

**UNIVERSITY DEPARTMENT OF ZOOLOGY
VINOBA BHAVE UNIVERSITY HAZARIBAG**



**FOUR YEAR BACHELOR'S DEGREE PROGRAMME WITH
HONOURS/RESEARCH**

**(B.Sc. Zoology)
SYLLABUS
(w.e.f. 2022-26)**

जीवनं सत्यशोधनम्

Implemented from Academic Session 2022-2026

Members of Board of Studies for preparing Provisional Syllabus of the Four-Year Undergraduate Programme (FYUGP)

Chairman:

Dr. B. K. Gupta

Head, University Department of Zoology, VBU, Hazaribag

Members:

1. Dr. A. K. Sharma (Invitee Member)

(Retired Professor, University Department of Zoology, VBU, Hazaribag)

2. Dr. K.K. Gupta

Associate Professor, University Department of Zoology, VBU, Hazaribag

3. Prof. Y Jaggi

University Department of Zoology, VBU, Hazaribag

4. Dr. Onkar Nath Chowdhary

Assistant Professor, Dept. of Zoology, Giridih College, Giridih

5. Dr. Manoj Kumar

Assistant Professor, University Department of Zoology

6. Dr. Rajendra Mistry

Assistant Professor, University Department of Zoology, VBU

7. Dr. J. P Sanyal

Assistant Professor, Annada College Department of Zoology, Hazaribag

8. Dr. Kalpana Chhaya Lakra

Assistant Professor, Department of Zoology, Markham College of Commerce, Hazaribag

9. Prof. Purnima Shalini Orea

Assistant Professor, Department of Zoology, St. Columba's College, Hazaribag

10. Prof. Priyanka Kujur

Assistant Professor, Department of Zoology, St. Columba's College, Hazaribag

11. Prof. Kanika Kumari

Assistant Professor, Department of Zoology, J.J. College, Jhumri Telaiya

12. Prof. Namrata Tirkey

Assistant Professor, Department of Zoology, R.K. Mahila College, Giridih

External Experts:

1. Dr. S. K. Sinha

Associate Professor, University Department of Zoology, BBMK University, Dhanbad

2. Dr. Venkat Appa Rao

Assistant Professor, Department of Zoology, St. Xavier's College, Ranchi

Special Invitee Member:

Prof. Dr. Firoz Ahmed

Retired Professor, University Department of Zoology, Ranchi University,

Ex- Vice- Chancellor, NPU, Daltonganj.

CONTENTS

S. No.	Topics	Page No.
1.	Highlights of Regulation of FYUGP	2-5
2.	Semester wise Course code and Credit points for Single Major	6-11
3.	Format of Question Paper for SIE & ESE for Major and Minor	12-15
4.	Syllabus of Major course	16-76
5.	Syllabus of Minor course	77-93



HIGHLIGHTS OF REGULATIONS OF FYUGP

PROGRAMME DURATION

The Full-time, Regular UG programme for a regular student shall be for a period of four years with multiple entries and multiple exit options.

PROGRAMME OVERVIEW/ SCHEME OF THE PROGRAMME

Undergraduate degree programmes of either 3 or 4-year duration, with multiple entries and exit points and re-entry options within this period, with appropriate certifications such as:

- UG Certificate after completing 1 year (2 semesters) of study in the chosen fields of study provided they complete one vocational course of 4 credits during the summer vacation of the first year or internship/Apprenticeship in addition to 6 credits from skill-based courses earned during first and second semester.
- UG Diploma after 2 years (4 semesters) of study provided they complete one vocational course of 4 credits or internship/Apprenticeship/ skill based vocational courses offered during first year or second year summer term in addition to 9 credits from skill- based courses earned during first, second, and third semester.
- Bachelor after a 3-year (6 semesters) programme of study.
- Bachelor's Degree (Honours) after a 4-year (8 semesters) programme of study
- Bachelor Degree (Honours with Research) after a 4-year (8 semesters) programme of study to the students undertaking 12 credit Research component in fourth year of FYUGP.

VALIDITY OF REGISTRATION

- Validity of a registration for FYUGP will be for maximum for Seven years from the date of registration.

CREDIT OF COURSES

The term 'credit' refers to the weightage given to a course, usually in terms of the number of instructional hours per week assigned to it. The workload relating to a course is measured in terms of credit hours. It determines the number of hours of instruction required per week over the duration of a semester (minimum 15 weeks).

- a) One hour of teaching/ lecture or two hours of laboratory/practical work will be assigned per class/interaction.

One credit for Theory = 15 Hours of Teaching i.e., 15 Credit Hours

One credit for Practical = 30 Hours of Practical work i.e., 30 Credit Hours

- b) For credit determination, instruction is divided into three major components:

Hours (L) – Classroom Hours of one-hour duration.

Tutorials (T) – Special, elaborate instructions on specific topics of one-hour duration

Practical (P) – Laboratory or field exercises in which the students must do experiments or other practical work of two-hour duration.

CALCULATION OF MARKS FOR THE PURPOSE OF RESULT

- Student's final marks and the result will be based on the marks obtained in Semester Internal Examination (SIE) and End Semester Examination (ESE) organized taken together.
- Passing in a subject will depend on the collective marks obtained in Semester internal and End Semester University Examination both. However, students must pass in Theory and Practical Examinations separately.

PROMOTION AND SPAN PERIOD

- i. The Requisite Marks obtained by a student in a particular subject will be the criteria for promotion to the next Semester.
- ii. No student will be detained in odd Semesters (I, III, V & VII).
- iii. To get promotion from Semester-II to Semester-III a student will be required to pass in atleast 75% of Courses in an academic year (a student must pass in minimum 9 papers out of the total 12 papers. However, it will be necessary to procure pass marks in each of the paper before completion of the course.
- iv. To get promotion from Semester-IV to Semester-V (taken together of Semester I, II, III & IV) a student must pass in minimum 16 papers out of the total 22 papers.
- v. Eligibility to get entry in Semester VII is to secure a minimum of 7.5 CGPA up to semester VI along with other criteria imposed by the Institution.

Table 1: Credit Framework for Four Year Undergraduate Programme (FYUGP) under State Universities of Jharkhand [Total Credits = 160]

Level of Courses	Semester	MJ: Discipline Specific Courses - Core or Major (80)										Credits	Double Major (DMJ)
		MN: Minor from discipline (16)	MN: Minor from vocational (16)	MDC: Multidisciplinary Courses [Life sciences, Physical Sciences, Mathematical and Computer Sciences, Humanities, etc.] (9)	AEC: Ability Enhancement Courses (Modern Indian Language and English) (8)	SEC: Skill Enhancement Courses (9)	VAC: Value Added Courses (6)	IAP: Internship/ Dissertation (4)	RC: Research Courses (12)	AMR: Advanced Courses in lieu of Research (12)			
I	2	3	4	5	6	7	8	9	10	11	12	13	14
100-199: Foundation or Introductory courses	I	4	4		3	2	3	4				20	4+4
	II	4+4		4	3	2	3					20	4+4
Exit Point: Undergraduate Certificate provided with Summer Internship/ Project (4 credits)													
200-299: Intermediate-level courses	III	4+4	4		3	2	3					20	4+4
	IV	4+4+4		4	2	2		2				20	4+4
Exit Point: Undergraduate Diploma provided with Summer Internship in 1st or 2nd year/ Project (4 credits)													
300-399: Higher-level courses	V	4+4+4	4						4			20	4+4
	VI	4+4+4+4		4								20	4+4
Exit Point: Bachelor's Degree													
400-499: Advanced courses	VII	4+4+4+4	4									20	4+4
	VIII	4		4						12	4+4+4	20	4+4
Exit Point: Bachelor's Degree with Hons./Hons. with Research												160	224

Note: Honours students not undertaking research will do 3 courses for 12 credits in lieu of a Research project / Dissertation.



Semester wise Course code and Credit points for Single Major:

Semester	Common, Introductory, Major, Minor, Vocational and Internship Courses		Credits
	Code	Papers	
I	AEC-1	Language and Communication Skills (MIL-1; Modern Indian language including TRL)	2
	VAC-1	Value Added Course-1	4
	SEC-1	Skill Enhancement Course-1	3
	MDC-1	Multi-disciplinary Course-1	3
	MN-1A	Minor from Discipline-1	4
	MJ-1	Major paper 1 (Disciplinary/Interdisciplinary Major)	4
II	AEC-2	Language and Communication Skills (English)	2
	SEC-2	Skill Enhancement Course-2	3
	MDC-2	Multi-disciplinary Course-2	3
	MN-2A	Minor from Vocational Studies/Discipline-2	4
	MJ-2	Major paper 2 (Disciplinary/Interdisciplinary Major)	4
	MJ-3	Major paper 3 (Disciplinary/Interdisciplinary Major)	4
III	AEC-3	Language and Communication Skills (MIL-2; Modern Indian language including TRL)	2
	SEC-3	Skill Enhancement Course-3	3
	MDC-3	Multi-disciplinary Course-3	3
	MN-1B	Minor from Discipline-1	4
	MJ-4	Major paper 4 (Disciplinary/Interdisciplinary Major)	4
	MJ-5	Major paper 5 (Disciplinary/Interdisciplinary Major)	4
IV	AEC-3	Language and Communication Skills (MIL-2/ English-2)	2
	VAC-2	Value Added Course-2	2

	MN-2B	Minor from Vocational Studies/Discipline-2	4
	MJ-6	Major paper 6 (Disciplinary/Interdisciplinary Major)	4
	MJ-7	Major paper 7 (Disciplinary/Interdisciplinary Major)	4
	MJ-8	Major paper 8 (Disciplinary/Interdisciplinary Major)	4
V	MN-1C	Minor from Discipline-1	4
	MJ-9	Major paper 9 (Disciplinary/Interdisciplinary Major)	4
	MJ-10	Major paper 10 (Disciplinary/Interdisciplinary Major)	4
	MJ-11	Major paper 11 (Disciplinary/Interdisciplinary Major)	4
	IAP	Internship/Apprenticeship/Field Work/Dissertation/Project	4
VI	MN-2C	Minor from Vocational Studies/Discipline-2	4
	MJ-12	Major paper 12 (Disciplinary/Interdisciplinary Major)	4
	MJ-13	Major paper 13 (Disciplinary/Interdisciplinary Major)	4
	MJ-14	Major paper 14 (Disciplinary/Interdisciplinary Major)	4
	MJ-15	Major paper 15 (Disciplinary/Interdisciplinary Major)	4
VII	MN-1D	Minor from Discipline-1	4
	MJ-16	Major paper 16 (Disciplinary/Interdisciplinary Major)	4
	MJ-17	Major paper 17 (Disciplinary/Interdisciplinary Major)	4
	MJ-18	Major paper 18 (Disciplinary/Interdisciplinary Major)	4
	MJ-19	Major paper 19 (Disciplinary/Interdisciplinary Major)	4
VIII	MN-2D	Minor from Vocational Studies/Discipline-2	4
	MJ-20	Major paper 20 (Disciplinary/Interdisciplinary Major)	4
	RC/	Research Internship/Field Work/Dissertation OR	12/
	AMJ-1 AMJ-2 AMJ-3	Advanced Major paper-1 (Disciplinary/Interdisciplinary Major) Advanced Major paper-2 (Disciplinary/Interdisciplinary Major) Advanced Major paper-3 (Disciplinary/Interdisciplinary Major)	4 4 4
		Total Credits	160

NUMBER OF CREDITS BY TYPE OF COURSE

The hallmark of the new curriculum framework is the flexibility for the students to learn courses of their choice across various branches of undergraduate programmes. This requires that all departments prescribe a certain specified number of credits for each course and common instruction hours (slot time).

Overall Course Credit Points for Single Major

Courses	Nature of Courses	4 yrs. UG Credits
Major	Core courses	80
Minor	i. Discipline/ Interdisciplinary courses and ii. Vocational Courses	32
MDC	Multidisciplinary – 3 credits in I,II& III	9
AEC	Language courses	8
SEC	Courses to be developed by the University	9
Value Added Courses (VAC)	Understanding India, Environmental Studies, Digital Education, Health & wellness, Summer Internship/ Apprenticeship/ Community outreach activities, etc.	6
IAP	Internship (In any summer vacation for Exit points or in Semester-V)	4
Research Courses (RC) / Dissertation/ Advanced Major Courses (AMJ)	Research Institutions/ 3 Courses	12
	Total Credits	160

Abbreviations:

- AEC Ability Enhancement Courses
 SEC Skill Enhancement Courses
 IAP Internship/Apprenticeship/Project
 VAC Value added courses
 MDC Multidisciplinary Courses
 MJ Major Disciplinary/Interdisciplinary Courses
 MN Minor Disciplinary/Interdisciplinary Courses
 AMJ Advanced Major Disciplinary/Interdisciplinary Courses
 RC Research Courses

Semester wise Examination Structure in Discipline Course

Semester	Courses		Examination Structure			
	Code	Papers	Credits	Mid Semester Theory (F.M.)	End Semester Theory (F.M.)	End Semester Practical/ Viva (F.M.)
I	MJ-1	SYSTEMATICS & DIVERSITY OF NON-CHORDATES	4	25 (20+5)	75	---
II	MJ-2	SYSTEMATICS & DIVERSITY OF CHORDATES	4	25 (20+5)	75	---
	MJ-3	PRACTICAL-I (Non-chordate and Chordate)	4	---	---	100
III	MJ-4	CELL AND MOLECULAR BIOLOGY	4	25 (20+5)	75	---
	MJ-5	Practical-II (Cell and Molecular Biology)	4	---	---	100
IV	MJ-6	MAMMALIAN PHYSIOLOGY & REPRODUCTIVE BIOLOGY	4	25 (20+5)	75	---
	MJ-7	BIOCHEMISTRY	4	25 (20+5)	75	---
	MJ-8	Practical-III (Mammalian Physiology and Reproductive Biology, Biochemistry)	4	---	---	100
V	MJ-9	GENETICS	4	25	75	---
	MJ-10	EVOLUTION & POPULATION GENETICS	4	25 (20+5)	75	---
	MJ-11	Practical-IV (Genetics, Evolution and Population Genetics)	4	---	---	100
VI	MJ-12	ENDOCRINOLOGY	4	25 (20+5)	75	---
	MJ-13	DEVELOPMENTAL BIOLOGY & MEDICAL ZOOLOGY	4	25 (20+5)	75	---
	MJ-14	ENVIRONMENTAL BIOLOGY	4	25 (20+5)	75	---
	MJ-15	Practical-V (Endocrinology, Developmental Biology and Medical Zoology, Environmental Biology)	4	---	---	100

VII	MJ-16	IMMUNOLOGY & MICROBIOLOGY	4	25 (20+5)	75	---
	MJ-17	BIOSTATISTICS & BIOINFORMATICS	4	25 (20+5)	75	---
	MJ-18	ANIMAL BEHAVIOUR AND ECONOMIC ZOOLOGY	4	25 (20+5)	75	---
	MJ-19	Practical-VI (Immunology and Microbiology, Bioinformatics and Biostatistics, Animal Behaviour and Economic Zoology)	4	---	---	100
VIII	MJ-20	BIOTECHNOLOGY	4	25	75	---
	AMJ-1	APPLIED ZOOLOGY	4	25 (20+5)	75	---
	AMJ-2	TOOLS & TECHNIQUES	4	25 (20+5)	75	---
	AMJ-3	Practical-VII (Biotechnology, Applied Zoology, Tools and Techniques)	4	---	---	100

Semester wise Course Code and Credit Points for Skill Enhancement Courses:

Semester	Common, Introductory, Major, Minor, Vocational & Internship Courses		Examination Structure			
	Code	Papers	Credits	Mid Semester Theory (F.M.)	End Semester Theory (F.M.)	End Semester Practical/ Viva (F.M.)
I	SEC-1	WILDLIFE CONSERVATION AND MANAGEMENT	3	---	75	---
II	SEC-2	SERICULTURE & APICULTURE	3	---	75	---
III	SEC-3	VERMICOMPOSTING & BIOFERTILIZERS	3	---	---	75
		Total Credits	9			

Semester wise Course Code and Credit Points for Minor Courses:

Semester	Common, Introductory, Major, Minor, Vocational & Internship Courses		Examination Structure			
	Code	Papers	Credits	Mid Semester Theory (F.M.)	End Semester Theory (F.M.)	End Semester (F.M.)
I	MN-1A	ANIMAL CLASSIFICATION & DIVERSITY	3 (45hrs)	15	60	75
	MNP-1A	PRACTICAL	1(30hrs)			25
III	MN-1B	CELLBIOLOGY, GENETICS & EVOLUTION	3 (45hrs)	15	60	75
	MNP-1B)	PRACTICAL	1(30hrs)			25
V	MN-1C	BIOCHEMISTRY, PHYSIOLOGY & DEVELOPMENTAL BIOLOGY	3 (45hrs)	15	60	75
	MNP-1C	PRACTICAL	1(30hrs)			25
VII	MN-1D	ECOLOGY & ECONOMIC ZOOLOGY	3 (45hrs)	15	60	75
	MNP_1D	PRACTICAL	1(30hrs)			25
		Total Credits	16			



Format of Question Paper for SIE & ESE for Major

INSTRUCTIONS TO QUESTION SETTER

SEMESTER INTERNAL EXAMINATION (SIE):

There will be **Only One Semester Internal Examination** in Major, Minor and Research Courses, which will be organized at college/institution level. However, Only One End semester evaluation in other courses will be done either at College/ Institution or University level depending upon the nature of course in the curriculum.

A. (SIE 10+5=15 marks): For Minor

There will be two group of questions. **Question No.1 will be very short answer type in Group A** consisting of five questions of 1 mark each. **Group B will contain descriptive type** two questions of 5 marks each, out of which any one to be answered.

The Semester Internal Examination shall have two components. (a) One Semester Internal Assessment Test (SIA) of 10 Marks, (b) Class Attendance Score (CAS) of 5 marks.

B. (SIE 20+5=25 marks): For Major

There will be two group of questions. **Group A is compulsory** which will contain two questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 will be short answer type** of 5 marks. **Group B will contain descriptive type** two questions of 10 marks each, out of which any one to be answered.

The Semester Internal Examination shall have two components. (a) One Semester Internal Assessment Test (SIA) of 20 Marks, (b) Class Attendance Score (CAS) of 5 marks.

Conversion of Attendance into score may be as follows:

Attendance Upto 45%= 1mark; 45< Attd. <55% =2 marks; 55<Attd. <65%= 3 marks; 65%<Attd. <75%=4 marks; 75%<Attd= 5 marks.

END SEMESTER UNIVERSITY EXAMINATION (ESE):

A. (ESE 60 marks): For Minor

There will be two group of questions. **Group A is compulsory** which will contain three questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 & 3 will be short answer type** of 5 marks. Group B will contain descriptive type six questions of 15 marks each, out of which any three are to be answered.

B. (ESE 75 marks): For Major

There will be two group of questions. **Group A is compulsory** which will contain three questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No. 2 & 3 will be short answer type** of 5 marks. Group B will contain descriptive type seven questions of 15 marks each, out of which any four are to be answered.

C. (ESE 100 marks):

There will be two group of questions. **Group A is compulsory** which will contain three questions. **Question No.1 will be very short answer type** consisting of ten questions of 1 mark each. **Question No. 2 & 3 will be short answer type** of 5 marks. Group B will contain descriptive type six questions of 20 marks each, out of which any four are to be answered.

FORMAT OF QUESTION PAPER FOR SEMESTER INTERNAL EXAMINATIONS

Question format for 10 Marks:

F.M. =10	Subject/ Code Time=1Hr.	Exam Year
General Instructions:		
i. Group A carries very short answer type compulsory questions.		
ii. Answer 1 out of 2 subjective/ descriptive questions given in Group B .		
iii. Answer in your own words as far as practicable.		
iv. Answer all sub parts of a question at one place.		
v. Numbers in right indicate full marks of the question.		
Group A		
1.		[5x1=5]
i.		
ii.		
iii.		
iv.		
v.		
Group B		
2.		[5]
3.		[5]
Note: There may be subdivisions in each question asked in Theory Examination.		

Question format for 20 Marks:

F.M. =20	Subject/ Code Time=1Hr.	Exam Year
General Instructions:		
i. Group A carries very short answer type compulsory questions.		
ii. Answer 1 out of 2 subjective/ descriptive questions given in Group B .		
iii. Answer in your own words as far as practicable.		
iv. Answer all sub parts of a question at one place.		
v. Numbers in right indicate full marks of the question.		
Group A		
1.		[5x1=5]
i.		
ii.		
iii.		
iv.		
v.		
2.		[5]
Group B		
3.		[10]
4.		[10]
Note: There may be subdivisions in each question asked in Theory Examination.		

Note: These formats may be modified or designed uniformly for a common type of courses.

FORMAT OF QUESTION PAPER FOR END SEMESTER UNIVERSITY EXAMINATIONS

Question format for 50 Marks:

F.M. =50	Subject/ Code Time=2Hrs.	Exam Year
General Instructions:		
i. Group A carries very short answer type compulsory questions. ii. Answer 3 out of 5 subjective/ descriptive questions given in Group B . iii. Answer in your own words as far as practicable. iv. Answer all sub parts of a question at one place. v. Numbers in right indicate full marks of the question.		
<u>Group A</u>		
1.		[5x1=5]
i.		
ii.		
iii.		
iv.		
v.		
<u>Group B</u>		
2.		[15]
3.		[15]
4.		[15]
5.		[15]
6.		[15]
Note: There may be subdivisions in each question asked in Theory Examination.		

Question format for 60 Marks:

F.M. =60	Subject/ Code Time=3Hrs.	Exam Year
General Instructions:		
i. Group A carries very short answer type compulsory questions. ii. Answer 3 out of 5 subjective/ descriptive questions given in Group B . iii. Answer in your own words as far as practicable. iv. Answer all sub parts of a question at one place. v. Numbers in right indicate full marks of the question.		
<u>Group A</u>		
1.		[5x1=5]
i.		
ii.		
iii.		
iv.		
v.		
2.		[5]
3.		[5]
<u>Group B</u>		
4.		[15]
5.		[15]
6.		[15]
7.		[15]
8.		[15]
Note: There may be subdivisions in each question asked in Theory Examination.		


Question format for 75 Marks:

F.M. = 75	Subject/ Code Time=3Hrs.	Exam Year
General Instructions:		
i. Group A carries very short answer type compulsory questions. ii. Answer 4 out of 6 subjective/ descriptive questions given in Group B . iii. Answer in your own words as far as practicable. iv. Answer all sub parts of a question at one place. v. Numbers in right indicate full marks of the question.		
<u>Group A</u>		
1.		[5x1=5]
i.		
ii.		
iii.		
iv.		
v.		
2.		[5]
3.		[5]
<u>Group B</u>		
4.		[15]
5.		[15]
6.		[15]
7.		[15]
8.		[15]
9.		[15]
Note: There may be subdivisions in each question asked in Theory Examination.		

Question format for 100 Marks:

F.M. = 100	Subject/ Code Time=3Hrs.	Exam Year
General Instructions:		
i. Group A carries very short answer type compulsory questions. ii. Answer 4 out of 6 subjective/ descriptive questions given in Group B . iii. Answer in your own words as far as practicable. iv. Answer all sub parts of a question at one place. v. Numbers in right indicate full marks of the question.		
<u>Group A</u>		
1.		[10x1=10]
i.	vi.	
ii.	vii.	
iii.	viii.	
iv.	ix.	
v.	x.	
2.		[5]
3.		[5]
<u>Group B</u>		
4.		[20]
5.		[20]
6.		[20]
7.		[20]
8.		[20]
9.		[20]
Note: There may be subdivisions in each question asked in Theory Examination.		





Syllabus of Major course

Semester-I

Paper– I

[Systematics & Diversity of Non-chordates]

Full Marks = 100 **End Semester: 75** **Internal: 20 + 5**
Marks: 25 (5 Attd. + 20 SIE:1Hr) + 75 (ESE:3Hrs) = 100 **Pass Marks: Th (SIE+ESE) = 40**

VBU/Sem-I/Zool/MJ- I

Credit – 4

About the course

The course is a walk for the Bachelor's entrant through the amazing diversity of living forms from simple to complex one. It enlightens how each group of organisms arose and how did they establish themselves in the environment with their special characteristics. It also deals with the differences and similarities between organisms based on their morphology and anatomy which led to their grouping into taxa and clades.

Learning outcomes

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

- ❖ Develop understanding on the diversity of life with reference to protists and non-chordates.
- ❖ Group animals on the basis of their morphological characteristics/ structures.
- ❖ Develop critical understanding how animals changed from a primitive cell to a collection of simple cells to form a complex body plan.
- ❖ Examine the diversity and evolutionary history of a taxon through the construction of a basic phylogenetic/ cladistics tree.
- ❖ Understand how morphological change due to change in environment helps driven evolution over a long period of time.
- ❖ The project assignment will also give them a flavour of research to find the process involved in studying biodiversity and taxonomy besides improving their writing skills. It will further enable the students to think and interpret individually due to different animal species chosen.

VBU/Sem-I/Zool/MJ- I

S. NO.	Topics	Hours of Teaching
1	Introduction to R.H. Whittaker's Classification Classification of various phyla upto Classes: Acoelomate, Pseudocoelomate and Coelomate, Protostomes and Deuterostomes, Bilateria and Radiata; Status of Parazoa, Onychophora and Hemichordata.	08
2	Protozoa: Locomotion, Nutrition, Reproduction.	07
3	Porifera: Skeleton, Canal system and Reproduction.	06
4	Cnidaria: Polymorphism in Siphonophora, Cnidoblast structures and its role; Coral reefs and their formation; metagenesis; general features and life history of <i>Obelia</i> . Ctenophora: General Characters and Classification.	07
5	Platyhelminthes & Nemathelminthes: Parasitic adaptation in helminthes.	06
6	Annelida: Metamerism & Segmental organs (Coelomoducts & Nephridia); adaptive radiation in polychaetes; general features of earthworm.	08
7	Arthropoda: Larval forms in Crustacea; vision and respiration in arthropods (prawn & cockroach); Different types of mouth parts in insects (Biting & Chewing type, Piercing & Sucking Type, Siphoning type and Sponging type)	07
8	Molluscs: Respiration, types of locomotory organelles, Torsion and de-torsion in Gastropods.	05
9	Echinodermata: Larval forms and Water vascular system.	06
	Total Hours	60

Books Recommended

Systematics (Animal Taxonomy)

1. Dalela and Sharma: Animal Taxonomy and Museology (Current edition, Jai Prakash Nath).
2. Kapoor: Theory and Practical's of Animal Taxonomy (Current edition, Oxford & IBH).
3. Simpson: Principles of Animal Taxonomy (1962, Oxford).
4. Roymahoney: Laboratory Techniques in Zoology (1966, Butterworths).
5. Mayer and Ashlock: Principles of Systematic Zoology (1991, McGraw Hill).

Non-Chordates

1. Ruppert and Barnes, RD (2006) Invertebrate Zoology, VIII edition. Holt Saunders International edition.
2. Barnes, R.S.K., Calow, P. Olive., Golding, D.W. and Spicer, J.LI. (2002) The Invertebrates; E.J.W, III Edition, Blackwell Science.
3. Barrington, E.J.W. (1979) Invertebrate structure and function. IInd edition. E.L.B. Sand Nelson
4. Boolotian and Stiles: College Zoology (10th ed. 1981, Macmillan).
5. Campbell and Reece: Biology (7th ed. 2005, Pearson).
6. Nigam: Biology of Non-chordates (Current edition, S. Chand).
7. Miller and Harley: Zoology (6th ed. 2005, W.C. Brown).
8. Parker and Haswell: Text Book of Zoology, Vol. I (2005, Macmillan).

ONLINE TOOLS AND WEB RESOURCES:

- ❖ Swayam (MHRD) Portal.
- ❖ Animal Diversity(<https://swayam.gov.in/courses/5686-animal-diversity>) .
- ❖ Advances in Animal Diversity, Systematics and Evolution(<https://swayam.gov.in/courses/5300-zoology>)
- ❖ ePG Pathshala (MHRD) Module10, 18, 19 of the paper P-08 (Biology of Parasitism)
<https://epgp.inflibnet.ac.in/ahl.php?csrno=35>

Semester– II

Paper– II [Systematics and Diversity of Chordates]

Full Marks = 100 End Semester: 75 Internal: 20 + 5
Marks: 25 (5Attd. + 20SIE:1Hr) +75 (ESE:3Hrs) = 100 Pass Marks: Th (SIE+ESE) = 40

VBU/Sem- II/Zool/MJ- II

Credit - 4

About the course

The course enlightens how each chordate group of organisms arose and how did they establish themselves in the environment with their special characteristics. It also deals with the differences and similarities between organisms on the basis of their morphology and anatomy which led to their grouping into taxa and clades.

Learning outcomes

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

- ❖ Develop understanding on the diversity of life of chordate species.
- ❖ Group animals on the basis of their morphological characteristics/structures.
- ❖ Understand how morphological characteristics change due to change in environment helps driven evolution over a long period of time.
- ❖ The project assignment will also give them a flavour of research to find the process involved in studying biodiversity and taxonomy besides improving their writing skills. It will further enable the students to think and interpret individually due to different animal species chosen.

S. NO.	Topics	Hours of Teaching
1	Origin of Chordates	02
2	Protochordates: General features and Life history of Herdmania (Retrogressive metamorphosis) and Branchiostoma; Ammocete Larva	08
3.	Cyclostomes and Pisces: General features and classification of upto sub class. Cyclostomes: General organisation of Petromyzon and Myxine. Pisces: Accessory Respiratory organs in Teleost; Dipnoi.	10
4	Amphibia: General features and classification of Amphibia upto order. Amphibia: Origin of tetrapod, Neoteny and Pedogenesis in Axolotl Larva.	06
5	Reptilia: General features and classification upto order. Origin of reptiles, distribution and Status of <i>Sphenodon</i> . Difference between poisonous and Non-poisonous snakes. Poison apparatus and Biting Mechanisms of snakes.	08
6	Aves: General features and classification upto order. Origin of birds, flight adaptation.	06
7	Mammalia: General features and classification upto order. Origin of mammals, dentition, general features of Prototheria and Metatheria. Aquatic mammals and Adaptive radiation in primates.	10
8.	Vertebrates: Comparative functional anatomy of various systems of vertebrates. Integument and its derivatives, Brain, circulatory system including heart and aortic arches, and urogenital system.	10
	Total Hours	60

Books Recommended

Diversity of Chordates

1. Miller and Harley: Zoology (6th ed. 2005, W.C. Brown)
2. Nigam: Biology of Chordates (1997, S. Chand)
3. Parker and Haswell: A Text Book of Zoology Vol. II (2005, Macmillan)
4. Purves et al: Life - The Science of Biology, (7th ed. 2004, Sinauer)
5. Romer, A.S. Parsons, T.S: The vertebrate body, 6th ed. 1986, CBS publishing, Japan Ltd.
6. Sinha, A.K., and Adhikari, S. and Ganguli, B: Biology of Animals Vol. II New Central Agency, Calcutta
7. Young, J.J.: The life of Vertebrates, 3rd ed. 1981, ELBS with oxford press.
8. Vishwanath: Vertebrate Zoology.

ONLINE TOOLS AND WEB RESOURCES:

- ❖ <https://www.khanacademy.org/science/biology/crash-course-bio-ecology/crash-course-biology-science/v/crash-course-biology-123>
- ❖ <https://opentextbc.ca/biology2eopenstax/chapter/chordates>

Semester– II
Paper– III
Practical (Non-chordates and Chordates)

Full Marks = 100

(No Internal exam)

Credits: 4 (120 hrs.)

Time: 3hrs.

S. No.	Practicals	Marks Distribution
1	Dissection Non-Chordate	15
2	Dissection Chordate	15
3	Slide Preparation (2 slides: One Invertebrate and One Vertebrate)	10+10=20
4	Spotting: (10 x 2.5 marks) Permanent Slides 04 Museum Specimen 04 Bones 02	25
5	Class Record, Poster/ Model and PowerPoint presentation	15
6	Viva-voce	10
TOTAL		100

S. No.	Suggested Practicals
1	Study of Available Museum Specimen of animals <i>Sycon, Physalia, Metridium, Adamsia, Fasciola, Taenia solium, Nereis, Aphrodite, Pheretima, Chiton, Pila, Unio, Sepia, Loligo, Octopus, Limulus, Millipedes, Centipedes, Palaemon, Asterias, Echinus, Holothuria</i>
2	Study of the following through permanent slide Paramecium (wm), Conjugation of Paramecium, <i>Obelia</i> colony, Gemmules of Sponges, Ephyra larva, Miracidium larva, Sporocyst larva, Redia larva, Cercaria larva, Trochophore larva, Glochidium larva, Nauplius, Zoea larva, Mysis larva, Megalopa larva, Bipinnaria larva, Echinopluteus larva, Ophiopluteus larva, T.S. of earthworm through pharynx, Gizzard, Typhlosole.
3	Dissection I. Dissection of Digestive, Nervous and Reproductive system of Earthworm II. Dissection of Digestive and Nervous system of <i>Palaemon</i> .

4	<p>Mounting Mounting of Nephridia & Ovary of Earthworm, trachea and salivary glands of <i>Periplaneta americana</i>, Cephalic appendages of <i>Palaemon</i></p>
5	<p>Chordate Diversity: Study with the help of models, Figures or Specimens</p> <p>1. Protochordate: <i>Balanoglossus</i>, <i>Herdmania</i> 2. Agnatha: <i>Petromyzon</i> and <i>Myxine</i> 3. Pisces: <i>Scoliodon</i>, <i>Torpedo</i>, <i>Chimaera</i>, <i>Labeo rohita</i>, <i>Cirrhinus mrigala</i>, <i>Hippocampus</i>, <i>Exocoetus</i>, <i>Syngnathus</i>, <i>Heteropneustes</i>, <i>Clarias batrachus</i>, <i>Anabas</i>, <i>Echeneis</i>, <i>Channa</i>, <i>Notopterus</i> 4. Amphibia: <i>Ambystoma</i>, <i>Axolotl larva</i>, <i>Alytes</i>, <i>Hyla</i>, <i>Bufo</i>, <i>Rana</i>. 5. Reptiles: Turtle, Tortoise, <i>Calotes</i>, <i>Draco</i>, <i>Chameleon</i>, <i>Naja naja</i>, <i>Bungarus</i> (Krait), <i>Vipera</i> (Chandrabora), <i>Hydrophis</i>, <i>Crocodylus</i>, Python. 6. Aves: <i>Columba livia</i>, <i>Psittacula</i> (Parrot), <i>Bubo</i> (Great Horned owl), <i>Alcedo</i> (Kingfisher), <i>Dinopium</i> (Woodpecker), <i>Passer</i> (House Sparrow), <i>Pycnonotus</i> (Bul-Bul), Ostrich model. Types of beaks and claws 7. Mammals: Prototheria, Duck-Bill Platypus, Spiny Anteater, <i>Pteropus</i> (Megachiroptera), <i>Manis</i> (Pangolin), <i>Funambulus</i>, <i>Hystrix</i> (Porcupine), <i>Cavia</i> (Guinea Pig), <i>Rattus rattus</i></p>
6	<p>Osteology: Bones of Amphibia and Mammal- pelvic girdle, pectoral girdle, forelimb, hindlimb, vertebrae.</p>
7	<p>Study of Histological Slides: (Frog & Mammal) V.S. of Skin, T.S. of Stomach, Intestine, Liver, Spleen, Kidney, Lung</p>
8	<p>Dissection: Dissection of Local Bony Fishes: Afferent, Efferent and Nervous system.</p>
9	<p>Mounting: Cycloid and Placoid scales of fish</p>
10	<p>Power Point presentation: Study of any two animals from two different classes by students (may be included if dissections not given permission).</p>

❖ जीवनं सत्यशोधनम् ❖

Semester– III

Paper– IV [Cell and Molecular Biology]

Full Marks = 100

End Semester: 75 Internal: 20 + 5

Marks: 25 (5 Attd. + 20 SIE:1Hr) + 75 (ESE:3Hrs) = 100 Pass Marks: Th (SIE+ESE) = 40

VBU/Sem- III/Zool/MJ- IV

Credit - 4

About the course

The course provides a detailed insight into basic concepts of cellular structure and function. It also gives an account of the complex regulatory mechanisms that control cell function. The course provides an insight into the life processes at the subcellular and molecular levels. Other important aspects include DNA and molecular genetics including gene cloning, sequencing and gene mapping in addition to the powerful techniques that revolutionized the pharmaceutical, health and agricultural industries.

Learning outcomes

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

- ❖ Understand the functioning of nucleus and extra nuclear organelles and understand the intricate cellular mechanisms involved.
- ❖ Acquire the detailed knowledge of different pathways related to cell signalling and apoptosis thus enabling them to understand the anomalies in cancer.
- ❖ Develop an understanding how cells work in healthy and diseased states and to give a 'health forecast' by analyzing the genetic database and cell information.
- ❖ Develop an understanding of concepts, mechanisms and evolutionary significance and relevance of molecular biology in the current scenario.
- ❖ Get well versed in recombinant DNA technology which holds application in biomedical & genomic science, agriculture, environment management, etc.
- ❖ Apply their knowledge in problem solving and future course of their career development in higher education and research.
- ❖ Get new avenues of joining research in related areas such as therapeutic strategies or related opportunities in industry.

Therefore, a fundamental understanding of Molecular Biology will help in career building in all these fields.

VBU-MJ-Z-IV

S. No.	Topics	Hours of Teaching
1	The Cell: Typical structure of animal cell, Comparison of a generalized pro-and eukaryotic cell.	02
2	Methods in Cell Biology: Elementary idea of microscopy and cell fractionation, Light Microscope, Scanning Electron Microscope (SEM), Transmission Electron Microscope (TEM).	05
3	Extra nuclear organization of cell: Structure and function of plasma membrane, Endo membrane system (Structure and functions of mitochondria, endoplasmic reticulum, Golgi complex, lysosome), peroxisome, Introduction to cytoskeleton.	12
4	Nuclear organization of cell: Nuclear envelope, nucleolus and biogenesis of ribosome, Ultrastructure of Chromosome, Introduction to Polytene and Lampbrush chromosomes.	06
5	Cell reproduction: Basic features of cell cycle, Brief idea of Cyclin and Cyclin Dependent Kinase in Control of Cell cycle, Mitosis and meiosis and its significance.	10
6	DNA: Structure, types and functions; RNA: Structure, types and functions.	04
7	Properties and Mechanisms of DNA Replication in Prokaryotes.	04
8	Gene Expression: Concept of Genetic Code, Central Dogma, Mechanism of Transcription in Prokaryotes, Mechanism of Translation in Prokaryotes.	06
9	Concept of Operons (Positive and Negative: Inducible and Repressible), Lac Operon.	04
10	DNA Damage: DNA Damage by Mutagens.	03
11	DNA Repair: Base Excision Repair, Nucleotide Excision Repair, Double Stranded Break Repair, Thymine Dimer Repair.	04
	Total Hours	60

Books Recommended:

Cell and Molecular Biology

1. Alberts *et al*: Essential Cell Biology (Current edition, Garland)
2. Karp: Cell and Molecular Biology (Current edition, John Wiley)
3. Lodish *et al*: Molecular Cell Biology (Current edition, 2004 Freeman)
4. Pollard and Earnshaw: Cell Biology (Current edition, Saunders)
5. Cooper and Hausman: The Cell, A Molecular approach (2007, Sinauer)

ONLINE TOOLS AND WEBRESOURCES

- ❖ <https://swayam.gov.in/course/150-cell-biology>
- ❖ <https://swayam.gov.in/courses/5173-biochemistry-and-cell-biology>
- ❖ <https://www.jove.com/science-education-library/9/cell-biology>
- ❖ <https://www.khanacademy.org/science/biology>



Semester– III

**Paper– V,
Practical (Cell and Molecular Biology)**

Full Marks = 100 (No Internal Exam)

VBU/Sem- III/Zool/MJ- V

Credit - 4

S. No.	Practicals	Marks Distribution
1	Preparation of Idiogram from photographs of given karyotypes and comment on genetic disorder	15
2	Preparation of solution for molecular biology (Molarity, Molality, Normality)	10
3	Onion root tip's squash preparation /polytene chromosome preparation	10
4	Spotting (6x5 marks) Photographs -03; Slides-03	30
5	Comment upon the Instrument	10
6	Class Record, Poster/Model and Power Point presentation	15
7	Viva-voce	10
	TOTAL	100

❖ **जीवनं सत्यशोधनम्** ❖

List of Practicals:

1. Preparation of ball and stick model for B-DNA molecule (A=T and G=C base pairs).
2. Isolation of genomic DNA by ethanol precipitation method.
3. Preparation of LB-agar plates (with and without 100 microgram/ml Ampicillin and 10 microgram/ml Tetracycline), streaking of *E.coli* DH5-alpha strain (normal) and transformed with plasmids [Ampicillin-resistant (pBlue script) and Tetracycline-resistant (pBR322)].
4. Isolation of the plasmid DNA from the *E.coli* culture by alkaline lysis method.
5. Agarose gel electrophoresis of the plasmid DNA and the genomic DNA.
6. Photographs of prokaryotic cell.
7. Photographs of cell organelles.
8. Stages of mitosis by squash technique.
9. Photographs of structure of DNA, RNA.
10. Diagrams of translation, transcription.
11. Preparation of solutions for molecular biology experiments.
12. Isolation of chromosomal DNA from bacterial cells.
13. Agarose gel electrophoresis of genomic DNA and plasmid DNA.
14. Preparation of restriction enzyme digests of DNA samples.
15. Demonstration of AMES test or reverse mutation for carcinogenicity.
16. Study of slides of prokaryotic cell-Bacteria.
17. Study of slides of unicellular eukaryotic cell –Amoeba, Paramecium.
18. Study of various stages of cell division through permanent slides mitosis and meiosis.
19. Preparation of mitotic slides from onion root tips.
20. Study of blood cells through slide preparation.
21. Study of Barr body through slide preparation from hair follicle/cheek cells of female.
22. Preparation of Idiogram from given karyotypes.
23. Instrument used in cell and molecular biology – Micropipette, Centrifuge, Autoclave, Laminar flow.

Semester– IV

Paper– VI

Mammalian Physiology and Reproductive Biology

Full Marks = 100

End Semester: 75

Internal: 20 + 5

Marks: 25 (5 Attd. + 20 SIE:1Hr) + 75 (ESE:3Hrs) = 100

Pass Marks: Th (SIE+ESE) = 40

VBU/Sem- IV/Zool/MJ- VI

Credit - 4

About the course

The course deals with various physiological functions in mammals. It also gives an account of the metabolic/ biochemical pathways and the probable impact of environment on them.

Learning outcomes

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

- ❖ Understand the physiology at cellular and system levels.
- ❖ Understand the mechanism and regulation of breathing, oxygen consumption and determination of respiratory quotient.
- ❖ Understand how mammalian body gets nutrition from different biomolecules.
- ❖ Understand the process of digestion and excretion.
- ❖ Understand the organization of nervous system and process of nerve impulse conduction.
- ❖ Understand the process of vision and hearing.
- ❖ Understand the process of muscle contraction.
- ❖ Learn the estimation of hemoglobin content, determination of blood groups and measurement of blood pressure.

VBU-MJ-Z-VI

S. No.	Topics	Hours of Teaching
1	Tissue and their functions: Epithelial tissue, Connective tissue, Muscular tissue and Nervous tissue.	04
2	Principles of physiology: Adaptation, Acclimatization, Acclimation, Homeostasis, acid-base balance, thermoregulation Feedback-control systems.	06
3	Concept of Balanced Diet, Digestion and Absorption: Role of salivary glands, liver, pancreas and Gastric glands, Digestion of Carbohydrate, Fats and Proteins in Gastro-Intestinal tract. Concept of BMR (Basal Metabolic Rate).	08
4	Composition and constituents of blood; blood groups and Rh Factor in man; factors and mechanism of coagulation; anticoagulants	06
5	Haemoglobin: Composition, types and role in transport of oxygen and carbon dioxide, Oxygen Dissociation Curve, Bohr's Effect, Transport of Carbon Dioxide, Carbon Dioxide Dissociation Curve, Halden's Effect.	08
6	Excretion: Excretory product, Structure of nephron and Mechanism of urine formation; Factors affecting GFR and role of ADH, Renin – Angiotensin aldosterone system and Osmo-regulation.	06
7	Neuron: Structure and types, Nerve impulse: conduction; Synaptic transmission and Neurotransmitters.	06
8	Muscles: Types, mechanism of contraction of skeletal muscles, effects of exercise on muscles. Cori Cycle	04
9	Structure of human eye, mechanism of vision and defects. Structure of human ear and hearing mechanisms.	06
10	Physiology of reproduction: Histophysiology of testis and ovary, Puberty, Menstrual cycle and Menopause.	06
	Total Hours	60

Books recommended:

Mammalian Physiology

1. Nielson: Animal Physiology– Adaptation and Environment (Current edition, Cambridge)
2. Marshal land Hughes: Physiology of Mammals and Vertebrates (Current edition, Cambridge)
3. Hoar: General and Comparative Physiology (Current edition, Prentice Hall)
4. Prosser: Comparative Animal Physiology (4th ed. 1991, Satish Book)
5. C. C. Chatterjee Medical physiology
6. Guyton– A book on medical physiology (Current edition)
7. Stuart Era Fox-Human Physiology (Current edition)
8. Gerard J. Tortora and Bryan Derrickson Principles of Anatomy and Physiology (Current edition)

ONLINE TOOLS AND WEB RESOURCES:

- ❖ eportals like SWAYAM and
- ❖ <http://nsdl.niscair.res.in>

Semester– IV

Paper– VII Biochemistry

Full Marks = 100 End Semester: 75 Internal: 20 + 5
Marks: 25 (5Attd. + 20 SIE:1Hr) + 75 (ESE:3Hrs) = 100 Pass Marks: Th (SIE+ESE) = 40

VBU/Sem- IV/Zool/MJ- VII
VBU-MJ-Z-VII

Credit - 4

About the course

The course introduces 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 about the importance and scope of biochemistry.
- ❖ Understand the structure and biological significance of carbohydrates, amino acids, proteins, lipids and nucleic acids.
- ❖ Understand the concept of enzyme, its mechanism of action and regulation.
- ❖ Understand the process of nucleotide biosynthesis .
- ❖ Learn the preparation of models of peptides and nucleotides.
- ❖ Learn biochemical tests for amino acids, carbohydrates, proteins and nucleic acids.
- ❖ Learn measurement of enzyme activity and its kinetics.

S. No.	Topics	Hours of Teaching
1	Biochemistry: Introduction, scope and importance. Water as biological solvent.	02
2	Metabolism: Basic concepts, Central role of ATP in metabolism, Carbon fuel and its oxidation, Concept of energy rich compounds (ATP, UTP, GTP, CP NAD and FAD)	05
3	Carbohydrates: Structure and biological importance. Classification- Reducing and non- reducing sugars, Monosaccharides, Oligosaccharides, Polysaccharides (Peptidoglycans and Glycosaminoglycans). Catabolism of carbohydrates and ATP production- (Glycolysis, Krebs cycle, Electron transport chain and ATP synthesis), Gluconeogenesis, Glycogenolysis and Glycogenesis.	12
4	Lipids: Structure and Biological significance. Fatty acids: Types and nomenclature (saturated and unsaturated). Classification: Triglycerides, Phospholipids, Sphingolipids, Cholesterol; β - oxidation and omega-oxidation of saturated fatty acids with even and odd number of carbon atoms.	12
5	Proteins: Composition and Biological significance. Amino acids- Structure, classification and properties, Ionization, titration curve, pK and pI. Physiological importance of essential and non-essential amino acids. Catabolism of amino acids: Transamination, Deamination, Urea cycle.	12
6	Enzymes: Nomenclature and classification, general properties, specificity, cofactors, isozymes. Mechanism of enzyme action (ES complex and lowering of activation energy, chemical catalysis). Kinetics (determination of K_m and V_{max} using Michaelis-Menten and Lineweaver-Burk plots). Regulation of enzyme activity, inhibition, allosteric regulation, role of covalent modifications, ribozymes and concept of abzymes	10
7	Nucleotide biosynthesis and metabolism, <i>de Novo</i> pathway and salvage pathways its regulation and diseases	05
8	Vitamins: Characteristics and Types of Fat Soluble and Water-Soluble Vitamins and their related diseases	02
	Total Hours	60

Books Recommended

Biochemistry

1. Boyer: Concepts in Biochemistry (Current edition, Brooks/Cole)
2. Lehninger, Nelson and Cox: Principles of Biochemistry, Current edition.
3. Harper's illustrated biochemistry Current edition, Appleton and Lange
4. Jeremy M. Berg, John L. Tymoczko, Lubert Stryer with Gregory J. Gatto Jr., Biochemistry W. H. Freeman and Company (Current edition).
5. Conn, Stumpf, Bruening and Doi: Principles of Biochemistry (Current edition, Wiley)

ONLINE TOOLS AND WEBRESOURCES

- ❖ CEC Gurukul (www.cec.nic.in).
- ❖ <https://www.youtube.com/user/cecedusat/featured>.
- ❖ National Institute of Science Communication and Information Resources (NISCAIR) (<http://www.niscair.res.in/>) and National Science Digital Library (NSDL) (www.nsdlnet.niscair.res.in).
- ❖ National Digital Library of India (NDL India; <https://ndl.iitkgp.ac.in/>).

Semester– IV

Paper– VIII

Practical [Physiology and Biochemistry]

Full Marks = 100

[No internal]

VBU/Sem- IV/Zool/MJ- VIII

Credit - 4

Time: 4 hrs

S. No.	Practicals	Marks Distribution
1	Preparation of slides	10
2	Preparation of buffer solution of given pH	10
3	Detection of biomolecules	10
4	Estimation of unknown biomolecules	15
5	Spotting 1-6 (06X5) = Histological slides -04, Contraceptive device-02	30
6	Class Record, Poster/Model and Power point Presentation	15
7	Viva-voce	10
	TOTAL	100

❖ जीवनं सत्यशोधनम् ❖

List of Practicals

1. Preparation of temporary mounts: Blood film, Squamous epithelium, Striated muscle fibres and nerve cells.
2. Counting of white blood corpuscles and red blood corpuscles.
3. Preparation of haemin crystals.
4. Estimation of haemoglobin content.
5. Determination of blood groups.
6. Measurement of blood pressure using sphygmomanometer.
7. Determination of oxygen consumption (cockroach).
8. Estimation of casein from milk.
9. Recording of simple muscle twitch with electrical stimulation (or Virtual).
10. Demonstration of reflex action.
11. Study of permanent histological sections of mammalian oesophagus, stomach, duodenum, rectum, lung, kidneys and brain cells
12. Examination of histological sections from photomicrographs/ permanent slides of rat/human: testis, epididymis and accessory glands of male reproductive systems.
13. Sections of ovary, fallopian tube, uterus (proliferative and secretory stages), cervix and vagina.
14. Sperm count and sperm motility in rat.
15. Study of modern contraceptive devices.
16. Study of common instruments used in laboratory- Weighing balance, pH meter, Haemocytometer, Haemometer, Stethoscope and Sphygmomanometer.

Biochemistry

1. Detecting adulteration in a) Ghee b) Sugars c) Tea leaves and d) Turmeric.
2. Estimation of Lactose in milk.
3. Titrimetric method for Ascorbic acid estimation.
4. Estimation of Calcium in foods by titrimetric.
5. Detection of biomolecules in the unknown sample-
 - a. Benedict's test for reducing sugars.
 - b. Ninhydrin test for α amino acids.
 - c. Iodine test for starch
6. Project- Computer aided diet analysis and nutrition counselling for different age groups.
7. Group discussion or Seminar presentation.

Semester–V

Paper– IX

Genetics

Full Marks = 100 End Semester: 75 Internal: 20 + 5

Marks: 25 (5Attd. + 20 SIE:1Hr) + 75 (ESE:3Hrs) = 100 Pass Marks: Th (SIE+ESE) = 40

VBU/Sem- V/Zool/MJ-IX

Credit - 4

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. A strong emphasis will be laid on the modern tools and techniques used in genetics.

Learning outcomes

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

- ❖ Understand how DNA encodes genetic information and the function of mRNA and tRNA
- ❖ Apply the principles of Mendelian inheritance.
- ❖ Understand the cause and effect of alterations in chromosome number and structure.
- ❖ Relate the conventional and molecular methods for gene manipulation in other biological systems.
- ❖ Discuss and analyze the epigenetic modifications and imprinting and its role in diseases.
- ❖ Get new avenues of joining research in related areas such as genetic engineering of cells, cloning, genetic disorders, human fertility programme, genotoxicity, etc.

VBU-MJ-Z-IX

S. No.	Topics	Teaching Hours
1	Mendel's laws of inheritance, Crossing over (Genetic recombination), linkage and linkage group, Sex linkage, Multiple alleles, genetics of blood groups, hereditary diseases in man (Sickle cell anaemia, Colour blindness, Haemophilia and Albinisms) linkage mapping.	10
2	Exceptions to Mendelian Inheritance: Incomplete dominance, Codominance, Multiple allelism, Lethal alleles, Pleiotropy, Epistasis - Recessive, Double recessive and double dominant. Genomic imprinting, Penetrance and expressivity, Phenocopy, Polygenic inheritance. Mendelian traits in man.	10
3	Classical and Modern concept of gene (Cistron, muton, recon), housekeeping gene, split gene, overlapping gene).	05
4	Sex chromosomes and their evolution, Sex determination methods: XX/XO, XX/XY, ZZ/ZW and haploidy/diploidy types, Genic balance theory, intersex, gynandromorphs. Hormonal influence on sex determination-Freemartin and sex reversal. Role of environmental factors- <i>Bonellia</i> and Sex determination in <i>Drosophila</i> and man. (Alternate splicing, Role of different genes in the determination of sex	10
5	Concept of Spontaneous and Induced Mutation, Structure and Numerical alterations of Chromosomes	04
6	Human Genetics: Pedigree analysis; Karyotype, banding and nomenclature of chromosome subdivisions. Genetic disorders: chromosomal aneuploidy (Down, Turner and Klinefelter syndromes).	05
7	Apoptosis and necrosis; Concept & Mechanisms of Apoptosis.	05
8	Bacterial genetics: Transformation, conjugation and transduction.	05
9	Transposomes and Transposition (Ac and Ds element and IS element)	04
10	Biology and genetics of Cancer	02
	Total Hours	60

Books Recommended

Genetics

1. Brooker: Genetics: Analysis and Principles (Current edition, Addison-Wesley).
2. Gardner *et. al.*, Principles of Genetics (Current edition, John Wiley).
3. Griffith *et. al.*, An Introduction to Genetic Analysis (Current edition Freeman).
4. Hartl and Jones: Essential Genetics: A Genomic Perspective (Current edition, Jones and Bartlett).
5. Russell: Genetics (Current edition, Benjamin Cummings).
6. Snustad and Simmons: John Wiley, Principles of Genetics (Current edition).
7. Lewin: Genes V, VI, VII, VIII, IX, X, XI, XII (Jones and Bartlett).
8. Genetics: Principles and Analysis Fourth Edition, Daniel. Hartal and Elizabeth W. Jones (Current edition)
9. Principle of Genetics – Tamarin.

ONLINE TOOLS AND WEB RESOURCES

- ❖ <https://swayam.gov.in/courses/4922-genetics-and-genomics>
- ❖ <https://www.coursera.org/learn/genetics-evolution>
- ❖ <https://onlinelearning.hms.harvard.edu/hmx/courses/hmx-genetics/>
- ❖ <https://learn.genetics.utah.edu/>

Semester–V
Paper– X
Evolution and Population Genetics

Full Marks = 100 End Semester: 75 Internal: 20 + 5

Marks: 25 (5Attd. + 20 SIE:1Hr) + 75 (ESE:3Hrs) = 100 Pass Marks: Th (SIE+ESE) = 40

VBU/Sem-V/ Zool/MJ-Z-X

Credit - 4

About the course

The present course gives insight into the origin of life and the related evolutionary processes. The evolutionary theories and the process of species formation will be elaborated in view of the natural selection process.

Learning outcomes

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

- ❖ Acquire an in-depth knowledge on the diversity and relationships in animal world.
- ❖ Develop a holistic appreciation on the phylogeny and adaptations in animals.
- ❖ Enable the students to understand the evolution of universe and life.
- ❖ Understanding on the process and theories in evolutionary biology.
- ❖ Develop an interest in the debates and discussion taking place in the field of evolutionary biology.

VBU-MJ-Z-X

S. No.	Topics	Teaching Hours
1	Theories of origin of life.	02
2	Theory and Sources of Evolution: Lamarckism, Neo-Lamarckism, Darwinism, Neo-Darwinism, Sources of Variations: Mutation and Recombination	08
3	Theories of evolution; Natural selection, Mutation theory of Evolution, role of mutation in evolution, evolutionary patterns, molecular drive.	10
4	Reproductive Isolation and its role in evolution. Modes of Speciation.	03
5	Hardy-Weinberg Law of Equilibrium, Genetic Drift, Founder effect and Bottle-neck effect	06
6	Geological time scale and Geological Era, Fossils and its types, modes of formation of fossils, Age determination of fossils.	06
7	Evolution of horse and man using fossil data.	06
8	Tectonic plates, Continental drift and distribution of animals. Corridors and Barriers.	05
9	Levels and Pattern of Evolution: Micro-evolution, Macro-evolution, Mega-evolution; Basic Pattern of Evolution: Divergent Evolution, Adaptive Radiation, Parallel Evolution and Convergent Evolution.	08
10	Zoo-geography- A concept with special reference to Oriental region, Ethiopian and Australian region.	06
	Total Hours	60

Books Recommended:

Evolution

1. Moody: Introduction to Evolution (1978, Kalyani).
2. Savage: Evolution (1963, Holt, Reinhart and Winston)
3. Veer Bala Rastogi: Organic Evolution (Current edition, Kedarnath & Ramnath)
4. Strickberger: Evolution (2004, Jones & Bartlett)

ONLINE TOOLS AND WEB RESOURCES

- ❖ <https://swayam.gov.in/courses/4922-genetics-and-genomics>
- ❖ <https://www.coursera.org/learn/genetics-evolution>
- ❖ <https://onlinelearning.hms.harvard.edu/hmx/courses/hmx-genetics/>
- ❖ <https://learn.genetics.utah.edu/>

Semester-V

Paper- XI

Practical [Genetics, Evolution, and Population Genetics]

VBU-MJ-Z-XI

S. No.	Practicals	Marks Distribution
1	Comment on Fossil /Living Fossil / Connecting Links	15
2	Estimation of gene and genotype frequency	15
3	Construction of genetic Map	15
4	Spotting:1 to 6 (6X 5 marks) Mutants of Drosophila-2 Transgenic animals/Cloned animals-2 Photographs-2	30
5	Class Record, Poster/Model and Power Point presentation	15
6	Viva-voce	10
	TOTAL	100



List of Practicals:

Genetics:

1. Application of probability in the law of segregation with coin tossing, seeds of pea.
2. Frequency of the following genetic traits in human: widow's peak, attached earlobe, dimple in chin, hypertrichosis, colour blindness, PTC tasting.
3. Study of mode of inheritance of the following traits by pedigree charts—attached ear lobe.
4. Familiarization with techniques of handling *Drosophila*, identifying males and females; observing wild type and mutant (white eye, wingless) flies, and setting up cultures
5. Demonstration of law of segregation (monohybrid and test cross) sex-linked inheritance in *Drosophila* making a cross between white eye dumpy winged or sepia eyed and wild type flies (criss-cross inheritance).
6. Demonstration of lethal alleles using Curly (Cy) mutant in *Drosophila*.
7. Demonstration of multiple allelism by showing mutants of white eye series in *Drosophila*
8. Study of structural chromosomal aberrations (dicentric, ring chromosomes and inversions in polytene chromosomes) from prepared slides/photographs.
9. Study of human karyotypes and numerical alterations (Down syndrome, Klinefelter syndrome and Turner syndrome).
10. Gene mapping.

Evolution

1. Fossils study of the distribution of gene frequency.
2. Study of adaptive radiations in feet of birds and mouth parts of insects.
3. Understanding embryological evidence of evolution (through charts and videos).
4. Study of types of fossils.
5. Analogy and homology (wings of birds and insects, forelimbs of bat and rabbit).
6. Serial homology in appendages of Palaemon.

Semester–VI

Paper– XII Endocrinology

Full Marks = 100

End Semester: 75

Internal: 20 + 5

Marks: 25 (5 Attd. + 20 SIE:1Hr) + 75 (ESE:3Hrs) = 100

Pass Marks: Th (SIE+ESE) = 40

VBU-MJ-Z-XII

Credit - 4

About the course

The course envisages information on endocrine system with emphasis on the structure of hypothalamus and anterior pituitary. 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 hypophyseal axis.
- ❖ Understand about different endocrine glands and their disorders.
- ❖ Understand the mechanism of hormone action.

S. No.	Topics	Hours of Teaching
1	Over view of the endocrine system, Classification of Hormones.	02
2	Mechanisms of Hormone Action, Hormone receptors, Transduction and regulation of Hormone action at Molecular level: Molecular mediators (C-Amp mediated; GPCR Family; IP3-Calcium Signalling Systems; RTKs, Protein Kinases and Phosphatases in Cellular Signalling); Steroid Hormone Receptor and its action	10
3	Pineal gland: Structure & Secretions of pineal gland and their functions in biological rhythms and reproduction.	03
4	Hypothalamus: Structure of hypothalamus, Hypothalamic nuclei and their functions, Feedback mechanisms.	04

5	Pituitary gland: Structure of pituitary gland, hormones and their functions. Hypothalamo- hypophyseal portal system, Disorders of pituitary gland.	06
6	Thyroid gland: Functional histology and Regulation of Thyroid, its hormones and disorders related to Thyroid dysfunction. (Simple goitre, Exophthalmic goitre –Graves' Disease)	06
7	Parathyroid: Functional histology and Regulation of Parathyroid. hormones and disorders related to Parathyroid Dysfunction.	02
8	Adrenal gland: Functional histology and Regulation of Adrenal gland and its hormones. Disorders related to Adrenal Dysfunction.	04
9	Pancreas: Functional histology and Regulation of endocrine Pancreas (Islet of Langerhans; Disorders related to hypersecretion and hyposecretion of hormones.	04
10	Gonads: Functional histology and Regulation of endocrine Gonads. Hormones and their function.	11
11	Gastro-Intestinal Hormones: Sources and Mode of Action Gastrin, Cholecystokinin and Secretin	04
12	Hormonal control of metamorphosis in insect	04
	Total Hours	60

Book Recommended:

Endocrinology

1. Hadley: Endocrinology (Current edition, Prentice Hall)
2. Turner and Bagnara: General Endocrinology (Current edition, Saunders)
3. Williams Text book of Endocrinology (Current edition)
4. David O Norris, Vertebrate Endocrinology (Current edition)

ONLINE TOOLS AND WEB RESOURCES

- ❖ <https://sites.google.com/site/openmeded/specialties/endocrinologyhttps://www.endocrine.org/topics>

Semester–VI
Paper– XIII
Developmental Biology and Medical Zoology

Full Marks = 100 End Semester: 75 Internal: 20 + 5
Marks: 25 (5 Attd. + 20 SIE:1Hr) + 75 (ESE:3Hrs) = 100 Pass Marks: Th (SIE+ESE) = 40

VBU-MJ-Z-XIII

Credit - 4

About the course

The course explains the sequence of events starting with a single cell to the production of a very complex organism. The course not only describes how embryos develop (embryology), but also highlights how the processes of development are brought about by changing individual cells into specialized cells with specific functions (the cellular level), and how genes within the genome of the organism drive and guide these changes (the molecular level). Medical zoology component takes care of the parasites and parasitism, emphasizing on the role of parasites in global, public, health.

Learning outcomes

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

- ❖ Develop critical understanding of how a single-celled fertilized egg becomes an embryo and then a fully formed adult by going through three important processes of cell division, cell differentiation and morphogenesis.
- ❖ Understand how developmental processes and gene functions within a particular tissue or organism can provide insight into functions of other tissues and organisms.
- ❖ Understand how the field of developmental biology has changed since the beginning of the 19th century with different phases of developmental research predominating at different times
- ❖ Diagnose the causative agents, describe pathogenesis and treatment of important diseases.

VBU-MJ-Z-XIII

S. No.	Topics	Hours of Teaching
	Developmental Biology	
1	Gametogenesis: spermatogenesis, composition of semen, in vitro and in vivo capacitation of mammalian sperm, Oogenesis.	08
2	Molecular events of fertilization, Polyspermy and its prevention. Morphogenesis and morphogen, blastogenesis, establishment of body axes formation.	08
3	Organiser Concept and embryonic induction.	04
4	Fate map, gastrulation in frog and chick, genes in development in chick homeotic genes.	06
5	Extra Embryonic Membrane in Chick.	03
6	Placenta in mammals.	03
7	Cell lineage, cell to cell interaction.	04
8	In vitro fertilization and embryo transfer technology.	05
9	Stem cells: Sources, types and their use in human welfare.	03
	Medical zoology	
10	Causes, symptoms, prevention and the treatment of following diseases: 1. Viral disease -Rabies, AIDS, Corona, Polio 2. Bacterial diseases – Tuberculosis, Cholera and Typhoid 3. Protozoan Diseases – Amoebiasis, Kalazar 4. Helminth Diseases – Teaniasis, Ascariasis, Filaria	16
	Total Hours	60

Books Recommended:**Developmental Biology**

1. Balinsky: An Introduction to Embryology (5th ed.)
2. Gilbert: Developmental Biology (10th ed., Sinauer)
3. Human Embryology and Developmental Biology by Bruce Carlson, (Elsevier 5th ed.)
4. Chordate Embryology Developmental Biology by PS Verma and VK Agarwal (S. Chand & Co.)

Medical Zoology – K.D. Chatterjee

Semester–VI
Paper– XIV
Environmental Biology

Full Marks = 100 End Semester: 75 Internal: 20 + 5
Marks:25(5Attd. +20SIE:1Hr) +75(ESE:3Hrs) = 100 Pass Marks: Th (SIE+ESE) = 40

VBU-MJ-Z-XIV

Credit - 4

About the course

This course will take students on a journey through the interactions between species and their environments. The course highlights on some of the important aspects viz. 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.

Learning outcomes

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

- ❖ Know the evolutionary and functional basis of animal ecology.
- ❖ Understand what makes the scientific study of animal ecology a crucial and exciting endeavour.
- ❖ Engage in field-based research activities to understand well the theoretical aspects taught besides learning techniques for gathering data in the field.
- ❖ Analyse a biological problem, derive testable hypotheses and then design experiments and put the tests into practice.
- ❖ Solve the environmental problems involving interaction of humans and natural systems at local or global level.

VBU-MJ-Z-XIV

S. No.	Topics	Hours of Teaching
1	Biosphere: Concept of biosphere; biomes. Ecosystem: Concept of ecosystem, structure, function and types of ecosystems.	05
2	Bio geochemical cycles: Carbon and Nitrogen. Human induced changes in atmosphere including greenhouse gases and mechanism of effect, Ozone Depletion, Acid rain.	10
3	Population: Characteristics, population dynamics, Population stabilization.	04

4	Community characteristics: stratification; Dominance, diversity, species richness, abundance, evenness, similarity. Diversity and food-web indices. Ecotone and edge effect.	03
5	Types of interaction: Positive interactions: commensalism, proto-cooperation, and mutualism. Negative interactions: parasitism and allelopathy; predation and predator-prey dynamics; herbivory. Interspecific competition and coexistence, Inter and intra-specific; abundance. Niche overlap and segregation. Gause's Principle.	07
6	Ecological succession, ecotones, community ecology, concept of Climax.	06
7	Environmental biodegradation, pollution and its impact.	03
8	Bio-mining, Bioremediation, Biosensor.	04
9	Soil and water conservation.	04
10	Renewable and Non-Renewable Sources of Energy.	04
11	Wild Life Depletion and conservation; Importance of conservation.	02
12	National Organisations involved in wild life conservation; Wild Life Legislation- Wild Protection Act 1972, its amendments and implementation, Eco-tourism/ Wild life tourism in forests.	04
13	Protected areas- National parks and sanctuaries, Community reserve; Important features of protected areas in India; Project Tiger. Tiger reserves in India; Red data book, IUCN, WWF.	04
	Total Hours	60

Books Recommended

1. Colinvax, P.A. (1993) Ecology (IInd Edition. Wiley John & sons, Inc.)
2. Kerbs, C. J. (2001) Ecology (VIth Edition, Benjamin Cuming).
3. Odum, E.P., (2008) Fundamentals of Ecology and field Biology (Harper and Row Publishers)
4. Ecology Environment and Resources conservation: J.S. Singh, S.P. Singh and S.R. Gupta, (Anamaya Publishers, New Delhi).
5. Ecology Concept and application: Manual C Molles Jr. (McGraw Hill)

ONLINE TOOLS AND WEB RESOURCES

- ❖ [Ugmoocs.inflibnet.ac.in/ugmoocs/view_module_ug.php/156](http://ugmoocs.inflibnet.ac.in/ugmoocs/view_module_ug.php/156)
- ❖ Swayam (MHRD) Portal.

Semester–VI
Paper– XV
PRACTICAL

(Endocrinology, Developmental Biology, Environmental Biology)

VBU-MJ-Z-XV

S. No.		Marks Distribution
1.	Estimation of dissolved oxygen/alkalinity/free CO ₂	10
2.	Construction and comment of food chain/food web	10
3.	Comment on spot No.1-6 a. WM of Chick embryo -03 b. WM of Frog developmental stage c. TS of Endocrines Gland -03	30
4.	Diagnostic of typhoid by widal test	15
5	Estimation of hormone from blood plasma or serum/urine	15
6	Class record and poster/model/power point presentation	10
7	Viva-voce	10
TOTAL		100

Practical: Environmental Biology

1. Measurement of microclimatic variables viz., temperature, humidity and light conditions in a microhabitat.
2. Making an ecosystem in a wide-mouthed bottle.
3. Constructing a food chain and food web by observing and collecting organisms from a given area.
4. Studying the impact of herbivore on plant species (planted in pots under specific conditions).
5. Constructing distribution map of species of a genus through GPS by estimating the coordinates.
6. Investigation of volatile inhibitory substances produced through decomposition of plant debris and root exudates.
7. Estimation of the ratio of the producers and consumers.
8. Studying insect diversity in a habitat.
9. Determination of Species Diversity index
10. Estimation of Dissolved Oxygen.
11. Estimation of free CO₂.
12. Estimation of Alkalinity.

Practical: Developmental Biology

1. Study of permanent slide:
 - a) W.M slides of frog embryo- Frog eggs, Cleavage, Blastula
 - b) W.M slide of Chick embryo- 18hrs, 24hrs, 36hrs, 72hrs.
2. T.S of Chick embryo
3. Window preparation for visualization of development in chick.
4. Study of fate maps through photographs in frog.

Practical: Endocrinology

1. Study of permanent slide of various endocrine gland:
T.S of Pituitary, T.S of Thyroid, T.S of Adrenal, T.S of Pancreas, T.S of Testis, T.S of Ovary.
2. Hormone assay (kit based).
3. Study of different endocrine gland- Location in Frog and Rabbit.
4. Study of different endocrine disorders through photographs:
Gigantism, Dwarfism, Acromegaly, Exophthalmic goitre (Graves' disease), Addison's disease, Cushing syndrome, Cystic Fibrosis, Gynecomastia, Feminism etc.

Semester–VII

Paper– XVI Immunology and Microbiology

Full Marks = 100 End Semester: 75 Internal: 20 + 5
Marks: 25 (5Attd. + 20 SIE:1Hr) + 75 (ESE:3Hrs) = 100 Pass Marks: Th (SIE+ESE) = 40

VBU-MJ-Z-XVI

Credit - 4

About the course

This is a composite course with remarkable utility and importance. Microbiology being the study of microorganisms such as viruses, bacteria etc., covers theoretical studies and practical proficiency training which may help in their placement at a clinical microbiological laboratory. Immunology part provides the students with the fundamental knowledge of the immune system and its protective roles against diseases.

Learning outcomes

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

- ❖ Carry out common procedures for culturing, purifying and diagnostics of micro-organisms.
- ❖ Understand the disease-causing potential of bacteria and viruses, and the responses of the immune system.
- ❖ Summarize and orally present current microbiological problem areas.
- ❖ Describe the mechanisms of transmission, virulence and pathogenicity in pathogenic micro-organisms.
- ❖ Assess the importance of incidence, prevalence and epidemiology in Microbiological diagnostic activities.
- ❖ Know how resistance development and resistance transfer occur.
- ❖ Identify the major cellular and tissue components which comprise the innate and adaptive immune system.
- ❖ Understand how are immune responses by CD4 and CD8 T cells and B cells initiated and regulated.
- ❖ Understand how the immune system distinguishes self from non-self.
- ❖ Gain experience at reading and evaluating the scientific literature in the area.

VBU-MJ-Z-XVI

S. No.	Topics	Hours of Teaching
	Immunology	
1	Introduction to Immune System and Immunity: Types of Immunity: Innate Immunity, Acquired Immunity	08
2	Cells and Organs of Immune System: Immuno-Competent Cells and Accessory Cells; Lymphoid Organs: Primary Lymphoid organs: Thymus, Bone marrow, Bursa Fabricius. Secondary Lymphoid Organs: Lymph Nodes, Spleen, MALT, Tonsils and GALT	10
3	Antigens, antigenicity, and immunogenicity. B and T cell epitopes	08
4	Antibody structure and function (classification of immunoglobulins, immunoglobulin domains, concept of variability, isotypes, allotypes and idiotypic markers). Antigen-antibody interactions.	04
5	Hybridoma technology and its uses. (Monoclonal antibody)	04
6	The complement system: classical and alternative pathways, Lectin pathway	04
7	Major Histocompatibility Complex: Structural Organization of HLA System in Human. Antigen processing and presentation pathways.	04
	Microbiology	
8	Methods in microbiology Theory and practice of sterilization, Culture media and types.	04
9	Bacteria: Structure, Classification and Reproduction, Bacterial growth and growth curve, Antibiotic and its mechanisms.	06
10	Virus: Structure & Classification of viruses, Reproduction: Lytic cycle, Lysogenic cycle.	04
11	Vaccine: Types, Vaccine preparation	04
	Total Hours	60

Suggested Books

Immunology

1. Abbas *et al*: Cellular and Molecular Immunology.
2. Alberts *et al*: Molecular Biology of the Cell (Current edition, Garland)
3. Kuby: Immunology (New edition)
4. Roitt and Delvis: Roitt's Essential Immunology (New edition)

Microbiology

1. Jawetz, M. and Adelberg (2015) Medical Microbiology (27th edition)



Semester–VII Paper– XVII

Bioinformatics and Biostatistics

Full Marks = 100 End Semester: 75 Internal: 20 + 5
Marks: 25 (5Attd. + 20 SIE:1Hr) + 75 (ESE:3Hrs) = 100 Pass Marks: Th (SIE+ESE)=40

VBU-MJ-Z-XVII

Credit - 4

About the course

The course is aimed at introducing the application of bioinformatics and statistics in biology. The course gives an insight into the key concepts and methods used in bioinformatics and computer storage, retrieval, analysis, visualization and distribution of information data related to biological macromolecules like DNA, RNA and proteins. It provides foundation on statistical methods to enable students to compute and interpret basic statistical parameters. As an interdisciplinary field it integrates biology, computer science, chemistry and statistics together. Sequence analysis, structure analysis and functional analysis of biological data.

Learning outcomes

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

- ❖ Know the theory behind fundamental bioinformatics analysis methods. Be familiar with widely used bioinformatics databases.
- ❖ Know basic concepts of probability and statistics.
- ❖ Describe statistical methods and probability distributions relevant for molecular biology data.
- ❖ Know the applications and limitations of different bioinformatics and statistical methods.
- ❖ Perform and interpret bioinformatics and statistical analyses with real molecular biological data.
- ❖ Acquire knowledge of various databases of proteins, nucleic acids. Primary, secondary and composite databases. BLAST, FASTA, DOT PLOT
- ❖ Make phylogenetic predictions or prediction of structure of proteins and nucleic acids
- ❖ Develop understanding in Primer designing
- ❖ Understand data mining tool and its practical application in a case study
- ❖ Apply the knowledge in future course of their career development in higher education and research

Biostatistics		
S. No.	Topics	Hours of Teaching
1.	Introduction to Biostatistics and its significance in Biology	02
2.	Primary and Secondary Data.	02
3.	Frequency Distribution, Classification and Tabulation.	02
4.	Representation of Data: Diagrammatic Representation- Histogram and Pie Diagram, Ogive Curve and Polygon Curve.	06
5.	Measures of Central Tendency: Mean, Median and Mode	06
6.	Measurement of Variation: Standard Deviation, Standard Error of Mean, Coefficient of Variation.	04
7.	Chi Square Test, Sign test and Student's t-test	03
8.	Measures of Dispersion.	04
9.	Correlation, its types and methods of calculation. Karl Pearsons Coefficient correlation, Rank Correlation.	04
10.	Regression analysis, line of Regression $Y = mx + c$, Regression equation (Y on X and X on Y).	05

Bioinformatics		
S. No.	Topics	Hours of Teaching
1	Introduction and scope of bioinformatics: concept of Digital Laboratory and Digital Library.	02
2	Introduction to data archiving systems (FASTA format, Accession, and GI- Number).	02
3	Biological database: Nucleic acid sequences databases, Genome databases, Protein database sequence, structures and interacting proteins databases, Literature databases (OMIM and PUB MED).	08
4	Introduction to data retrieval systems, Search engines, Entrez, sequence retrieval system (SRS) and protein identification resource (PIR).	05
5	Prediction of motifs, folds and domains, Sequence alignments (BLAST and Clustal W) and phylogenetic trees (PHYLIP).	05
	Total Hours	60

Books Recommended:

Biostatistics

1. Statistics Theory and Practice by Bagavathi Pillai, R.S. N. (Current edition)
2. Fundamentals of Statistics by Gupta S.C. (Current Edition) Himalaya Publishing House
3. Statistics by VK Kapoor DC Sancheti (Current edition)
4. Introductory Statistics C-P. Mann (Wiley, Current edition)
5. Statistical Methods for Psychology David C. Howell (Current Edition)
6. Biostatistics by Khan and Khanum.

Bioinformatics

1. Barnes, M.R. and Gray, I.C. (2003) Bioinformatics for geneticists, Wiley.
2. Mount, D.W. (2006) Bioinformatics (2nd edition) CBS.



Semester–VII
Paper– XVIII

Animal Behaviour and Economic Zoology

Full Marks = 100 End Semester: 75 Internal: 20 + 5
Marks:25(5Attd.+20SIE:1Hr)+75(ESE:3Hrs) = 100 PassMarks:Th(SIE+ESE)= 40

VBU-MJ-Z-XVIII

Credit - 4

About the course

The course aims to explain the natural behaviour patterns, how the behaviour varies among individuals and species (wild, domestic and captive). How current and past environments and ecology influence not only behaviour, but also the underlying gene- environment interactions that shape it. The course is also unique in highlighting the commercial and industrial significance/value of animals. It discusses the techniques/ methods of rearing of animals for commercial usage and the prerequisites for their successful maintenance and sustenance.

Learning outcomes

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

- ❖ To learn a wide range of theoretical and practical techniques used to study animal behaviour.
- ❖ To develop skills, concepts and experience to understand all aspects of animal behaviour.
- ❖ To objectively understand and evaluate information about animal behaviour and ecology encountered in our daily lives.
- ❖ To understand and objectively evaluate the role of behaviour in the protection and conservation of animals in the wild.
- ❖ To consider and evaluate behavior of all animals, including humans, in the complex ecological world, including the urban environment.
- ❖ To understand the culture techniques of prawn, pearl and fish.
- ❖ To understand the silkworm rearing and their products.
- ❖ To understand the Bee keeping equipment and apiary management.
- ❖ To learn various concepts of lac cultivation.
- ❖ To be aware of a broad array of career options.

VBU-MJ-Z-XVIII

S. No.	Topics	Hours of Teaching
1	Concept and Patterns of Behaviour: Types of Behaviour, Innate/Instinct Behaviour, Acquired/Learned Behaviour. Patterns of Behaviour: Taxes, Reflexes, Orientation, Instinct and Motivation.	08
2	Social Organization and Communication: Social Organization in Honey Bees and Termites, Communication in Animals: Chemical, Audio, Visual, Tactile.	08
3	Parental Care: Parental Care in Fishes and Amphibia. Migration in fishes & Birds.	05
4	Role of hormones in drive; role of pheromones in alarm spreading; crypsis, predator detection, predator tactics, Social hierarchies in primates.	08
5	Orientation, navigation, homing; biological rhythms: Biological clock, tidal, seasonal and circadian rhythms.	08
6	Methods of studying animal behaviour including Sexual conflict, Selfishness, Kinship and Altruism.	05
7	Behaviour: Sensory filtering, Responsiveness, Sign stimuli, Learning and Memory, Instinct, Habituation, Conditioning and Imprinting.	04
8	Apiculture: Bee-keeping and Bee Economy. Varieties of honeybees in India, Setting up an apiary, Rearing equipments, Diseases of honey bee and their management, Beneficial products of honeybee.	06
9	Sericulture: Silk and Silk Production. Different types of silk and silkworms in India; Host plants and Rearing of <i>Bombyx mori</i> ; Silk worm pests and parasites: Uzi fly and their management.	04
10	Lac Culture: Species of Lac Insect, Host Plants, Methods of Rearing/ Cultivation and crops of Lac in Jharkhand, Enemies of Lac insect. Economic Importance of Lac.	04
	Total Hours	60

❖ जीवनं सत्यशोधनम् ❖

Books Recommendation

1. John Alcock: Animal Behaviour (Current edition).
2. Reena Mathur: Animal Behaviour (Current edition).
3. David Mc Farland: Animal Behaviour: Psychobiology, Ethology and Evolution (Current edition).
4. V.K. Agarwal- Animal Behaviour (Ethology) S. Chand (Current edition).
5. Hare Govind Singh: A Text book of Animal Behaviour.
6. Economic Zoology: Saras Publication.
7. G. S. Shukla, V. B Upadhyay: Economic Zoology.
8. Prost, P. J. (1962). Apiculture. Oxford and IBH, New Delhi.
9. Sericulture, FAO Manual of Sericulture.
10. Sardar Singh, Bee keeping in India, Indian Council of Agricultural Research, New Delhi.
11. N. Arumugam, K.V. Jayashree, C.S. Tharadevi: Bee Keeping in India, Saras publication.
12. Dhyan Singh Bisht, Apiculture, ICAR Publication.
13. Kumar and Nigam-Economic and applied Entomology.



Semester–VII

Paper– XIX

Practical

(Immunology, Bioinformatics, Biostatistics, Ethology and Economic Zoology)

VBU-MJ-Z-XIX

S. No.	Practicals	Marks Distribution
1	Graphical representation of statistical data.	10
2	Create a file format of given gene / protein /BLAST.	10
3	Preparation of blood film and identification of immune cells.	10
4	Demonstration of agglutination by blood group test.	10
5	Detect the orientation behaviour (phototaxis) in house fly.	10
6	Spotting: 1-5 (5 X 3 marks) a. Home page of NCBI/Entrez -01 b. Specimen showing Communalism/ Specimen showing Parental care -01 c. Paddy pest and Stored grain -02 d. Cocoon of silk worm / lac infestation stick/ Honey comb -01	15
7	Field Report	10
8	Records, Poster/Model and Power Point Presentation	15
9	Viva- Voce	10
	TOTAL	100

❖ जीवनं सत्यशोधनम् ❖

List of Practicals:

Immunology

1. Study of Immune cells in a blood film.
2. Demonstration of agglutination reaction by blood grouping.
3. Mancini's radial immuno-diffusion test
4. Ouchterlony double immuno diffusion test

Biostatistics:

1. Sampling, Data collection, tabulation and graphical representation.
2. Measurement of central tendencies
3. Measures of deviation
4. Test of significance- chi square test
5. Co-relation and regression analysis of data

Bioinformatics:

1. Creating a file format for Protein and Nucleic acid (Gen bank & FASTA)
2. To perform experiment with BLAST
3. Prediction of Secondary structure by using SOPMA
4. Study of home page: NCBI, BLAST & ENTREZ

Ethology

1. Parental care behaviour in Amphibia– (*Ichthyophis* and *Alytes*)
2. Ecological interaction- Commensalism by Hermit crab & Mollusca
3. Determination of orientation in animal.

Economic Zoology

1. Life Cycle of Honey bee, Lac insect, silk worm
2. Report on field visit to site of sericulture, apiculture, lac culture and aquaculture.

Semester–VIII

Paper– XX

[Biotechnology]

Full Marks = 100 End Semester: 75 Internal: 20 + 5
Marks: 25 (5 Attd.+ 20 SIE:1Hr) + 75 (ESE:3Hrs) = 100 Pass Marks: Th (SIE+ESE)= 40

VBU-MJ-Z-XX

Credit – 4

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, mechanisms, biological designs, functions and evolutionary significance of genetic modification or manipulation in special organisms and discusses the recent advance in recombinant DNA technology.

Learning outcomes

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

- ❖ Develop an understanding of the fundamental molecular tools and their applications of DNA modification and cloning.
- ❖ Appreciate shifting their orientation of learning from a descriptive explanation of biology to a unique style of learning through graphic designs and quantitative parameters to realize how such research and innovations have made science interdisciplinary and applied.
- ❖ Develop future course of their career development in higher education and research with a sound base.
- ❖ Apply their knowledge with problem solving approach to recommend strategies of genetic engineering for possible applications in Biotechnology and allied industry.

VBU-MJ-Z-XX

S. No.	Topics	Hours of Teaching
1	Introduction to Biotechnology, branches and its application.	02
2	RDT: Restriction Enzymes, DNA Polymerase, Ligase. Restriction-Modification System, DNA-modifying enzymes, T4 and E. coli DNA Polymerase (Klenow), DNA-methylase, Polynucleotide Kinase, DNA- ligase, Taq DNA polymerase, Reverse Transcriptase, T7 and T3 RNA polymerase.	09
3	Cloning Vectors: Plasmids and Cosmids.	05
4	DNA (Gene) cloning, recombinant DNA, cDNA library, genomic library. Isolation of gene from gene library. Screening and identification of recombinant DNA clone from gene library	06
5	Polymerase Chain Reaction (PCR) and Site-directed mutation.	05
6	DNA Sequencing and Genome Analysis, Model Genomes. Human Genome Project and Human Genome Sequences. Applications of Genetic Engineering and Biotechnology in agriculture, medicine and its economic and social implications	12
7	Cloned animal: Concept and Creation of Dolly	02
8	Transgenic animals: basic concept.	03
9	Introduction to applications of genetic engineering: Molecular diagnosis of genetic disorders and gene therapy Crop and livestock improvement	08
10	RFLP, RAPD and AFLP and application of RFLP in DNA finger-printing, ribozyme technologies, human genome	08
	Total Hours	60

❖ जीवनं सत्यशोधनम् ❖

Books Recommended:

1. Primrose, S.B. and Twyman, R. (2006) Principles of Gene manipulation and Genomics (7th ed.) Black well Publishing.
2. Nicholl, D.S.T. (2008) An introduction to Genetic Engineering (3rd edition) Cambridge University Press.
3. Watson, J.D. (2006) Recombinant DNA (3rd edition) Cold Spring Harbor Laboratory Press.
4. Brown, T.A. (2001) Gene Cloning and DNA Analysis: An Introduction.
5. A PBS Documentary entitled, "Playing God" [History of Genetic Engineering]
6. B. D Singh, A text of Biotechnology.



Semester–VIII

Paper– AMJ - I Applied Zoology

Full Marks = 100

End Semester: 75

Internal: 20 + 5

Marks: 25 (5 Attd. + 20 SIE:1Hr) + 75 (ESE:3Hrs) = 100

Pass Marks: Th (SIE+ESE) = 40

VBU-AMJ – I

Credit - 4

About the course

The course is unique in highlighting the commercial and industrial significance/value of animals. It discusses the techniques/methods of rearing of animals for commercial usage and the prerequisites for their successful maintenance and sustenance. The course gives insight into the various types of biological pesticides used to control pest and about their selective mode of action. It also gives an account of eco-friendly biological pesticides. The course also gives insight to Intellectual Property Right (IPR) its genesis and scope.

Learning outcomes

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

- Gain knowledge and expertise on the agrochemicals and their modes of action and their fates in the agro-ecosystem.
- Have the knowledge of pesticide families and be able to differentiate among families based on their specific modes of activity.
- Develop appropriate pesticide management strategies by evaluating specific pest type.
- Understand the culture techniques of Prawn, Pearl and Fish.
- Have a concept of IPR.
- Be aware of a broad array of career options and activities in human medicine, biomedical research and allied health professions.

VBU-AMJ – I

S.No.	Topics	Hours of Teaching
1	<p>Concept of Pest, Pesticides & Management</p> <p>Definition, classification, morphology and nature of damage of common agricultural pests – Paddy, Sugarcane, Stored grains Chemical control -Conventional chemicals/ pesticides based on target species: Insecticides, Fumigants and Repellents;</p> <p>Based on chemical nature: Organophosphates; Organochlorines, Carbamates etc.; Structure, chemical name, physical and chemical properties; Mode of action, uses and toxicity;</p> <p>Biological control -</p>	12
2	Biofertilizers: Classification and value; viz., Rhizobium, Azotobacter, Azolla and vermicomposting.	04
3	<p>Aquaculture and its scope-</p> <p>a. Mono & Polyculture of fish</p> <p>b. Prawn farming</p> <p>c. Pearl culture, (Marine and Fresh water pearl culture) edible oyster</p>	04
4	Integrated fish culture and management	04
5	Transgenic fish: Methods of Production and application	04
6	<p>Modern trend in biosystematics – Chemotaxonomy, Cytotaxonomy and molecular taxonomy.</p> <p>DNA barcoding for identification of species.</p>	08
7	<p>Introduction to Intellectual Property Right (IPR) Copyright Act and IPR and its importance. IPR in India.</p> <p>IPR - Objectives, Rights, Patent treaty, 1970 and its amendments.</p>	05
8	Homeotic gene expression in Drosophila	05
9	<p>Temporal and spatial gene expression (In Globin gene and in Arabidopsis)</p> <p>Trp operon mode of gene regulation (Attenuation)</p>	04
10	Concept of somatic cell hybridization and its application	05
11	Human gene therapy (In vivo and In vitro)	05
	Total Hours	60

Recommended readings

1. Hill, D. S. (1983) Agricultural insect pests of the tropics and their control (Cambridge Univ. Press.)
2. Atwal, A. S. (1979) Agricultural pests of India and south East Asia.
3. Dent, D. (2000) Insect pest management (2nd edition) CAB International.
4. Roberts, D. A. (1978) Fundamentals of Plant Pest Control.
5. De Bach, P. (1964) Biological Control of Insect Pests and Weeds, Chapman & Hall, New York.
6. Koul, O. and Dhaliwal, G.S.(2003) Phytochemical Biopesticides, Harwood Academic Publishers, Amsterdam.
7. Pedigo, L. P. (1996) Entomology and pest management, Prentice Hall, N. Delhi.



Semester–VIII
Paper– AMJ - II
Tools and Technique

Full Marks = 100 End Semester: 75 Internal: 20 + 5
Marks: 25 (5 Attd.+ 20 SIE:1Hr) + 75 (ESE:3Hrs) = 100 Pass Marks: Th (SIE+ESE)= 40

VBU-AMJ – II

Credit - 4

About the course

This is the only laboratory course taught independently of lecture courses. It has full hands-on approach to expose the students to modern techniques and methodologies. The diverse techniques are included to make the student well versed with these protocols and methods.

Learning outcomes

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

- ❖ Understand the purpose of the techniques, its proper use and possible modifications/improvement.
- ❖ Learn the theoretical basis of techniques, its principle of working and its appropriate application.
- ❖ Learn the construction repair and adjustment of any equipment required for a technique.
- ❖ Learn the accuracy of technique.
- ❖ Learn the maintenance of laboratory equipments/tools, safety hazards and precautions.
- ❖ Understand the techniques of cell and tissue culture. Learn the preparation of solution of given percentage and molarity.
- ❖ Understand the process of preparation of buffer. Learn the techniques of separation of amino acids, proteins and nucleic acids.

❖ **जीवनं सत्यशोधनम्** ❖

VBU-AMJ –II

S. No.	Topics	Hours of Teaching
1	<p>General Laboratory Practices</p> <p>Understanding the details labelled on reagent bottles. Preparation of solutions. Molarity and normality of common acids and bases. Dilutions. Percentage solutions. Molar, molal and normal solutions. Technique of handling pipettes and micropipettes. Knowledge of common corrosive and toxic chemicals and safety measures in their handling. Maintenance of equipments.</p>	06
2	<p>Laboratory Instruments</p> <p>Working principles, basic operation and application of Microtome, weighing balance, pH meter, autoclave, colorimeter, Centrifuge, Spectrophotometer, Oven, laminar air flow and Water Baths. Principle of asepsis and sterilization technique.</p>	08
3	<p>Tissue Micro-Techniques</p> <p>Weighing and staining procedures, classification and chemistry of stains. Staining equipment. Reactive dyes and fluoro-chromes (including genetically engineered protein labelling with GFP and other tags). Cytogenetic techniques with squashed tissues.</p>	04
4	<p>Methods to Study Tissue Structure</p> <p>Whole mounts, squash preparations, clearing, maceration and sectioning. Tissue preparation: living vs fixed, physical vs chemical fixation, coagulating fixatives, non-coagulant fixatives; tissue dehydration using graded solvent series; Paraffin; Preparation of thin and ultrathin sections</p>	05
5	<p>Understanding statistical concepts</p> <p>Sampling and sampling methods, understand statistical Correlation and regression; parametric and non-parametric test, sign test, Null and alternate Hypothesis testing; work with students t-test, Analysis of Variance, Theoretical distribution</p>	06
6	<p>Statistical Analysis with Software Application</p> <p>Bio-statistical data analysis through software – Use of Excel for statistical analysis; creating graph by Excel. Analysis through SPSS.</p>	04
7	<p>Sequencing: Nucleotide and protein sequencing.</p>	04
8	<p>Chromatography: Principles and applications of gel filtration, ion-exchange, affinity, thin layer, gas chromatography and high-pressure liquid chromatography (HPLC) and FPLC. Application of chromatographic technique in biology.</p>	04

9	Electrophoresis and centrifugation: Principles and applications of agarose and polyacrylamide gel electrophoresis; ultracentrifugation (velocity and buoyant density).	05
10	Safety measurement in handling radioisotopes. Methods of ELISA, RIA and non-radio labelling, Immuno-Histo-chemistry (IHC). Study of radioisotopes in biological samples autoradiography.	04
11	PCR techniques: Working principles, Types. Basic operation and application of PCR.	04
12	Southern, Western and Northern blotting techniques. Dot Blot technique.	04
13	DNA finger and foot printing.	2
	Total Hours	60



Semester–VIII
Paper– AMJ - III



Practical Applied Zoology

S. No.	Practicals	Marks Distribution
1	Comment upon the Instruments	10
2	Nucleotide Sequence detection by gel electrophoresis pattern	10
3	Permanent histological slide preparation or Histochemical demonstration	10
4	Statistical analysis of data and graphical representation	10
5	Spotting 5 x 5 marks a. Pest -02 b. Photographs of Cloned animal -01 c. Transgenic animal / Maize representing Transposomes 01 d. Hox mutants - Bithorax / antennapedia 01	25
6	A project report	10
7	Class record, Poster/Model and Power Point Presentation	15
8	Viva- voce	10
	Total	100

List of Practicals:

1. Preparation of molar solutions.
2. Study of lab instruments.
3. Calibration of micropipettes.
4. Lambda and Max estimation.
5. Histological preservation, fixation and processing.
6. Histochemical demonstration of carbohydrates, proteins and lipids.
7. Creating graphs by excel.
8. Statistical tests using ANOVA.
9. Finding nucleotide sequences through gel electrogram.
10. Finding protein sequences by result Polypeptide fragments after enzymatic treatment (Data based).
11. Separation of biomolecules through Paper Chromatography and Thin Layer Chromatography.
12. Separation of biomolecules by Gel electrophoresis.
13. Gene amplification by PCR.
14. Estimation of steroid hormones through ELISA.

Group discussion or Seminar presentation on one or two related topics from the list

- 1) Mutations and cancer
- 2) Epithelial tissue and its importance
- 3) Genome modification/ editing
- 4) Recent advances in gene cloning
- 5) Epigenetic disorders in humans
- 6) Diseases due to chromosomal anomalies
- 7) Stem cell technology
- 8) Genetic counselling
- 9) RNA interference
- 10) DNA barcoding
- 11) Stem cells and Induced Pluripotent Stem Cells (iPS)
- 12) Current trends in DNA sequencing
- 13) DNA markers and Genetic diversity
- 14) Comparative genomics in understanding of gene function
- 15) Biodiversity and climate change
- 16) Biotechnology: Past, present and Future.
- 17) Molecular Taxonomy, New Classification systems
- 18) Tree of Life.
- 19) Marine zooplanktons and their ecological importance including oxygen evolution
- 20) Bioprospecting and Biopiracy
- 21) Molecular systematics vs. traditional taxonomy
- 22) Biochemical Pathways and their evolutionary background, Regulation
- 23) Biodiversity Hotspots.
- 24) Biotechnology; Past present and Future
- 25) Climate change: threat to food security
- 26) Stratospheric Ozone depletion and marine productivity
- 27) Good ozone vs. bad ozone
- 28) Air pollution and climate change
- 29) Biodiversity under climate changing scenario
- 30) Preparing healthy/ fit animal stock for tomorrow; Conventional Breeding
- 31) Hybrids of transgenic animals
- 32) Vital body enzymes
- 33) Hormonal disorders
- 34) The process of Transcription
- 35) Advances in DNA hybridization
- 36) Essential and non-essential amino acids
- 37) Important body lipids
- 38) Parental care in animals
- 39) Learning in birds
- 40) Instinctive behaviour invertebrates
- 41) Social behaviour in Primates
- 42) Application of animal behaviour studies

- 43) Behaviour in captivity
- 44) Circadian rhythm
- 45) Environmental ethics
- 46) Biodiversity hotspots
- 47) Biodiversity mapping
- 48) Population explosion
- 49) Ecological indices
- 50) Niche segregation
- 51) Carrying capacity
- 52) Eukaryotic genome
- 53) Regulation of gene expression
- 54) RNA editing and splicing
- 55) DNA damage and repair
- 56) Central dogma of molecular biology
- 57) Molecular cloning
- 58) Monoclonal and polyclonal antibodies production techniques
- 59) Immunological techniques in disease diagnosis
- 60) Basic principles of light microscopy
- 61) Using SEM and TEM
- 62) Principles of Fluorescence and confocal microscopes
- 63) Applications of calorimetry and spectrophotometry
- 64) Techniques involving separation of biomolecules.
- 65) Diseases caused by viruses
- 66) Common bacterial diseases
- 67) Autoimmune diseases
- 68) Hybridoma technology and its applications
- 69) Zoonotic diseases
- 70) Helminth infections in humans
- 71) Concept of Immunity
- 72) Graphical representation of biological results
- 73) Statistical methods of hypothesis testing
- 74) Information technology in data acquisition and retrieval
- 75) Database management
- 76) Use of bioinformatics in biological research
- 77) Basics of information technology
- 78) Fish culture
- 79) Dairy management
- 80) Cattle diseases and their management
- 81) Apiculture and Sericulture
- 82) Pearl culture industry
- 83) Vermiculture
- 84) Prawn culture, good source of revenue generation
- 85) In vitro fertilization techniques
- 86) Phenoplasticity and its relevance

Suggested List of Supplementary Web Resources for Laboratory Exercises

1. Anatomy of Frog: Pro Dissector (CD)- www.prodissector.com
2. Physiology of Frog: PhysioEx4.0 (CD)- www.physioex.com
3. Anatomy of Chordates: The Vertebrate Dissection Guide Series (CD)–LearningDevelopment Centre, University of Portsmouth
4. Anatomy of earthworm: The dissection works (CD); Source–
www.scienclass.com;www.neosci.com
5. Anatomy of shark: Shark dissection and anatomy(video)- www.neosci.com
6. Cockroach dissection- www.ento.vt.edu
7. Mammalian Physiology– www.biopac.com

Guidelines for Individual/Team Projects and Field Reports


The aim of the individual/team project/s is to develop an aptitude for research in Zoology and to inculcate proficiency to identify appropriate research topic and presentation.

The topics of biological interest and significance can be selected for the project. Project is to be done by a group not exceeding 5 students. The project report should be submitted on typed A4paper, 12 Font,1.5 Space in spirally bound form and duly attested by the supervising teacher and the Head of the Department on the day of practical examination before a board of two Examiners for End Semester. The viva-voce based on the project is conducted individually. Project topic once chosen shall not be repeated by any later batches of students. The project report may have the following sections:

1. Preliminary (Titlepage, declaration, certificate of the supervising teacher, content etc.)
2. Introduction with relevant literature review and objective
3. Materials and Methods
4. Result
5. Discussion
6. Conclusion / Summary
7. References.

Field Study/ Study tour:

Students must visit one research institute and one wildlife sanctuary / museum/ zoo. Scientifically prepared hand-written study tour report along with photographs of candidate at the places of visit must be submitted by each student for End Semester on the day of the examination of project.



**Syllabus
of
Minor course**

Semester-I
Paper- Minor I
[Animal Classification and Diversity]

Full Marks: 75

End Semester: 60

Internal: 10 + 5

Marks: 15 (5 Attd. + 10 SIE:1Hr) + 60 (ESE:3Hrs) = 75 **Pass Marks: Th (SIE+ESE) = 40**

SEM-1/ZOOL/MINOR-I (Theory)

Credit – 3 (45 Hrs)

About the course

The course enlightens how each group of organisms arose and how did they establish themselves in the environment with their special characteristics. It also deals with the differences and similarities between organisms on the basis of their morphology and anatomy which led to their grouping into taxa and clades.

Learning outcomes

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

- ❖ Develop understanding on the diversity of life.
- ❖ Group animals on the basis of their morphological characteristics/ structures.
- ❖ Develop critical understanding how animals changed from a primitive cell to a collection of simple cells to form a complex body plan.
- ❖ Examine the diversity and evolutionary history of a taxon through the construction of a basic phylogenetic/ cladistics tree.
- ❖ Understand how morphological change due to change in environment helps driven evolution over a long period of time.
- ❖ The project assignment will also give them a flavour of research to find the process involved in studying biodiversity and taxonomy besides improving their writing skills. It will further enable the students to think and interpret individually due to different animal species chosen.

S. No.	Topics	Hours of Teaching
Group A		
1.	General characters and classification (up to classes) of the following phyla Protozoa, Porifera, Coelenterate, Platyhelminthes, Mollusca Annelida, Arthropoda, Echinodermata and Hemichordate with examples	10
2	Non-Chordates Form and Function <i>a. Protozoa: Pathogenecity, treatment and prevention of diseases caused by Entomeba histolytica and Leishmania donovani</i> <i>b. Porifera: Canal System of sycon</i> <i>c. Coelenterata: Life Cycle of obelia and Metagenesis</i> <i>d. Aschelminthes: Ascaris- life cycle and their pathogenicity</i> <i>e. Annelida: Pheretima -Excretory system</i> <i>f. Arthropoda: Palaemon- Respiratory System</i> <i>g. Mollusca: Pila- Respiratory system</i> <i>h. Echinodermata: Asterias- Water vascular System</i>	20
Group B		
3	General characters and classification of living chordates of the following Classes Amphibia and Reptilia	05
4	Study of following types: <i>a. Pisces: Respiratory and Accessory Respiratory organs</i> <i>b. Reptilia: Difference between poisonous and non-poisonous snakes, Biting mechanism of snakes, Poison gland, Venom</i> <i>c. Aves: Flight Adaptation in Birds</i> <i>d. Mammals: Characters, distribution and affinities of Prototheria</i>	10
	Total Hours	45

Books Recommended:

Non-Chordates and Chordates

1. Ruppert and Barnes, RD (2006) Invertebrate Zoology, VIII edition. Holt Saunders International edition
2. Nigam: Biology of Non-chordates (Current edition, S Chand)
3. Parker and Haswell: Text Book of Zoology, Vol. I (2005, Macmillan)
4. Modern Text Book of Zoology: Invertebrate by R.L. Kotpal
5. Modern Text Book of Zoology Vertebrates by R. L. Kotpal
6. Sinha, A.K., and Adhikari, Sand Ganguli, B.B Biology of Animals Vol. I and II New Central Agency, Calcutta



Semester– I
Paper– Practical (Minor)
(Animal Classification and Diversity)

Full Marks = 25

(No Internal exam)

Credits: 1 (30Hrs)

Time: 3hrs.

FM:25

Pass Marks 10

SEM-I/ZOOL/ MINOR -I P (PRACTICAL)

Semester I Zoology Practical (Minor)

S. No.	Practicals	Marks Distribution
1.	Dissection (One)	10
2.	Mounting of given specimens	02
3.	Spotting	
	Slides 2X2	04
	Specimens 2X2	04
4.	Practical Record and Viva-voce	05
	Total	25

List of suggested Practical's:

- 1. Dissection** –*Palaemon* –Nervous system
- 2. Mounting:** Spicules of porifera; *Obelia* colony, *Daphnia*, trachea and salivary gland of cockroach
- 3. Museum Specimens:** *Sycon*, *Euspongia*, *Aurelia*, *Gorgonia*, *Porpitta*, *Vallela*, *Metridium*, *Fungia*, *Tubipora*, *Pennatula*, *Meandrina*, Tapeworm, *Fasciola*, *Ascaris*, *Pheretima*, *Hirudinaria*, *Neries*, *Pila*, *Unio*, *Loligo*, *Sepia*, Octopus, Hermit Crab, Prawn, *Asterias*, Sea Urchin, Brittle star

Permanent slides: Paramecium Slide (WM), L.S of *Sycon*, *Obelia* Colony, Medusa, *Fasciola* (W.M), Proglottids of Tapeworm, T.S of *Pheretima* through different regions

Semester–III
Paper– Minor II
[Cell Biology, Genetics and Evolution]

Full Marks = 75 End Semester: 60 Internal: 10 + 5
Marks: 15 (5 Attd.+ 10 SIE:1Hr) + 60 (ESE:3Hrs) = 75 Pass Marks: Th (SIE+ESE)= 40

SEM-3/ZOOL/MINOR-II (Theory)

Credit – 3 (45 hrs)

About the course

The course provides a detailed insight into basic concepts of cellular structure and function. The course provides an insight into the life processes at the subcellular and molecular levels. Other important aspects include DNA and RNA study. The course is also 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. The present course also gives insight into the evolutionary theories and the process of species formation will be elaborated in view of the natural selection process.

Learning outcomes

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

- ❖ Understand the functioning of plasma membrane and cell organelles and understand the intricate cellular mechanisms involved.
- ❖ Develop an understanding how cells divide.
- ❖ Understand the structure of DNA and RNA.
- ❖ Apply the principles of Mendelian inheritance.
- ❖ Understand protein formation in Prokaryotes.
- ❖ Develop a holistic appreciation on the phylogeny and adaptations in animals.
- ❖ Enable the students to understand the evolution of universe and life.
- ❖ Understanding on the process and theories in evolutionary biology.

S. No.	Topics	Hours of Teaching
1.	Cell Structure and Functions <i>a.</i> Study of structure and Function of Plasma membrane <i>b.</i> Study of cell organelle- Mitochondria, Ribosomes, lysosomes <i>c.</i> Ultra structure of Chromosome <i>d.</i> Cell Division: mitosis	20
2	Principle of Genetics <i>a.</i> Mendel's Law of Inheritance <i>b.</i> Linkage and Crossing Over <i>c.</i> Structure of DNA and RNA	05

3	Concept of gene expression <i>a.</i> Semi conservative DNA Replication in prokaryotes <i>b.</i> Transcription in Prokaryotes <i>c.</i> Translation in Prokaryotes	10
4	Evolution <i>a.</i> Theory of organic evolution; Lamarckism's theory of inheritance of acquired characters <i>b.</i> Darwin's theory of natural selection <i>c.</i> Evolution of human	10
	Total Hours	45

Books Recommended:

Evolution

1. Veer Bala Rastogi: Organic Evolution (Current edition, Kedarnath & Ramnath)
2. Strickberger: Evolution (2004, Jones & Bartlett)

Genetics

1. Brooker: Genetics: Analysis and Principles (Current edition, Addison-Wesley)
2. Gardner *et. al.*, Principles of Genetics (Current edition, John Wiley)

Cell and Molecular Biology

1. Alberts *et al.*: Essential Cell Biology (Current edition, Garland)
2. Karp: Cell and Molecular Biology (Current edition, John Wiley)
3. Lodish *et al.*: Molecular Cell Biology (Current edition, Freeman) 2004

ONLINE TOOLS AND WEB RESOURCES

- ❖ <https://swayam.gov.in/course/150-cell-biology>
- ❖ <https://swayam.gov.in/courses/5173-biochemistry-and-cell-biology>
- ❖ <https://www.jove.com/science-education-library/9/cell-biology>
- ❖ <https://www.khanacademy.org/science/biology>

Semester– III
Paper– Practical Minor
(Cell Biology, Genetics and Evolution)

Full Marks = 25

(No Internal exam)

Credits: 1 (30Hrs)

Time: 3hrs.

FM:25

Pass Marks 10

SEM- 3 /ZOO/ MINOR -III P (PRACTICAL)

S. No.	Practicals	Marks Distribution
1.	Pedigree Analysis (One)	05
2.	Slide Preparation	05
3.	Spotting Slides of cell division 2X2.5 marks= Analogous and Homologous Organs Fossils/ Extinct Models 2X2.5 marks=	05 05
4.	Practical Record and <i>Viva-voce</i>	05
	Total	25

List of Practicals:

1. Study of permanent slides of Cell division (Mitosis)
2. Study of sex linked characters: Haemophilia and colour blindness through Pedigree Analysis.
3. Study of homologous and analogous organ.
4. Study of some fossils /extinct models: Dinosaurs, Archeopteryx.

Semester–V
Paper– Minor III

[Biochemistry, Physiology and Developmental Biology]

Full Marks = 75 End Semester: 60 Internal: 10 + 5
Marks: 15 (5 Attd.+ 10 SIE:1Hr) + 60 (ESE:3Hrs) = 75 Pass Marks: Th (SIE+ESE)= 40

SEM-3/ZOOL/MINOR-III (Theory)

Credit – 3 (45 hrs)

About the course

The course introduces the structure of biomolecules with emphasis on the metabolism of these biomolecules. The course deals with various physiological functions in mammals. The course explains the sequence of events starting with a single cell to the production of a very complex organism. The course not only describes how embryos develop (embryology), but also highlights how the processes of development are brought about by changing individual cells into specialized cells with specific functions (the cellular level), and how genes within the genome of the organism drive and guide these changes (the molecular level).

Learning outcomes

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

- ❖ Understand the structure and biological significance of carbohydrates, amino acids, proteins and lipids.
- ❖ Understand the metabolism process of biomolecules.
- ❖ Understand the physiology at cellular and system levels.
- ❖ Understand the basics of respiration.
- ❖ Understand how mammalian body gets nutrition from different biomolecules.
- ❖ Understand the process of digestion and excretion.
- ❖ Learn the determination of hemoglobin content, blood groups and bloodpressure.
- ❖ Develop critical understanding how a single-celled fertilized egg becomes an embryo and then a fully formed adult by going through three important processes of cell division, cell differentiation and morphogenesis.
- ❖ Understand how developmental processes and gene functions within a particular tissue or organism can provide insight into functions of other tissues and organisms.

S. No.	Topics	Hours of Teaching
	Biochemistry	
1.	Unit 1: Structure and Classification of biomolecules 1.1 Protein 1.2 Carbohydrate 1.3 Lipids	07
2.	Unit 2: Metabolism 2.1 Glycolysis 2.2 Krebs Cycle	07
	Physiology	
3.	UNIT 3: Physiology 3.1 Blood composition, Blood Coagulation 3.2 Respiration: Transport of gases (O ₂ and CO ₂) 3.3 Digestion of food: Protein, Carbohydrate and Lipid 3.4 Excretion: Nephron and Urine formation	16
	Developmental Biology	
4.	UNIT 4: Developmental Biology 4.1 Fertilization 4.2 Cleavage 4.3 Extra Embryonic Membrane in Chick 4.4 Placenta and their Function	15
	Total Hours	45

Books Recommended:

Biochemistry

1. Biochemistry by Dr. U. Satyanarayana and Dr. U. Chakrapani
2. Harper's Biochemistry (Current edition)
3. Lehninger's Principles of Biochemistry

Physiology

1. Guyton & Hall Textbook of Medical Physiology
2. Essentials of Medical Physiology by K Sembulingam

Developmental Biology

1. Balinsky: An Introduction to Embryology (5th edition).
2. Chordate Embryology Developmental Biology by P.S. Verma and V K Agarwal, S. Chand & Co.

Semester– V
Paper– Practical Minor
(Biochemistry, Physiology and Developmental Biology)

Full Marks = 25

(No Internal exam)

Credits: 1 (30Hrs)

Time: 3hrs.

FM:25

Pass Marks 10

SEM- 5 /ZOO/ MINOR -III P (PRACTICAL)

S. No.	Practicals	Marks Distribution
1.	Detection of presence of bio molecules in the sample	05
2.	Physiology Experiment	05
3.	Spotting	
	i. Slides of reproductive organs 01	10
	ii. Endocrine Slides 02	
	iii. Slides of Developmental Biology 02	
4.	Practical Record and <i>Viva-voce</i>	05
	Total	25

List of Practicals:

Biochemistry, Physiology and Developmental Biology

1. Biochemical test for Protein carbohydrate (Starch and Glucose) and Lipids
2. Determination of Hb%
3. Records of Blood pressure in Normal and after exercise.
4. Study of slides of Reproductive organ: Testes, Ovary and Uterus
5. Study of Endocrine Gland's Slides
6. Study of Permanent slides of Chick Embryo (WM) -18 hrs, 24 hrs, 36 hrs and 72 hrs.

Semester–VII
Paper– Minor IV

[Ecology and Economic Zoology]

Full Marks = 75 End Semester: 60 Internal: 10 + 5
Marks: 15 (5 Attd.+ 10 SIE:1Hr) + 60 (ESE:3Hrs) = 75 Pass Marks: Th (SIE+ESE)= 40

SEM-7/ZOOL/MINOR-IV (Theory)

Credit – 3 (45 hrs)

About the course

This course will take students on a journey through the interactions between species and their environments. The course highlights on some of the important aspects viz., energy flow in the ecosystems, interactions between the communities, and consequences of changing environment on the biodiversity. The course is also unique in highlighting the commercial and industrial significance/value of animals. It discusses the techniques/ methods of rearing of animals for commercial usage and the prerequisites for their successful maintenance and sustenance.

Learning outcomes

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

- ❖ Know the functional basis of animal ecology.
- ❖ Understand what makes the scientific study of animal ecology a crucial and exciting endeavour.
- ❖ Engage in field-based research activities to understand well the theoretical aspects taught besides learning techniques for gathering data in the field.
- ❖ Analyse a biological problem, derive testable hypotheses and then design experiments and put the tests into practice.
- ❖ Solve the environmental problems involving interaction of humans and natural systems at local or global level.
- ❖ To understand the culture techniques of pearls.
- ❖ To understand the silkworm rearing and their products.
- ❖ To understand the Bee keeping equipment and apiary management.
- ❖ To learn various concepts of lac cultivation.
- ❖ To be aware of a broad array of career options.

S. No.	Topics	Hours of Teaching
	Ecology	
1.	General Concepts 1.1 Ecosystem 1.2 Food Chain and food Web and Ecological Pyramids 1.3 Energy Flow 1.4 Bio-Geochemical Cycle: Nitrogen and Carbon cycle	10
2.	Population and Communities 2.1 Ecological succession	05
3.	Environmental Pollution 3.1 Pollution Sources and Impacts of Environmental Pollution-Air and Water 3.2 Green House Gases and Effects	15
4.	Natural Resources and conservation 4.1 Renewable and Non-renewable Energy Source	05
	Economic Zoology	
5.	5.1 Apiculture 5.2 Sericulture 5.3 Lac culture 5.4 Pearl culture 5.5 Biology of paddy, Sugar cane and stored grains Pest	10
	Total Hours	45

Books Recommended:

1. Ecology Environment and Resources conservation: J.S. Singh, S. P. Singh and S. R. Gupta, Anamaya Publishers, New Delhi
2. Fundamental Concepts in Environmental Studies by Dr. D.D Mishra
3. Economic Zoology by Kumar and Nigam

Semester– VII
Paper– Practical Minor
(Ecology and Economic Zoology)

Full Marks = 25

(No Internal exam)

Credits: 1 (30Hrs)

Time: 3hrs.

FM:25

Pass Marks 10

SEM- 7 /ZOO/ MINOR -IV P (PRACTICAL)

S. No.	Practicals	Marks Distribution
1.	Ecology Practical	10
2.	Spotting	
	a. Slides of Economic Zoology 2x2 marks	04
	b. Specimens of Economic Zoology 3x2 marks	06
3.	Practical Record and <i>Viva-voce</i>	05
	Total	25

List of Practicals:

Ecology

1. Determination of pH in soil and water
2. Estimation of dissolved oxygen
3. Estimation of free carbon dioxide
4. Model of Food chain

Economic Zoology

1. Slides of Mouth part of Culex, Anopheles, Plasmodium (Signet ring)
2. Common paddy and sugar cane pest
3. Life cycle of Honey bee
4. Cocoon of silk worm
5. Lac infestation on stick