



BANKURA UNIVERSITY

(West Bengal Act XIX of 2013- Bankura University Act, 2013)

Main Campus, Bankura Block-II, P.O.: Purandarapur, Dist.: Bankura, Pin- 722155, West Bengal

Office of the Secretary

Faculty Council for Undergraduate Studies

Ref: BKU/FCUG/163/2026

Date: 16/06/2026

NOTIFICATION

As directed, the undersigned is pleased to inform all concerned that Bankura University has initiated the process to implement New Curriculum and Credit Framework for Undergraduate Programme, UGC 2022 (as per NEP 2020) for 4-years Undergraduate programme with Zoology as Major, Minor etc. from the academic session 2023-2024. The syllabus as framed / drafted and partially implemented deserves to be analysed after receiving feedback from different stakeholders. As an important corollary to the process, a workshop will be organized on the date mentioned herewith to get the feedback from the stakeholders. Present Students, Alumni, Guardians, Academicians and other stakeholders related to the specific programme/course are requested for their kind participation in the workshop and to present their views/ observations, etc. The stakeholders may go through the draft syllabus attached herewith and convey their observations to the office of the undersigned on ugsecretaryoffice@bankurauniv.ac.in within seven days from the date of publication of this notice.

Date: 22.06.2026

Time: 7:30 PM

Google Meet joining link: <https://meet.google.com/rgw-uxjd-vqx>

Sd/-

Dr. Arindam Chakraborty

Secretary

Faculty Council for Undergraduate Studies

Ref: BKU/FCUG/163(6)/2026

Date: 16/06/2026

1. Registrar (Addl. Charge), Bankura University.
2. Dean (Officiating), Faculty Council of P.G. Studies in Arts, Science etc. Bankura University.
3. Chairperson / Convenor, Undergraduate Board of Studies in Zoology, Bankura University with request for necessary action.
4. System Administrator, Bankura University with request to upload this in website.
5. Secretary, Hon'ble Vice Chancellor, Bankura University.
6. Guard File.

Sd/-

Dr. Arindam Chakraborty

Secretary

Faculty Council for Undergraduate Studies



Syllabus for Four Years Undergraduate Courses in Zoology

[New Curriculum and Credit Framework for undergraduate Programme]

Following NEP 2020

With effect from the Academic Session 2023-24



BANKURA UNIVERSITY

BANKURA

WEST BENGAL

PIN722155



Medium of study is English. Questions for all papers will be prepared in English only for NEP curriculum

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Introduction:

The syllabus for Zoology at undergraduate level using the NEP-2020 and formulation of a new student-centric “**Curriculum and Credit Frame work for Undergraduate Programmes (CCFUD)**”, the syllabus for Zoology has been framed following the UGC guidelines facilitating students to pursue their career path by choosing the subject. While framing the syllabus as per the UGC guideline, the topics have been kept as generic as possible in order to provide enough freedom to the individual Universities to detail out their own syllabus as per their own infrastructure, expertise and strength.

The main objective of framing this new syllabus is to give the students a holistic understanding of the subject giving substantial weightage to both the core content and techniques used in Zoology. The incorporation of a flexible choice-based credit system, a multidisciplinary approach, and many entry and exit alternatives with a focus on the students' chosen majors and minors has been done correctly in accordance with our own infrastructure, competence, and strength.

Keeping in mind and in tune with the changing nature of the subject, adequate emphasis has been given on new techniques and understanding of the subject.

The syllabus has also been framed in such a way that the basic skills of subject are taught to the students, and everyone might not need to go for higher studies and the scope of securing a job after graduation will increase.

There is wide deviation in the infrastructure, be it physical or in human resource, in the form of teachers' expertise and ability and aspiration of the students. In addition scope of research and summer internship has been introduced in the new syllabus.



BANKURA UBIVEERSITY

Programme and Course Structure with Credit Distribution: UG Degree Programmes with Single Major (Zoology)

Category of Course (credit) SEM	Major (04)		Minor Stream (4)	Multidisciplinary (3)	Skill Enhancement Courses (SEC) (3)	Ability Enhancement Courses (AEC) (2)	Value Added Courses (common for all) (4)	Internship (2)	Research Project / Dissertation* (12)	TOTAL CREDIT / NUMBER OF COURSES
	DSC	DSE								
I	1x4=4 XY/101/MJC-1		1x4=4 XY/102/MN-1	1x3=3 XY/103/MD-1	1x3=3 XY/104/SEC-1	1x2=2 ACS/105/AEC-1	1x4=4 ACS/106/VAC-1			20 / 6
II	1x4=4 XY/201/MJC-2		1x4=4 XY/202/MN-2	1x3=3 XY/203/MD-2	1x3=3 XY/204/SEC-2	1x2=2 ACS/205/AEC-2	1x4=4 ACS/206/VAC-2			20 / 6
CERTIFICATE (Total credit)	8		8	6	4		6	4*(ADDITIONAL) ACS/207/INT-1		40
III	2X4=8 XY/301/MJC-3 XY/301/MJC-4		1X4=4 XY/303/MN-3	1X3=3 XY/304/MD-3	1x3=3 XY/305/SEC-3	1x2=2 ACS/306/AEC-3				20 / 6
IV	4X4=16 XY/401/MJC-5 XY/402/MJC-6 XY/401/MJC-7 XY/402/MJC-8		1X4=4 XY/405/MN-4			1x2=2 ACS/406/AEC-4				22 / 6
DIPLOMA (Total credit)	32		16	9	9	8	8	4*(ADDITIONAL) ACS/407/INT-2		82
V	4X4=16 XY/501/MJC-9 XY/502/MJC-10 XY/501/MJC-11 XY/502/MJC-12		1X4=4 XY/505/MN-5					1X2=2 ACS/506/INT-3		22 / 6
VI	3X4=12 XY/602/MJC-13 XY/601/MJC-14 XY/603/MJC-15 XY/602/MJC-16		1X4=4 XY/605/MN-6							20 / 6
UG DEGREE (Total credit)	16X4=64 64		24	9	9	8	8	2		124
VII	4X4=16 XY/701/MJC-17 XY/702/MJC-18 XY/703/MJC-19 XY/704/MJC-20		1X4=4 XY/705/MN-7							20 / 5
VIII	4X4=16** XY/801/MJC-21 XY/801/MJC-22 XY/801/MJC-23 XY/801/MJC-24		1X4=4 XY/805/MN-8							20 / 5
UG HONS. (Total credit)	24X4=96 96		32	9	9	8	8	2		164
UG HONS. WITH RESEARCH (Total credit)	21X4=84		32	9	9	8	8	2	12** XY/806/RPD-1	

** Honours students not undertaking research will do 3 courses for 12 credits for Major in lieu of a research project / Dissertation and total four courses in Major in VIII semester
Honours with Research students will opt any one core course from available four courses in Major in VIII semester



BANKURA UNIVERSITY
Curriculum Framework for UG Degree Programmes with Single Major (Zoology)

Semester	Major Paper (MJC)	Skill enhancement Course Paper (SEC)	Minor Paper (MN)	Multidisciplinary Paper (MD)
I	Non Chordate Diversity	Sericulture	Non Chordate	Sericulture and Silk production Technology
II	Chordate diversity and Comparative anatomy of Vertebrate	Aquarium fish Management	Chordate and Comparative Anatomy	Environment and Public Health Management
III	Ecology	Economic Zoology	Physiology and Biochemistry	Apiculture
	Fundamentals of Biochemistry			
IV	Cell Biology		Genetics and Evolution	
	Animal Physiology Life sustaining System			
	Developmental Biology			
	Evolutionary Biology			
V	Molecular Biology		Cell and Molecular Biology	
	Genetics			
	Animal Behaviour and Chronobiology			
	Endocrinology			
VI	Immunology		Parasitology and Vector Biology	
	Biology of Insecta			
	Parasitology			
	Microbiology			
VII	Biotechnology and Bioinformatics		Developmental Biology	
	Biostatistics and Biophysics			
	Histology and Histochemistry			
	Fish and Fisheries			
VIII (With Research)	Bioinstrumentation and Research Methodology			
	Research Project (12 Credit)			
VIII (Without Research)	Bioinstrumentation and Research Methodology		Ecology and conservation Biology	
	Environmental Chemistry and Toxicology			
	Biodiversity and Conservation Biology			
	Medical techniques			



Curriculum and Credit Framework for ZOOLOGY

(Basic, Honours and Honours with Research)
With effect from the Academic Year 2023-24

SEMESTER-I										
Sl. No.	Course Code	Course Title	Credit	Marks			No. of Hours			
				IA	ESE	Total	L	T	P	
1	S/ZOO/101/MJC-1	Nonchordate Diversity (Theory & Practical)	4 (T+P)	10	40 T:25 P:15		50	3	0	2
2	S/ZOO/102/MN-1	Nonchordate (Theory & Practical)	4 (T+P)	10	40 T:25 P:15		50	3	0	2
3	S/ZOO/103/MD-1	Sericulture and Silk Production Technology (For students of other discipline)	3(T)	10	40		50	3	NA	NA
4	S/ZOO/104/SEC-1	Sericulture	3(T)	10	40		50	3	NA	NA
5	ACS/105/AEC-1	Communicative English	2	10	40		50	2	NA	NA
6	ACS/106/VAC-1	Environmental Studies	4	10	40		50	4	NA	NA
Total in Semester-I			20	60	240		300			

SEMESTER-II										
Sl. No.	Course Code	Course Title	Credit	Marks			No. of Hours			
				IA	ESE	Total	L	T	P	
1	S/ZOO/201/MJC-2	Chordate Diversity and Comparative Anatomy of Vertebrates (Theory & Practical)	4 (T+P)	10	40 T:25 P:15		50	3	NA	2
2	S/ZOO/202/MN-2	Chordate and Comparative Anatomy (Theory & Practical)	4 (T+P)	10	40 T:25 P:15		50	3	NA	2
3	S/ZOO/203/MD-2	Environment and Public Health Management	3(T)	10	40		50	3	NA	NA
4	S/ZOO/204/SEC-2	Aquarium Fish Management	3(T)	10	40		50	3	NA	NA
4	ACS/205/AEC-2	MIL (Santali/Bengali/Sanskrit)	2	10	40		50	2	NA	NA
6	ACS/206/VAC-2	Understanding India/Health and wellness	4	10	40		50	4	NA	NA
Total in Semester-II			20	60	240		300			



SEMESTER-III									
Sl. No.	Course Code	CourseTitle	Credit	Marks			No. of Hours		
				IA	ESE	Total	L	T	P
1	S/ZOO/301/MJC-3	Ecology (Theory & Practical)	4 (T+P)	10	40 T:25 P:15	50	3	NA	2
2	S/ZOO/302/MJC-4	Fundamentals of Biochemistry (Theory & Practical)	4 (T+P)	10	40 T:25 P:15	50	3	NA	2
3	S/ZOO/303/MN-3	Physiology and Biochemistry (Theory & Practical)	4 (T+P)	10	40 T:25 P:15	50	3	NA	2
4	S/ZOO/304/MD-3	Apiculture	3(T)	10	40	50	3	NA	NA
5	S/ZOO/305/SEC-3	Economic Zoology	3(T)	10	40	50	3	NA	NA
6	ACS/306/AEC-3	MIL-II (Santali/Bengali/Sanskrit)	2	10	40	50	2	NA	NA
Total in Semester-III			20	60	240	300			

SEMESTER-IV									
Sl. No.	Course Code	CourseTitle	Credit	Marks			No. of Hours		
				IA	ESE	Total	L	T	P
1	S/ZOO/401/MJC-5	Cell Biology (Theory & Practical)	4 (T+P)	10	40 T:25 P:15	50	3	NA	2
2	S/ZOO/402/MJC-6	Animal Physiology: Life sustaining System (Theory & Practical)	4 (T+P)	10	40 T:25 P:15	50	3	NA	2
3	S/ZOO/403/MJC-7	Developmental Biology (Theory & Practical)	4 (T+P)	10	40 T:25 P:15	50	3	NA	2
4	S/ZOO/404/MJC-8	Evolutionary Biology (Theory & Practical)	4 (T+P)	10	40 T:25 P:15	50	3	NA	2
5	S/ZOO/405/MN-4	Genetics and Evolution (Theory & Practical)	4 (T+P)	10	40 T:25 P:15	50	3	NA	2
6	ACS/406/AEC-4	Compulsory English: Literature, Language and Communication	2	10	40	50	2	NA	NA
Total in Semester-IV			22	60	240	300			



SEMESTER- V										
Sl. No.	Course Code	Course Title	Credit	Marks			No. of Hours			
				IA	ESE	Total	L	T	P	
1	S/ZOO/501/MJC-9	Molecular Biology (Theory & Practical)	4 (T+P)	10	40 T:25 P:15		50	3	NA	2
2	S/ZOO/502/MJC-10	Genetics (Theory & Practical)	4 (T+P)	10	40 T:25 P:15		50	3	NA	2
3	S/ZOO/503/MJC-11	Animal Behaviour & Chronobiology (Theory & Practical)	4 (T+P)	10	40 T:25 P:15		50	3	NA	2
4	S/ZOO/504/MJC-12	Endocrinology (Theory & Practical)	4 (T+P)	10	40 T:25 P:15		50	3	NA	2
5	S/ZOO/505/MN-5	Cell and Molecular Biology (Theory & Practical)	4 (T+P)	10	40 T:25 P:15		50	3	NA	2
Total in Semester-V			20	50	200		250			

SEMESTER- VI										
Sl. No.	Course Code	Course Title	Credit	Marks			No. of Hours			
				IA	ESE	Total	L	T	P	
1	S/ZOO/601/MJC-13	Immunology (Theory & Practical)	4 (T+P)	10	40 T:25 P:15		50	3	NA	2
2	S/ZOO/602/MJC-14	Biology of Insecta (Theory & Practical)	4 (T+P)	10	40 T:25 P:15		50	3	NA	2
3	S/ZOO/603/MJC-15	Parasitology (Theory & Practical)	4 (T+P)	10	40 T:25 P:15		50	3	NA	2
4	S/ZOO/604/MJC-16	Microbiology (Theory & Practical)	4 (T+P)	10	40 T:25 P:15		50	3	NA	2
5	S/ZOO/605/MN-6	Parasitology and Vector Biology (Theory & Practical)	4 (T+P)	10	40 T:25 P:15		50	3	NA	2
Total in Semester-VI			20	50	200		250			



SEMESTER– VII										
Sl. No.	Course Code	Course Title	Credit	Marks			No. of Hours			
				IA	ESE	Total	L	T	P	
1	S/ZOO/701/MJC-17	Biotechnology and Bioinformatics (Theory & Practical)	4 (T+P)	10	40 T:25 P:15		50	3	NA	2
2	S/ZOO/702/MJC-18	Biostatistics and Biophysics (Theory & Practical)	4 (T+P)	10	40 T:25 P:15		50	3	NA	2
3	S/ZOO/703/MJC-19	Histology-Histochemistry (Theory & Practical)	4 (T+P)	10	40 T:25 P:15		50	3	NA	2
4	S/ZOO/704/MJC-20	Fish and Fisheries (Theory & Practical)	4 (T+P)	10	40 T:25 P:15		50	3	NA	2
5	S/ZOO/705/MN-7	Developmental Biology (Theory & Practical)	4 (T+P)	10	40 T:25 P:15		50	3	NA	2
Total in Semester-VII			20	50	200		250			

- Major Courses in Zoology are for the students who opted for Certificate/Diploma/Degree in Zoology
- Minor Courses in Zoology for the students opted whose major courses other than Zoology.
- Multidisciplinary subject (for the students who donot studied the subject in H.S. level).
- Skill Enhancement Course (SEC)for the students of Zoology Major.
- Summer Internship one of 4 credits is compulsory within 1st year for Certificate, within 2nd year for Diploma, within 3 year for degree and within 4th year for Degree with Honours.
-

Question pattern for Zoology

For 25 Marks paper

Sl No.	Questions to be answered	Out of	Marks of each questions	Total Marks
1	5	8	1	5X1=05
2	2	4	5	2X5= 10
3	1	2	10	1X10=10

For40Markspaper

Sl No.	Questions to be answered	Out of	Marks of each questions	Total Marks
1	5	8	2	5X2= 10
2	4	6	5	4X5=20
3	1	2	10	1X10=10

**Programme Outcome of Zoology (PO)**

PO	Programme Outcome	Description
PO.1	Sound knowledge in different fields of Zoology	Students are expected to learn the fundamental concepts, principles and processes underlying the academic field of Zoology with special reference to the characteristics of animal diversity, ecological aspects, comparative anatomy and development , physiology and biochemistry, genetics and evolutionary biology, animal biotechnology, applied zoology, aquatic biology, immunology, reproductive biology, insect, vectors and diseases, apiculture, aquarium fish keeping, medical diagnostics, sericulture and microbiological relationship.
PO.2	Professional skills	Professional skills in the field of Zoology in relation to academia and industry require sound knowledge of the core courses as well as related fields of study such as chemistry, physics, mathematics etc. and above all interest in studying with the habit of asking questions to find out the cause and effect. Therefore, there must be the sincerity from both the teachers and learners to extend curiosity and grasp knowledge.
PO.3	Environmental awareness	Going through the courses as enshrined in the syllabus concerned students would generously and spontaneously develop the characteristics of thinking on the global environmental aspects.
PO.4	Designing and conducting experiments to test a hypothesis	On obtaining wholesome knowledge from learning the courses it would be possible for the learners to step into higher learning which requires designing experiments to prove hypotheses.
PO.5	Job opportunity	Biological Sciences today extend great opportunity towards sincere learners for healthy jobs in different fields beside academia such as health, medicines, research, biotechnological industry and such many. Therefore the students must be prepared in such a way so that they may able to face these competitive fields.

**Programme Specific Outcomes of Zoology (PSO)**

PSO	Description
PSO.1	<p>The core courses include diversified fields of life sciences viz:</p> <p>a) Overall concept of living organisms with special reference to animal kingdom; wherein it would be possible for the learners to have an idea of diverse group of animals, their structural aspects with functional anatomy .</p> <p>b) Concept of classifying these diversified groups of animals using taxonomical approaches. Evolutions of animals are studied by following evolutionary principles.</p> <p>c) Idea of developing ecological concepts in relation to individual, population and community along with the roles in organizing ecosystems and other structural and functional components.</p> <p>d) Similarities in Biochemistry, physiology and molecular aspects of all living organisms are taught in the light of modern approaches to develop the concept and generate interest.</p> <p>e) Molecular biological parameters in the form of DNA, RNA and proteins and their similarities and uniqueness in all living organisms.</p> <p>f) Protective approaches of animals against infectious diseases termed as immunity are studied to develop global concept of immunity following immunological principles.</p> <p>g) Development of animals from fertilized embryo is studied in relation to amphibian and avian embryonic development to have an overall concept of developmental pattern in animals.</p> <p>h) Endocrine regulation and coordination of different physiological system are studied in an independent course in the form of endocrinology.</p> <p>i) Heredity and variation of animals are studied following the general principles of genetics. Therefore using these study materials it becomes possible for the learners to develop Improved knowledge on the field.</p>
PSO.2	Applied zoology in the form of fish farming, poultry etc. Are studied in dependently by including separate programme called department specific elective in broader perspective so that the learners become seriously devoted to the subject.
PSO.3	Skill enhancement courses are introduced such as medical technology.....etc. to develop Specific skill in the area of self development to start the learners own laboratories.
PSO.4	Generic Elective courses have been incorporated as interdisciplinary to teach overall concept of the subject so that student from other discipline may choose the courses according to their interest.
PSO.5	Students ripen their investigative proficiency so that they can open up the entrances of the future knowledge world.
PSO.6	To help the students for development of essential academic skills like critical thinking, analytical reasoning, research skills to identifying various Invertebrate and Vertebrate fauna and their classification as well as to understand the relations among these organisms with an evolutionary perspective.
PSO.7	Students will be able to analyze and solve the problems related to animal sciences without relying on assumptions and guesses.
PSO.8	Students will be able to make solutions of biological problems by experimentation and Subsequent data processing by modern technologies and computer applications.



PSO.9	The programme will fortify the students to develop fundamental knowledge in biodiversity and their conservation, pollution of environment and their control measures.
PSO.10	They will be able to understand the basic zoological principles with critical understanding and analytical skills as well as to develop effective methods for experimentation and problem solving.
PSO.11	The programme will help the students to learn the safety measures in animal handling and management programmes in laboratories. Students will be able to learn the field survey for ecological studies as well as they will be capable of designing precise experimental setup for studying animal behavior.
PSO.12	The programme will strengthen the students for developing laboratory skills for Genetics and Molecular Biology. The laboratory programme will enable them to learn the techniques for the qualitative as well as quantitative assays of bio molecules.
PSO.13	They will understand the importance and role biodiversity and can recognize the Economically important animals around us.
PSO.14	Students will be able to learn about different diseases, causative organisms, parasites, hosts, vectors as well as the basic principles of immunology including vaccinations and genetic basis several diseases like cancer.
PSO.15	The programme will strengthen the students to understand the structure and function of the gene, chromosomes, genome, cell, tissue, organ and organ-system.
PSO.16	They will understand the importance of the physiological adaptations, development pathways, hormonal regulation of reproduction and other physiological mechanisms.
PSO.17	Another important programme outcome will be the ability of students to estimate various important environmental parameters like O ₂ , CO ₂ content, Ph, water turbulence, temperature, salinity, nutrient content.
PSO.18	Some special courses of the programme will help the students to develop essential skill and practical knowledge in application of economic Zoology in fishery, sericulture, apiculture Which will provide gainful employment and economic development.
PSO.19	Project work and field study provide them with an encouragement for self-learning.
PSO.20	Research Motivation is also another significant outcome that the students are endowed with on the completion of the programme.

**Semester- VII****Zoology Major-17****MJC-17: BIOTECHNOLOGY AND BIOINFORMATICS (Theory)****3 Credits**

Course Outcomes: To understand the basic principles and applications of biotechnology. To understand the theoretical as well as practical aspects of gene cloning, expression of recombinant proteins, cell culture, transgenic development and Intellectual Property Right. The aim of this course is to introduce the students from basics to advances of bioinformatics.

Group A: Biotechnology**Unit 1: Molecular Techniques in Gene manipulation**

1. Introduction to Biotechnology and IKS
2. Basic steps of genetic engineering and recombinant DNA technology.
3. Restriction endonucleases, DNA modifying enzymes.
4. Cloning Vectors: Plasmids, Phage vectors, BAC, YAC.
5. Restriction enzymes: Types, Nomenclature, cutting sites, detailed study of Type II.
6. Selection of Host cell with recombinant vector: Blue-white colony screening

Unit 2: Animal Cell Culture and Transgenic Animal Technology

1. Types of media used in animal cell culture; Preparation of primary and secondary culture system; Maintenance of cell culture and sub culture.
2. Production of transgenic animals: nuclear transplantation of Dolly.

Unit 3: Applications of Biotechnology

1. Transgenic animals (Transgenic Fish); Transgenic plants (cry protein)
2. Production of Human Recombinant insulin.
3. Applications of Gene Therapy in SCID
4. Molecular diagnosis of genetic diseases Sickle cell anaemia.
5. Basic concepts of Genomic libraries and cDNA libraries

Unit 4: Intellectual Property Right and Management of Biotechnology

1. IPR- IPP, Forms of Protection, Patenting strategy, Copy right, WIPO, GATT, WTO.
2. Role and regulation of Indian Patent. Biosafety guideline and regulation

Group B: Bioinformatics**Unit 5: Introduction**

1. Basic concept of Bioinformatics
2. Importance of bioinformatics in zoology, medicine, and public health

Unit 6: Biological Databases

1. Nucleic acid sequence databases: GenBank, EMBL, DDBJ
2. Concept of whole-genome databases w.r.t Human Genome Project
3. Purpose of protein databases: UniProt

Unit 7: Sequence Alignment & Analysis

1. FASTA format: Definition, Basic Structure
2. BLAST: Purpose and applications
3. Clustal W: Concept of multiple sequence alignment

Unit 8: Applications

1. Basic idea of: Health informatics & Nutrigenomics

**MJC-17: BIOTECHNOLOGY AND BIOINFORMATICS (Practical)****1 Credit**

Course Outcomes: This course will enable the students to gather practical knowledge on sterilization techniques and DNA isolation techniques. This course will enable the students to explore major biological database, search, and retrieve data from the database using their respective search engines.

1. Laboratory organization and GLP.
2. Demonstration of Sterilization techniques. (Autoclave, Laminar Airflow, Flame dry).
3. DNA isolation from bacteria (Curd sample).
4. Genomic DNA isolation from animal tissues (Cheek cells).
5. Demonstration of Separation of DNA by agarose gel electrophoresis.
6. Searching Databases: Genbank, Uni Prot
7. Similarity search tool: BLAST.
8. Visualization of Protein structures from PDB using RasMol.

Examination Pattern:**Full marks:15**

- | | | |
|----|--|---|
| 1. | Isolate DNA from the provided sample from item no. 3 or 4. | 6 |
| 2. | Any one tool from item no. 6 or 7 | 5 |
| 3. | Submission of laboratory note book | 2 |
| 4. | Viva voce | 2 |



Zoology Major-18

MJC-18: BIO STATISTICS AND BIO PHYSICS (Theory)

3 Credits

Course Outcomes: (a) knowledge on different types of data of the subject (b) skill to organise data, graphical displays and evaluation of summary measures such as measures of central tendency and dispersion etc. (c) Knowledge on different analytical statistical methods. (d) To acquire knowledge on some common biophysical chemical parameters and Microscopy.

Unit 1: Concept of data and its distribution

1. Definition of data.
2. Classification of Data: Continuous and discrete, Qualitative and quantitative, primary and secondary, grouped and ungrouped.
3. Presentation of data: Tabular and graphical
4. Types of distribution: Normal, skewed, Basic concept of Kurtosis.
5. Methods of sampling

Unit 2 Measures of Central Tendency

1. Mean, median, mode
2. Standard deviation, standard error with simple problems

Unit 3: Analytical Methods

1. Chi square Test
2. Student's t test (Paired and Unpaired)
3. Types of Analysis of variance (ANOVA). Simple problems on ANOVA
4. Correlation
5. Regression

Unit 4: Biophysical Chemistry

1. pH and Buffer.
2. Concepts of Osmosis, Diffusion, Donnan membrane equilibrium.
3. Laws of Thermodynamics; Concept of free energy, entropy and enthalpy.

Unit 5 Biological tools and techniques

1. Microscopy - Light (Bright-field, Dark-field and Phase contrast) and Electron (SEM and TEM).

Reading references:

1. Essential Bioinformatics by Jin Xiong, 1st Edition, 2006, Cambridge University press
2. Genetics: Analysis and Principles by Robert Brooker, 4th Edition, 2012, McGraw Hill
3. Biostatistics: A guide to design, analysis and discovery by Ronald Forthofer Eun Lee Mike Hernandez, 2nd Edition, 2006, Academic Press (Elsevier)

**MJC-18: BIO STATISTICS AND BIO PHYSICS (Practical)****1 Credit**

Course Outcomes: It gives the introductions of basic statistics to the students. It focuses on the application of basic statistics to the different real situations of daily life and our different activities in the society.

List of practical:

1. Calculation of chi-square from hypothetical data.
2. Determination of LC_{50} and LD_{50} by Probit analysis from hypothetical data.
3. Submission of a project report on field generated data with application of at least one statistical tool (i.e. correlation, regression, t Test, mean, median, mode, standard deviation, and standard error).

Examination Pattern:**Full marks:15**

- | | | |
|----|--|---|
| 5. | Any one problem from hypothetical data (From Item no.1 or 2) | 7 |
| 6. | Submission of a project report | 4 |
| 7. | Submission of laboratory note book | 2 |
| 8. | Viva voce | 2 |



Zoology Major-19

MJC-19: HISTOLOGY–HISTOCHEMISTRY (Theory)**3 Credits**

Course Outcomes: Explain the scientific basis of tissue preparation and be able to apply that understanding to the practice of the subjects such as making tissue sections, embedding, staining etc. To know about procedures of PAS, Feulgen and tissue preparation for Electron microscopy.

Unit 1: Fixation and Tissue preparation for histology

1. Purpose of tissue fixation, Types of fixation Mechanism of tissue Fixation Fresh-frozen sections;
2. Decalcification, Gum-sucrose/gelatin and paraffin wax embedding

Unit 2: Microtomy

1. Methods, problems and remedies of microtomy including cryostat freezing microtome

Unit 3: Biological dyes and stains

1. Characteristic features of biological dyes and stain;
2. Principle of staining
3. Orthochromatic vs metachromatic staining.
4. Mordant and Mordanting.
5. Properties, source and use of haematoxylin, eosin and fuchsin, orange G, aniline blue in single, double and triple staining.

Unit 4: Principles and methods of histochemical localization and identification of the following

1. Carbohydrate moieties: Glycogen and glycoproteins by Periodic acid Schiff method
2. Nucleic acids: Feulgen reaction for DNA
3. Enzymes: Metallic and Azo dye methods for acid and alkaline phosphatases

Unit 5: Immunohistochemistry

1. Fluorescence histochemistry Basic principles and applications
2. Preparation of biological material for TEM and SEM

Suggested readings

- Bancroft, J.D. and Gamble, M. (2002). *Theory and Practice of Histological Technique*. Churchill Livingstone.
- Bloom, W. and Fawcett, D.W. (1998). *A Textbook of Histology*. 12th Edition. W.B. Saunders Company.
- Fawcett, D.W., Ronald, P. and William, B. (2002). *Bloom and Fawcett's: Concise Histology*. 2nd Edition. Arnold, London.
- Friefelder, D. (1982). *Physical Biochemistry: Applications to Biochemistry and Molecular Biology*. 2nd Edition. W.H. Freeman and Co., San Francisco (Reprint 1999).
- Glauert, A.M. (1975). *Fixation, Dehydration and Embedding of Biological Specimens*. Elsevier, New York and North-Holland.
- Gurr, G.T. (1956). *A Practical Manual of Medical and Biological Staining Techniques*. Interscience, New York.
- Junqueira, L.C. and Carneiro, J. (2005). *Basic Histology: Text and Atlas*. 11th Edition. McGraw-Hill Lange Medical Publication, New York.
- Kiernan, J.A. (2008). *Histological and Histochemical Methods: Theory and Practice*. 4th Edition. Scion, Bloxham, UK.
- Leeson, T.S., Leeson, C.R. and Paparo, A.A. (1988). *Text/Atlas of Histology*. 1st Edition. W. B. Saunders Company, Philadelphia.
- Pearse, A.G.E. (1980). *Histochemistry, Theoretical and Applied*. Vol. 1. 4th Edition. Churchill Livingstone, New York.
- Reoschenko, V.P. (2012). *DiFiore's Atlas of Histology with Functional Correlations*. 12th Edition.
- Wolter Kluwer, Netherlands.
- Ross, M.H., Kaye, G.I. and Pawlina, W. (2003). *Histology: A Text and Atlas*. 4th Edition. Lippincott Williams and Wilkins, Philadelphia.
- Ross, M.H. and Reith, E. (1985). *Histology: A Text and Atlas*. Harper and Row Publishers.
- Sharma, B.K. (1991). *Techniques in Microscopy and Cell Biology*. Tata-McGraw Hill, New Delhi.
- Singh, I. (2010). *Text Book of Human Histology with Colour Atlas and Practical Guide*. Jaypee brothers' Medical Publishers Ltd., Delhi.
- Stoward, P.J. and Pearse, A.G.E. (1991). *Histochemistry: Theory and Practical*. 4th Edition. Churchill Livingstone.
- Weesner, F.M. (1965). *General Zoological Techniques*. The William and Wilkins Company.

**MJC-19: HISTOLOGY–HISTOCHEMISTRY (Practical)****1 Credit**

Course Outcomes: The practical course will enable students to identify the endocrine glands, Pituitary, Pineal, Thyroid, Parathyroid, Adrenal, Pancreas, Testis, Ovary through permanent slides e.t.c. through permanent slides. The course will help the students to know about different techniques of Microtomy and PAS reaction.

Practical:

1. Fixation, dehydration, embedding, section cutting, stretching, orientation, staining, and mounting of rat tissues (Liver, kidney, spleen, and testis) (Haematoxylin and eosin staining).
2. Histochemical reactions for localization carbohydrates by PAS.
3. Observation of permanent slides of mammalian organs – liver, lung, kidney, stomach, intestine, spleen.

Examination Pattern:**Full marks:15**

- | | |
|--|---|
| 1. Identification of any two mammalian organs through permanent slide | 4 |
| 2. Perform any three processes of microtomy techniques from item no 1. | 3 |
| 3. Perform PAS reaction to localize carbohydrate in a provided tissue | 4 |
| 4. Submission of laboratory note book | 2 |
| 5. Viva voce | 2 |

**Zoology Major-20****MJC-20: FISH AND FISHERIES (Theory)****3 Credits**

Course Outcomes: The theory course would fortify the students with in-depth subject knowledge about aquatic organisms as well as marine biology and management of aquatic resources.

Unit 1: Morphology and Physiology

1. Types of scales, Use of scales in classification and determination of age of fish
2. Gills and gas exchange
3. Electric organs
4. Bioluminescence
5. Osmoregulation
6. Locomotion in fish

Unit 2: Fisheries

1. Inland fisheries
2. Marine fisheries
3. Application of remote sensing and GIS in fisheries

Unit 3: Aquaculture

1. Freshwater prawn culture,
2. Fish culture in paddy fields
3. Composite fish culture
4. Induced breeding of fish
5. Pearl culture
6. Extensive, semi-intensive and intensive culture of fish

Unit 4: Fish Pathology and Transgenesis

1. Fish diseases: bacterial, viral, fungal and parasites; Preservation, diagnosis and treatment,
2. Fishery by-products
3. Transgenic fish, zebra fish as a model organism in research.

Unit 5 Fishery Management

1. Fish food organisms and their production.
2. Transport of fish seed and Brood fish.

**MJC-20: FISH AND FISHERIES (Practical)****1 Credit**

Course Outcomes: This practical course will enable them to identify the important fishes present in aquatic ecosystem and to determine some water parameters in water collected from a water body.

PRACTICAL

1. Study of *Chimaera*, *Gambusia*, *Labeo rohita*, *Labeo bata*, *Labeo calbasu*, *Anabas*, *Rastrelliger kanagurta*, *Sardinella longiceps*, *Puntius*, *Lates calcarifer*, *Macrobrachium rosenbergii*.
2. Morphometric and meristic characters of fishes.
3. Study of crafts and gears used in fisheries.
4. Water quality criteria for aquaculture: assessment of pH, conductivity, total dissolve solids.
5. Study of air breathing organs in *Channa*, *Heteropneustes*, *Anabas* and *Clarias*.
6. Project Report on a visit to any fish farm/pisciculture unit/Zebrafish rearing Lab.
8. Laboratory note book

Examination Pattern:**Full marks:15**

- | | | |
|-----|---|---|
| 9. | Identification of any three specimens from item no 1 and 3 | 6 |
| 10. | Perform an experiment/morphometric study from item no 2 and 4 | 2 |
| 11. | Submission of project report | 3 |
| 12. | Submission of laboratory note book | 2 |
| 13. | Viva voce | 2 |

**Semester-VII****Zoology Minor-7****MN-7: Developmental Biology (Theory)****3 Credits****Unit 1: Introduction**

1. Basic concepts: Phases of Development

Unit 2: Early Embryonic Development

1. Gametogenesis: Spermatogenesis, Oogenesis, Types of eggs, Egg membranes
2. Fertilization (External and Internal), prevention of polyspermy.
3. Planes and Patterns of cleavage
4. Early development of frog up to gastrulation.

Unit 3: Late Embryonic Development

1. Fate of Germ Layers (Brief idea).
2. Implantation of embryo in human.
3. Placenta (Structure, types and functions).

Unit 4: Post Embryonic Development

1. Brief idea of regeneration: Types and examples

Unit 5: Implications of Developmental Biology

1. Teratogenesis: Definition and example
2. Basic concept of Stem cell

MN-7: Developmental Biology (Practical)**1 Credit****Practicals**

1. Identification of whole mounts of developmental stages of chick through permanent slides: 24, 48 and 72 hours of incubation.
2. Identification of different sections of placenta (epitheliochorial, endotheliochorial and hemochorial) (photomicrograph / slides)
3. Examination of gametes - frog/rat - sperm and ova through permanent slides or photomicrographs.

Distribution of Marks**Examination Pattern****Fullmarks: 15**

1. Identification with reasons (any three) (From Item no.1 & 2)	9(3×3)*
2. Spot identification of any one from item no. 3	2
3. Laboratory note book:	2
4. Viva voce	2

***Note:**

- Q1. Identification: 1 mark and reasons: 2 marks