine J.E. 2007. Endocrinology,6th Edition. Pearson Prentice-Hall, Pearson Education Inc., New Jersey.
- Vertebrate Endocrinology by David O. Norris& James A Carr, 6th Edition, Elsevier

MJZO20(E): BEHAVIOURAL BIOLOGY (4 Credits; 100 Marks)

About the Course:The course will provide an in-depth knowledge and scientific understanding of animal behaviour and chronobiology.

Learning Outcomes:After successfully completing this course, the students will be able to

- Understand the scientific basis of animal behaviour and its adaptive significance
- Learn the details of animal migration
- Understand the social and courtship behaviour, and biological rythym in animals

MJZO20(E): BEHAVIOURAL BIOLOGY [THEORY] (3 Credits; 75 Marks)

	No. of lectures
Unit 1: Introduction	
Pioneers of Animal behaviour (Karl Von Frish, IvanPavlov,KonradLorenz,NikoTinbergen)Proximateandultimatecausesof behaviour,	8
Significance of animal behaviour study	8
Unit 2: Patterns of Behaviour	
Innate Behaviours (Orientation, Reflexes, nest building); Learnt Behaviour; Associative learning, classical and operant conditioning, Habituation, Imprinting	10
Unit 3: Social and Sexual Behaviour	
Communication, Défense, Social behaviour (Kin Selection, Altruism, Territoriality); Mate selection, Parental care, Parent-Offspring conflict	
Unit 4: Chronobiology and Rhythmic Behaviour	
Circadian rhythm (Types, Mode of action, Role of melatonin), Biological clock,	9
Migration (Causes of migration, Types of birds and fish migration), Hibernation	10
Unit 5: Human Behaviour	
Happiness (Evolutionary-Cybernatics theory, Empirical confirmation theory), Learning of languages, Aggression (male and female), Adolescence, Haptic communication (Attribution, Politeness, Prosocial)	

MJZO20(E): BEHAVIORAL BIOLOGY [PRACTICAL] (1 Credit; 25 Marks)

1. Study of nests and nesting building habits of the birds and social linsects.
2. Study of the behavioral responses of wood lice to dry and humid condition.
3. Study of geotaxis and phototaxis behavior in earthworm.
4. Visit to Forest/Wildlife Sanctuary/BiodiversityPark/ZoologicalParktostudybehavioralactivitiesofanimalsand

prepare as short report.

5. Study and actogram construction of locomotor activity of suitable animal models.
6. Study of circadian functions in daily eating, sleep and temperature patterns.

Suggested Readings:

- John Alcock: Animal Behavior: An Evolutionary Approach (11th Edition)
- Lee Alan Dugatkin: Principles of Animal Behavior (4th Edition) University of Chicago Press
- Reena Mathur: Animal Behaviour (6th Edition) Rastogi Publications
- David Mcfarland: Animal Behaviour (3rd Edition) Pearson

DISCIPLINE-SPECIFIC CORE COURSES

SEMESTER - VIII

MJZO21: METHODS IN BIOLOGY – II: MOLECULAR ANALYSES (4 Credits; 100 Marks)

About the Course:This course provides fundamental knowledge on usage of Immunologicaland molecular analysis of DNA, RNA and proteins.

Learning Outcomes: After successfully completing this course, the students will be able to

- Learn the principles of different immunohistochemical and immunological techniques;
- Understand the principlesof different molecular biological techniques;
- Learn handling of advanced instruments.

MJZO21: METHODS IN BIOLOGY – II: MOLECULAR ANALYSES [THEORY] (3 Credits; 75 Marks)

	No. of lectures
Unit 1: Immunohistochemical techniques Immunohistochemistry and *in situ* hybridization	8
Unit 2: Immunological Techniques Immunoprecipitation; Detection of proteins using western blot, Flow cytometry and FACS; raising of antibodies against a protein/ peptide in rabbit/mouse /rat etc.	10
Unit 3: Molecular Biology Techniques Genomic DNA and RNA isolation; PCR and qRT-PCR; Nucleic Acid Hybridization to detect genes - Southern, Northern hybridization, Microarrays. RFLP. RAPD, SNP, DNA fingerprinting. Genome sequencing techniques. Next generation sequencing	15
Unit 4: Proteomics 2D PAGE, Isoelectric focusing, DIGE and Gel free proteomics – MALDI- MS (Labelled and unlabelled analysis), Surface plasmon resonance and Protein arrays	12

MJZO21: METHODS IN BIOLOGY – II: MOLECULAR ANALYSES [PRACTICAL] (1 Credit; 25 Marks)

1. Restriction digestion of plasmid and RFLP/ RAPD analysis.
2. Polymerase chain reaction; Demonstration of real-time PCR.
3. Preparation of antigen and antibody. Immunoprecipitation, Protein A/G.

Suggested Readings:

- Michael R. Green & Joseph Sambrook: Molecular Cloning: A Laboratory Manual, 4th Edition, Cold Spring Harbor Laboratory
- T A Brown: Gene Cloning and DNA Analysis, 8th Edition, Wiley
- R M Twyman: Principles of Proteomics, 2nd Edition, Taylor and Francis
- S. Kim Suvarna, Christopher Layton & John D. Bancroft: Bancroft's Theory and Practice of Histological

Techniques, 8th Edition, Elsevier.

MJZO22: TOXICOLOGY (4 Credits; 100 Marks)

About the Course:The aim of the course is to provide insight into the impact and mode of action of environmental toxicants/xenobiotics in animal.

Prelude for IKS-Farmers across India traditionally use bio-insecticides and biopesticides **to manage pests and storage insects like aphids, stem borers, weevils, and moths. These botanicals are integrated into farming systems through experience and passed across generations, and are deeply rooted in the** IKS.

Learning Outcomes: After successfully completing this course, the students will be able to

- Learn the adverse effect of xenobiotics.
- Understand the mechanism of toxicity and detoxification.
- Gain awareness on environmental pollutants.
- Evaluate different methods of toxicity assessment.

MJZO22: TOXICOLOGY [THEORY] (3 Credits; 75 Marks)

	No. of lectures
Unit 1: Introduction Concept of Toxicology; Typesoftoxicants (naturaltoxins,xenobiotics, mutagens,clastogens,teratogens,carcinogens), Biotransformation(Phase I and PhaseII), Bioaccumulation and Biomagnification, Drugsastoxic agents (Paracetamol,Aspirin,Thalidomide), Toxicity remediation through application of IKS	8
Unit 2: Effects of Toxicants Biochemical and physiological effects, Interactive effects :additive effects, potentiation and synergism	6
Unit 3: Toxicity tests Dose, Dosage, Dose response; Acute toxicity tests: LC_{50} and LD_{50}, Probit analysis; Chronic toxicitytests:Methods;Mutagenicity testing (Ames test)	8
Unit 4: Pesticides & Endocrine disrupting compounds Classification; Insecticides and herbicides:Types (including bioinsecticides), Sources, Effects and degradation kinetics; Mechanism of action: Organochlorine,Organophosphate, Bisphenol, Pthalates, Brominated flame retardants	10
Unit 5: Metal Toxicity Source,exposure,disposition and effects of heavy metals (Cd,Hg,Pb) and lighter element(As), Metal chelation	8
Unit 6: Applied Toxicity Environmental toxicology; Occupational and industrial toxicology; Clinical toxicology; Forensic toxicology	5

MJZO22: TOXICOLOGY [PRACTICAL] (1 Credit; 25 Marks)

1. Determination of LC_{50}through Probit analysis
2. Estimation of Malondialdehyde (MDA) for lipid peroxidation
3. Estimation of reduced Glutathione (GSH)
4. Estimation of antioxidant enzymes (CAT and SOD)

Suggested Readings:

- De, A. K. (2000). *Environmental chemisrtry.* 4th ed. New Age International (P) Ltd. Publishers.
- Duffus,J.H.andWorthH.G.J.(Ed.)(2006).*FundamentalToxicology*.RSCpublishing.
- Klaassen,C.D.(Ed.)(1996).*CasarettandDaul'sToxicology:TheBasicScienceofPoisons*.5th ed. McGraw-Hill,NewYork.
- Lu,F.C.(1996).*BasicToxicology:Fundamentals,TargetorgansandRiskAssessment*.3rd ed. TaylorandFrancis.
- Pandey,K.,Shukla,J.P.andTrivedi,S.P.(2005).*FundamentalsofToxicology*.NewCentralBookAgency(P)Ltd.Kolkata.
- Plant,N.(2003).*MolecularToxicology*.1st Ed.BiosScientificPublishers.
- Stine,K.E.andBrown,T.M.(2006).*PrinciplesofToxicology*.2nd Ed.CRC,TaylorandFrancisGroup,NewYork.
- Timbrell,J.(2002).*IntroductiontoToxicology*.3rd Ed.,TaylorandFrancis,London.
- Walker, C. H., Hopkins, S. P., Sibly, R. M. and Peakall, D. B. (2000). *Principles of Ecotoxicology*. 2nd ed. Taylor and Francis, London.

MJZO23(E): ANIMAL CELL BIOTECHNOLOGY (4 Credits; 100 Marks)

About the Course:This course gives an insight into the direct manipulation of DNA to alter the characteristics of an organism in a particular way. It envisages concepts and mechanisms of genetic manipulation and also discusses the recent advances in recombinant DNA technology.

Learning Outcomes: After successfully completing this course, the students will be able to

- Understand the fundamental molecular tools and their applications of DNA modification and cloning;
- Apply their knowledge with problem solving approach to recommend strategies of genetic engineering for possible applications in Biotechnology and allied industry.

MJZO23(E): ANIMAL CELL BIOTECHNOLOGY [THEORY] (3 Credits; 75 Marks)

	No. of lectures
Unit 1: Techniques of Gene Manipulation Outline process of genetic engineering and recombinant DNA technology, Isolation of genes, Concept of restriction and modification: Restriction endonucleases, DNA modifyingenzymes; Cloning Vectors: Plasmids, Phage vectors, Cosmids, Phagemids, BAC, YAC, HAC. Shuttle and Expression Vectors; Construction of Genomic libraries and cDNA libraries	14
Unit 2: Transformation Techniques Transformation techniques: microbial, plants and animals; Cloning in mammalian cells, Integration of DNA into mammalian genome- Electroporation and Calcium Phosphate Precipitation method	6 8
Unit 3: Animal Cell Culture Aseptic handling procedures; types of media used in animal cell culture; Preparation of primary and secondary culture system; Maintenance of cell culture and sub culture; Cell viability assays	10
Unit 4: Transgenic Animal Technology Production of transgenic animals: nuclear transplantation, Retroviral method, DNA microinjection method, Dolly and Polly	7
Unit 5: Application in Health Development of recombinant Vaccines, Hybridoma technology, Gene Therapy; Production of recombinant Proteins: Insulin and growth hormones	

MJZO23(E): ANIMAL CELL BIOTECHNOLOGY [PRACTICAL] (1 Credit; 25 Marks)

1. Packing and sterilization of glass and plastic wares for cell culture.
2. Preparation of culture media.
3. Plasmid DNA isolation (pUC 18/19) and DNA quantitation using agarose gel electrophoresis (by

using lambda DNA as standard).

4. Restriction digestion of lambda (λ) DNA using EcoR1 and Hind III.
5. Preparation of competent cells and Transformation of *E. coli* with plasmid DNA using CaCl2, Selection of transformants on X-gal and IPTG.

Suggested Readings:

- Animal Cells Culture and Media, D.C. Darling and S.J. Morgan, 1994. BIOS Scientific Publishers Limited.
- Methods in Cell Biology, Volume 57, Jennie P. Mathur and David Barnes, 1998. Animal Cell Culture Methods Academic Press.
- P.K. Gupta: Biotechnology and Genomics, Rastogi publishers (2003).
- B.D. Singh: Biotechnology, Kalyani publishers, 1998 (Reprint 2001).
- T.A. Brown: Gene cloning and DNA analysis: An Introduction, Blackwell Science (2001).
- Bernard R. Click & Jack J. Pasternak: Molecular Biotechnology, ASM Press, Washington (1998).
- Methods in Gene Biotechnology, W. Wu, M.J. Welsh, P.B. Kaufman &H.H. Zhang, 1997, CRC Press, New York
- Griffiths, A.J.F., J.H. Miller, Suzuki, D.T., Lewontin, R.C. and Gelbart,
- W.M. (2009). An introduction to genetic analysis. IX Edition. Freeman & Co., N.Y., USA

MJZO24(E): BIOLOGY OF INFECTIOUS DISEASES (4 Credits; 100 Marks)

About the Course:This course provides the epidemiology and pathology of different infectious diseases like vector borne, zoonotic, air and food borne diseases and sexually transmitted diseases; the interaction between host and pathogen. In addition, it provides insights into the underlying causes, prevention and treatment of infectious diseases.

Prelude for IKS-Biology of Infectious Disease**—specifically** mosquito-borne diseases**,** leprosy**, and** food- and water-borne diseases**—aligns with** India's Indigenous Knowledge Systems (IKS)**, emphasizing centuries-old insights, botanical remedies, and culturally embedded preventive practices.**

Learning Outcomes:After successfully completing this course, the students will be able to

- Gain insight into the basis of infectious diseases and approaches for treatment and prevention;
- Understand public health issues and can develop approaches to designing, implementing and communicating public health interventions that are sensitive and respectful of society.

MJZO24(E): BIOLOGY OF INFECTIOUS DISEASES [THEORY] (3 Credits; 75 Marks)

No. of lectures

Unit 1: Mosquitoes as Vectors and Related Diseases — 8

Epidemiology of Malaria, Dengue and Chikungunya; Molecular Host vector interaction; Prophylaxis /control measure of vector and infectious agent — 8

Unit 2: Zoonotic Diseases

Yersinia pestis and Plague: Life cycle of *Yersinia pestis,* Epidemiology and Prophylaxis of Plague; Rabies virus and Rabies: Life cycle of Rabies virus*,* Epidemiology and Prophylaxis of Rabies;*Echinococcus granulossus*. Structure, Life cycle of the parasite, Manifestation of thedisease, prophylaxis; *Toxoplasma gondii*. Structure, Life cycle of the parasite, Manifestation of the disease,prophylaxis — 15

Unit 3: Air-borne Diseases

Tuberculosis: Prevalence of Infection, Epidemiology, Structure and Life cycle of

Mycobacteria tuberculosis, Antibiotic drugs, antibiotic resistant, Molecular host-pathogen host interaction and control 7

Leprosy: Prevalence of Infection, Epidemiology, Structure Life cycle of *Mycobacterium leprae* and Prophylaxis of Leprosy

Flu: Types of Influenza virus, Morphological and genomic structure, Epidemiology,Translation and replication of the virus, Drugs and vaccines 7

Unit 4: Food and Water-borne Diseases

Amoebiasis: Symptoms, Life cycle of *Entamoeba histolytica*, Epidemiology and Prophylaxis of Amoebiasis

Cholera: Epidemiology, Structure and Life cycle of *Vibrio cholerae*, and Prophylaxis of Cholera

Typhoid: Structure of Salmonella Typhi and Life cycle of *Salmonella Typhi*, Epidemiology and Prophylaxis of Typhoid; Molecular of Host pathogen interaction

Unit 5: Sexually Transmitted Diseases

Neisseria gonorrhoeae and Gonorrhea: Life cycle of *Neisseria gonorrhoeae*, Epidemiology and Prophylaxis of Gonorrhea;

Treponema pallidum and Syphillis: Life cycle of *Treponema pallidum*, Epidemiology and Prophylaxis of Syphillis;

Human immunodeficiency virus (HIV) and Acquired immunodeficiency syndrome (AIDS): History, Epidemiology and Manifestation of diseases, Life cycle of HIV, Virus and Host Immune system and Prophylaxis of AIDS

MJZO24(E): BIOLOGY OF INFECTIOUS DISEASES [PRACTICAL] (1 Credit; 25 Marks)

1. Isolation of Pure culture
2. Cultural characteristics of Microorganisms
3. Study of *Mycobacterium tuberculosis, Mycobacterium leprae, Echinococcus granulossus, Toxoplasma gondii*, *Entamoeba histolytica* and different types of *Plasmodium* species from permanent slides/charts.
4. Methylene blue reductase test for quality determination of milk sample.
5. Microbiological analysis of food products

Suggested Readings:

1. S.Jane Flint, Glenn F Rall, Anna Marie Skalka, Theodora Hatziioannou, VincentRacaniello. Principles of Virology Fourth Edition (Vol 1&2)
2. S. Ram Reddy and SM Reddy Esentials of Virology 2 nd Revised and Enlarged Edition
3. JJoseph Marr, Timothy W. Nilsen and Richard W. Komuniecki. Molecular MedicalParasitology
4. Joanne M Willey, Linda Sherwood, Christopher J. Woolverton. Prescott's Microbiology2017
5. Peter M. Howley, David M. Knipe, Sean Whelan; Fields Virology: Emerging Viruses.

6. Anthony A. Nash, Robert G. Dalziel, J. Ross Fitzgerald; Mims' Pathogenesis of Infectious Disease 6th Edition, Elsevier

SEMESTER – VII/VIII

MNZO04: REPRODUCTIVE BIOLOGY (4 Credits; 100 Marks)

About the Course:This course will enable students gain knowledge on the reproductive organs, reproductive physiology, endocrine control on gametogenesis, fertilization, lactation and on the causes of infertility and assisted reproductive technology.

Learning Outcomes: After successful completion of this course, the students will be able to

- Understand the mechanism of androgen hormone actions and their role in reproductive cycle and gametogenesis
- Gain knowledge on the structure and functions of male and female reproductive system
- .Learn the causes and management of infertility.
- Learn about the assisted reproductive techniques and on modern contraceptive technology.

MNZO04: REPRODUCTIVE BIOLOGY [THEORY] (3 Credits; 75 Marks)

	No. of lectures
Unit1: Reproductive Endocrinology Gonadal hormones and mechanism of hormone action, steroids, glycoprotein hormones, andprostaglandins, hypothalamo – hypophyseal – gonadal axis, regulation of gonadotrophin secretion in male and female; Reproductive System: Development and differentiation of gonads	8
Unit 2: Male Reproduction Outline and histology of male reproductive system in rat and human; Testis: Cellularfunctions, germ cell, system cell renewal; Spermatogenesis.	10
Unit 3: Female Reproduction Outline and histology of female reproductive system in rat and human; Ovary: folliculogenesis, ovulation, corpus luteum formation and regression; Steroidogenesis and secretion of ovarian hormones; Reproductive cycles (rat and human) and their regulation, changes in the female tract; Ovum transport in the fallopian tubes; fertilization; Lactation and its regulation	15
Unit 4: Reproductive Health Infertility in male and female: causes, diagnosis and management; Assisted ReproductiveTechnology: sex selection, sperm banks, frozen embryos, in vitro fertilization, ET, EFT,IUT, ZIFT, GIFT, ICSI, PROST; Modern contraceptive technologies; Demographic terminology used in family planning	12

MNZO04: REPRODUCTIVE BIOLOGY [PRACTICAL] (1 Credit; 25 Marks)

1. Surgical techniques: principles of surgery in endocrinology. Ovarectomy, hysterectorny, castration and vasectomy in rats.
2. Examination of histological sections from photomicrographs/ permanent slides of rat/human: testis, epididymis and accessory glands of male reproductive systems; Sections of ovary, fallopian tube, uterus (proliferative and secretory stages), cervix and vagina.

Suggested Readings:

- Austin CR and Short RV, Reproduction in mammals. CAMBRIDGE University Press
- Dagroot LJ and Jameson JL (eds) Endocrinology W.B. Saunders and Company
- Knobil et al The Physiology of Reproduction Raven Press Ltd
- Hatcher RA etal The Essential of Contraceptive technology, Population Information programme