



**VINOBA BHAVE UNIVERSITY**  
HAZARIBAG – 825301, JHARKHAND, INDIA



## **Curriculum Framework**

**Four Year Undergraduate Programme  
(FYUGP)**  
(B.Sc. Zoology with Honours & Research)



As per NEP 2020 and Learning Outcomes-based National Curriculum Framework  
(Aligned with NCrF and NHEQF)

**Effective From Academic Year 2025-2026**

**Members of Board of Studies for preparing Provisional Syllabus of the Four-Year Undergraduate Programme ( FYUGP ) as per notification VBU / NEP06 / 2025 / R / 2157 / 25, dtd.20. 08.2025**

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**Syllabi to be designed for Practical Subjects:  
Major Courses**

Sem.	Code	Paper	Credits		
			Theory	Practical	Total
I	MJ-1	Major paper 1	3	1	4
II	MJ-2	Major paper 2	3	1	4
III	MJ-3	Major paper 3	3	1	4
	MJ-4	Major paper 4	3	1	4
IV	MJ-5	<b>Major paper 5 (having IKS component)</b>	3	1	4
	MJ-6	Major paper 6	3	1	4
	MJ-7	Major paper 7	3	1	4
V	MJ-8	Major paper 8	3	1	4
	MJ-9	Major paper 9	3	1	4
	MJ-10	Major paper 10	3	1	4
	MJ-11	Major paper 11	3	1	4
VI	MJ-12	Major paper 12	3	1	4
	MJ-13	Major paper 13	3	1	4
	MJ-14	Major paper 14	3	1	4
	MJ-15	Major paper 15	3	1	4
VII	MJ-16	<b>Major 16 (Research methodology)</b>	3	1	4
	MJ-17	Major paper 17	3	1	4
	MJ-18	Major paper 18	3	1	4
VIII	MJ-19	Major paper 19	3	1	4
	MJ-20	Major paper 20	3	1	4
					<b>(Total 80 credits)</b>

**Associated Core and Elective (Minor) Courses**

Sem.	Paper	Credits		
		Theory	Practical	Total
I or II	Associated Core Course	3	1	4
III or IV	Elective Course –I	3	1	4
V or VI	Elective Course –II	3	1	4
VII or VIII	Elective Course –III	3	1	4

**For MJ /AC/ELC:**

**Theory** : End Semester Examination : 60 Marks

Internal Examination : 10 (Written)+ 5(Day-to-day assessment)

**Practical** : End Semester Examination : 25 Marks

**Credit distribution for Research Courses (For Hons. with Research)**

Sem.	Code	Paper	Credits
VII	RC-1	<b>Research Proposal-Planning &amp; Techniques</b>	4
VIII	RC-2	<b>Research Internship/Field work/Project/ Dissertation/Thesis</b>	8(Guidelines to be framed)

**Credit distribution for Advanced Major Courses**

Sem.	Code	Paper	Credits			Remarks
			Theory	Practical	Total	

VII	AMJ-1	Advanced Major paper 1	4	0	4	Syllabus should be of PG First year level.
VIII	AMJ-2	Advanced Major paper 2	4	0	4	
	AMJ-3	Advanced Major paper 3	4	0	4	
	AMJ-4	Advanced Major paper 4	4	0	4	

### For Advanced Major

End Semester Examination : 75 Marks

Internal Examination : 20 (Written)+ 5(Day-to-day assessment)

### Research Proposal-Planning & Techniques

End Semester examination : 50 Marks

Term Paper : 25 Marks

Internal Examination : 20 Marks (written) + 5 Marks (Day-to- Day assessment)

### Research Internship/Field work/Project/Dissertation/Thesis

Assessment of Project Synopsis : 50 Marks

Assessment of Project Thesis :100 Marks

Viva-Voce : 50 Marks

### Syllabi to be designed for Non-Practical Subjects:

#### Major Courses

Sem.	Code	Paper	Credits
I	MJ-1	Major paper 1	4
II	MJ-2	Major paper 2	4
III	MJ-3	Major paper 3	4
	MJ-4	Major paper 4	4
IV	MJ-5	Major paper 5 (having IKS component)	4
	MJ-6	Major paper 6	4
	MJ-7	Major paper 7	4
V	MJ-8	Major paper 8	4
	MJ-9	Major paper 9	4
	MJ-10	Major paper 10	4
	MJ-11	Major paper 11	4
VI	MJ-12	Major paper 12	4
	MJ-13	Major paper 13	4
	MJ-14	Major paper 14	4
	MJ-15	Major paper 15	4
VII	MJ-16	<b>Major 16 (Research methodology)</b>	4
	MJ-17	Major paper 17	4
	MJ-18	Major paper 18	4
VIII	MJ-19	Major paper 19	4
	MJ-20	Major paper 20	4

### Associated Core and Elective (Minor) Courses

Sem.	Paper	Credits
I or II	Associated Core Course	4
III or IV	Elective Course –I	4
V or VI	Elective Course –II	4
VII or VIII	Elective Course –III	4

**Credit distribution for Research Courses (For Hons. with Research)**

Sem.	Code	Paper	Credits
VII	RC-1	Research Proposal-Planning & Techniques	4
VIII	RC-2	Research Internship/Field work/Project/ Dissertation/Thesis	8(Guidelines to be framed)



Table 1: Semester wise course credits points for single major during the first three years of FYUGP

Semester	Common, Introductory, Major, Minor, Vocational and Internship Courses		Credits	
	Code	Papers	Paper	Semester
<b>I</b>	AEC-1	Language and Communication Skills (MIL-1; Modern Indian language including TRL)	2	<b>20</b>
	VAC-1	Value Added Course-1	2	
	IKS-1	Indian Knowledge System-1/ Social Awareness Activities	2	
	SEC-1	Skill Enhancement Course-1	3	
	MDC-1	Multi-disciplinary Course-1	3	
	AC-1	Associated core course from discipline/ interdisciplinary/ vocational	4	
	MJ-1	Major paper 1 (Disciplinary/Interdisciplinary Major)	3+1	
<b>II</b>	AEC-2	Language and Communication Skills (English)	2	<b>20</b>
	VAC-2	Value Added Course-2	2	
	IKS-2	Indian Knowledge System-2/ Social Awareness Activities	2	
	SEC-2	Skill Enhancement Course-2	3	
	MDC-2	Multi-disciplinary Course-2	3	
	AC-2	Associated core course from discipline/ interdisciplinary/ vocational	4	
	MJ-2	Major paper 2 (Disciplinary/Interdisciplinary Major)	3+1	
<b>III</b>	AEC-3	Language and Communication Skills (MIL-2; Modern Indian language including TRL)	2	<b>20</b>
	SEC-3	Skill Enhancement Course-3	3	
	MDC-3	Multi-disciplinary Course-3	3	
	ELC-1	Elective courses from Discipline/Interdisciplinary/ vocational	4	
	MJ-3	Major paper 3 (Disciplinary/Interdisciplinary Major)	3+1	
	MJ-4	Major paper 4 (Disciplinary/Interdisciplinary Major)	3+1	
<b>IV</b>	AEC-4	Language and Communication Skills (MIL-2/ English-2)	2	

	VAC-3	Value Added Course-2	2	<b>20</b>
	ELC-2	Elective courses from Discipline/Interdisciplinary/ vocational	4	
	MJ-5	Major paper 5 (Disciplinary/Interdisciplinary Major having IKS)	3+1	
	MJ-6	Major paper 6 (Disciplinary/Interdisciplinary Major)	3+1	
	MJ-7	Major paper 7 (Disciplinary/Interdisciplinary Major)	3+1	
<b>V</b>	ELC-3	Elective courses from Discipline/Interdisciplinary/ vocational	4	<b>20 (excluding IAP)</b>
	MJ-8	Major paper 8 (Disciplinary/Interdisciplinary Major)	3+1	
	MJ-9	Major paper 9 (Disciplinary/Interdisciplinary Major)	3+1	
	MJ-10	Major paper 10 (Disciplinary/Interdisciplinary Major)	3+1	
	MJ-11	Major paper 11 (Disciplinary/Interdisciplinary Major)	3+1	
	IAP	Internship/Apprenticeship/Field Work/Dissertation/Project	4	
<b>VI</b>	ELC-4	Elective courses from Discipline/Interdisciplinary/ vocational	4	<b>20</b>
	MJ-12	Major paper 12 (Disciplinary/Interdisciplinary Major)	3+1	
	MJ-13	Major paper 13 (Disciplinary/Interdisciplinary Major)	3+1	
	MJ-14	Major paper 14 (Disciplinary/Interdisciplinary Major)	3+1	
	MJ-15	Major paper 15 (Disciplinary/Interdisciplinary Major)	3+1	
	<b>Total credits excluding one Internship (IAP) of 4 credits =</b>			

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Table 2: Semester-wise course code and credit points for single major during the fourth years of FYUGP for Bachelor's Degree (Honours with Research)

Semester	Common, Introductory, Major, Minor, Vocational and Internship Courses		Credits	
	Code	Papers	Paper	Semester
VIIA	ELC-5	Elective courses from discipline/ interdisciplinary/ vocational	4	20
	MJ-16	Major Paper 16 (Research Methodology)	4	
	MJ-17	Major Paper 17 (Disciplinary/ interdisciplinary Major)	4	
	MJ-18	Major Paper 18 (Disciplinary/ interdisciplinary Major)	4	
	RC-1	Research Proposal- Planning & Techniques (Disciplinary/ interdisciplinary Major)	4	
VIII A	ELC-6	Elective courses from discipline/ interdisciplinary/ vocational	4	20
	MJ-19	Major Paper 19 (Disciplinary/ interdisciplinary Major)	4	
	MJ-20	Major Paper 20 (Disciplinary/ interdisciplinary Major)	4	
	RC-2	Research Internship/ Field Work/ Project/ Dissertation/ Thesis	8	
	<b>Total credits excluding one Internship of 4 credits =</b>			

Table 3: Semester-wise course code and credit points for single major during the fourth years of FYUGP for Bachelor's Degree (Honours)

Semester	Common, Introductory, Major, Minor, Vocational and Internship Courses		Credits	
	Code	Papers	Paper	Semester
VIIB	ELC-5	Elective courses from discipline/ interdisciplinary/ vocational	4	20
	MJ-16	Major Paper 16 (Research Methodology)	4	
	MJ-17	Major Paper 17 (Disciplinary/ interdisciplinary Major)	4	
	MJ-18	Major Paper 18 (Disciplinary/ interdisciplinary Major)	4	
	AMJ-1	Advanced Major Paper-1 (Disciplinary/ interdisciplinary Major)	4	
VIIBB	ELC-6	Elective courses from discipline/ interdisciplinary/ vocational	4	20
	MJ-19	Major Paper 19 (Disciplinary/ interdisciplinary Major)	4	
	MJ-20	Major Paper 20 (Disciplinary/ interdisciplinary Major)	4	
	AMJ—2	Advanced Major Paper-2 (Disciplinary/ interdisciplinary Major)	4	
	AMJ-3	Advanced Major Paper-3 (Disciplinary/ interdisciplinary Major)	4	
	<b>Total credits excluding one Internship of 4 credits =</b>			

## 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 programs. This requires that all departments prescribe a certain specified number of credits for each course and common instruction hours (slot)

<b>Courses</b>	<b>Nature of Courses</b>	<b>4 yrs. UG Credits</b>
Major	Core courses	80
ELC	Elective courses	24
AC	Associated Core Course from discipline/interdisciplinary/ vocational	08
MDC	Multidisciplinary – 3 credits in I,II& III	9
IKS	Indian Knowledge system	4
AEC	Language courses	8
SEC	<b>Courses to be developed by the University</b>	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
<b>Total Credits</b>		<b>160+4 (IAP)= 164</b>

AEC - Ability Enhancement Courses  
 SEC- Skill Enhancement Courses  
 IAP- Internship/Apprenticeship/Project  
 VAC- Value added courses  
 MDC- Multidisciplinary Courses  
 MJ- Major

DSC - Disciplinary/Interdisciplinary Courses  
 AC – Associated core course  
 ELC – Elective courses  
 AMJ- Advanced Major  
 RC-Research Courses  
 IAP - Internship

## Semester wise Examination Structure in Discipline Course

Semester	Courses		Examination Structure			
	Code	Papers	Credits (Theory+ Practical)	Mid Semester Theory (F.M.)	End Semester Theory (F.M.)	End Semester Practical/ Viva (F.M.)
I	MJ-1	DIVERSITY OF NON- CHORDATES	3(T)+1(P)	15 (10+5)	60	25
II	MJ-2	DIVERSITY OF CHORDATES	3(T)+1(P)	15 (10+5)	60	25
III	MJ-3	COMPARATIVE ANATOMY OF VERTEBRATES	3(T)+1(P)	15 (10+5)	60	25
	MJ-4	CELL BIOLOGY	3(T)+1(P)	15 (10+5)	60	25
IV	MJ-5	IKS IN ANIMAL SCIENCE	3(T)+1(P)	15 (10+5)	60	25
	MJ-6	HISTOLOGY AND HUMAN PHYSIOLOGY	3(T)+1(P)	15 (10+5)	60	25
	MJ-7	BIOCHEMISTRY	3(T)+1(P)	15 (10+5)	60	25
V	MJ-8	GENETICS	3(T)+1(P)	15 (10+5)	60	25
	MJ-9	EVOLUTION & POPULATION GENETICS	3(T)+1(P)	15 (10+5)	60	25
	MJ-10	DEVELOPMENTAL BIOLOGY	3(T)+1(P)	15 (10+5)	60	25
	MJ-11	MOLECULAR BIOLOGY	3(T)+1(P)	15 (10+5)	60	25
VI	MJ-12	ANIMAL BEHAVIOUR	3(T)+1(P)	15 (10+5)	60	25

	MJ-13	ENVIRONMENTAL BIOLOGY	3(T)+1(P)	15 (10+5)	60	25
	MJ-14	ECONOMIC ZOOLOGY	3(T)+1(P)	15 (10+5)	60	25
	MJ-15	PARASITOLOGY	3(T)+1(P)	15 (10+5)	60	25
VII	MJ-16	RESEARCH METHODOLOGY	3(T)+1(P)	15 (10+5)	60	25
	MJ-17	IMMUNOLOGY	3(T)+1(P)	15 (10+5)	60	25
	MJ-18	BIOSTATISTICS	3(T)+1(P)	15 (10+5)	60	25
	AMJ-I	APPLIED ENTOMOLOGY	4(T)	25 (20+5)	75	-
VIII	MJ-19	BIOTECHNOLOGY	3(T)+1(P)	15 (10+5)	60	25
	MJ-20	BIOINFORMATICS	3(T)+1(P)	15 (10+5)	60	25
	AMJ-2	MAMMALIAN ENDOCRINOLOGY AND ASSISTED REPRODUCTIVE TECHNOLOGY (ART)	4(T)	25 (20+5)	75	-
	AMJ-3	BIOINSTRUMENTATION AND BIOTECHNIQUES	4(T)	25 (20+5)	75	-
	AMJ4	APPLIED FISH & FISHERIES	4(T)	25 (20+5)	75	-

## 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.)
<b>I</b>	SEC-1	WILDLIFE CONSERVATION AND MANAGEMENT	3	---	75	---
<b>II</b>	SEC-2	SERICULTURE & APICULTURE	3	---	75	---
<b>III</b>	SEC-3	VERMICOMPOSTING & BIOFERTILIZERS	3	---	75	--
		<b>Total Credits</b>	<b>9</b>			

## Semester wise Course Code and Credit Points for Associated course and Elective 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.)
<b>I</b>	AC-1	GENERAL ZOOLOGY & FUNCTIONAL DIVERSITY	3 (45hrs)	15	60	75
	ACP-1	PRACTICAL	1(30hrs)			25
<b>III</b>	ELC-1	CELL BIOLOGY, GENETICS & EVOLUTION	3 (45hrs)	15	60	75
	ELCP-1	PRACTICAL	1(30hrs)			25
<b>V</b>	ELC-2	BIOCHEMISTRY, PHYSIOLOGY & DEVELOPMENTAL BIOLOGY	3 (45hrs)	15	60	75
	ELCP-2	PRACTICAL	1(30hrs)			25
<b>VII</b>	ELC-3	ECOLOGY & ECONOMIC ZOOLOGY	3 (45hrs)	15	60	75
	ELCP-3	PRACTICAL	1(30hrs)			25
		<b>Total Credits</b>	<b>16</b>			

## 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 10+5=15 marks): For Major**

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 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 60 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 three are to be answered.

### C. **(ESE 75 marks): For Major/AMJ**

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.

### D. **(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
<b>General Instructions:</b>		
i. <b>Group A</b> carries very short answer type compulsory questions.		
ii. <b>Answer 1 out of 2</b> subjective/ descriptive questions given in <b>Group B</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.		
<b>Group A</b>		
1.		[5x1=5]
i.	.....	
ii.	.....	
iii.	.....	
iv.	.....	
v.	.....	
<b>Group B</b>		
2.	.....	[5]
3.	.....	[5]
<b>Note:</b> 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
<b>General Instructions:</b>		
i. <b>Group A</b> carries very short answer type compulsory questions.		
ii. <b>Answer 1 out of 2</b> subjective/ descriptive questions given in <b>Group B</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.		
<b>Group A</b>		
1.		[5x1=5]
i.	.....	
ii.	.....	
iii.	.....	
iv.	.....	
v.	.....	
2.	.....	[5]
<b>Group B</b>		
3.	.....	[10]
4.	.....	[10]
<b>Note:</b> 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
<b>General Instructions:</b>		
i. <b>Group A</b> carries very short answer type <b>compulsory</b> questions.		
ii. <b>Answer 3 out of 5</b> subjective/ descriptive questions given in <b>Group B</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.		
<b><u>Group A</u></b>		
1.		[5x1=5]
i. ....		
ii. ....		
iii. ....		
iv. ....		
v. ....		
<b><u>Group B</u></b>		
2. ....		[15]
3. ....		[15]
4. ....		[15]
5. ....		[15]
6. ....		[15]
<b>Note:</b> 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
<b>General Instructions:</b>		
i. <b>Group A</b> carries very short answer type <b>compulsory</b> questions.		
ii. <b>Answer 3 out of 5</b> subjective/ descriptive questions given in <b>Group B</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.		
<b><u>Group A</u></b>		
1.		[5x1=5]
i. ....		
ii. ....		
iii. ....		
iv. ....		
v. ....		
2. ....		[5]
3. ....		[5]
<b><u>Group B</u></b>		
4. ....		[15]
5. ....		[15]
6. ....		[15]
7. ....		[15]
8. ....		[15]
<b>Note:</b> 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
<b>General Instructions:</b>		
i. <b>Group A</b> carries very short answer type <b>compulsory</b> questions. ii. <b>Answer 4 out of 6</b> subjective/ descriptive questions given in <b>Group B</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.		
<b>Group A</b>		
1.		[5x1=5]
i. ....		
ii. ....		
iii. ....		
iv. ....		
v. ....		
2. ....		[5]
3. ....		[5]
<b>Group B</b>		
4. ....		[15]
5. ....		[15]
6. ....		[15]
7. ....		[15]
8. ....		[15]
9. ....		[15]
<b>Note:</b> 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
<b>General Instructions:</b>		
i. <b>Group A</b> carries very short answer type <b>compulsory</b> questions. ii. <b>Answer 4 out of 6</b> subjective/ descriptive questions given in <b>Group B</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.		
<b>Group A</b>		
1.		[10x1=10]
i. ....	vi. ....	
ii. ....	vii. ....	
iii. ....	viii. ....	
iv. ....	ix. ....	
v. ....	x. ....	
2. ....		[5]
3. ....		[5]
<b>Group B</b>		
4. ....		[20]
5. ....		[20]
6. ....		[20]
7. ....		[20]
8. ....		[20]
9. ....		[20]
<b>Note:</b> There may be subdivisions in each question asked in Theory Examination.		



# **Syllabus of Major Course [2025-29]**

## Semester-I

### Paper– I

#### [Diversity of Non-chordates]

**Full Marks = 75      End Semester: 60)      Internal: 10 + 5**

**Marks: 15(5 Attd.+10 SIE : 1 Hr ) + 60 (ESE : 3Hrs) Pass marks: Th (SIE+ESE)=30**

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VBU-MJ-Z-I

Credit-3(45 Hrs)

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#### 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.

## SEMESTER-I

### MJ-1 DIVERSITY OF NONCHORDATES

VBU-MJ-Z- I

S. NO.	Topics	Hours of Teaching
1.	Introduction to R.H. Whittaker's Classification Acoelomate, Pseudocoelomate and Coelomate, Protostomes and Deuterostomes, Radiata and Bilateria	03
2.	Characters and classification of various phyla upto classes of Non Chordate with examples	05
3.	Protozoa: Locomotion, Nutrition, Reproduction.	05
4.	Porifera: Skeleton, Canal System and Reproduction.	06
5.	Cnidaria: Polymorphism in Siphonophora, Cnidoblast structures and its role; Coral reefs and their formation; Life history of <i>Obelia</i> and metagenesis Ctenophora: General Characters and Classification with examples	05
6.	Platyhelminthes & Nemathelminthes: Life cycle of <i>Ascaris</i> Life cycle of <i>Wuchereria</i> Life cycle of <i>Schistosoma</i> Parasitic adaptation in helminthes.	04
7.	Annelida: Metamerism & Segmental organs (Coelomoducts & Nephridia); Adaptive radiation in polychaetes; General features of earthworm	04
8.	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)	05
9.	Molluscs: Respiration, types of locomotory organelles, Torsion and de-torsion in Gastropods.	04

10.	Echinodermata: Larval forms, Water vascular system.	04
<b>Total Lectures / Hours/Periods</b>		<b>45</b>

### Recommended Books: Systematics (Animal Taxonomy)

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. II<sup>nd</sup> edition. E.L.B. Sand Nelson
4. Nigam: Biology of Non-chordates (Current edition, S. Chand).
5. Kotpal, R.L. (2019) Modern textbook of zoology: Invertebrates. 11th edition, Rastogi publication.
6. नॉनकॉर्डेटा की विविधता- डॉ ललित गुप्ता, डॉ मनोज चन्द्रकान्ता, २०२३
7. जंतु विविधता : अकशेरुकी - के.सी. गुप्ता, २०२१

### 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?cs>

## Semester -I

### Practical

#### (MJ-1 P): Diversity of Non-chordates

Full Marks=25

(No internal exam in practical)

Pass Marks: 10

VBU-MJ-Z-IP

Credit – 1 (30hrs)

S. No.	Practicals	Marks Distribution
1	Dissection Non-Chordate* (*subject to approval from UGC)	05
2	Slide Preparation	05
3	Spotting: (4x 2 marks) Permanent Slides 02 Museum Specimen 02	08
4	Class Record, Poster/ Model and PowerPoint presentation	03
5	Viva-voce	04
	<b>TOTAL</b>	<b>25</b>

#### List of suggested Practical

##### 1. Study of available museum specimen of animals

*Sycon, Physalia, Metridium, Adamsia, Fasciola, Taenia solium, Nereis, Aphrodite, Pheretima, Chiton, Pila, Unio, Sepia, Loligo, Octopus, Limulus, Millipedes, Centipedes, Palaemon, Asterias, Echinus, Holothuria*

##### 2. Study of the following through permanent slide

*Paramecium* (wm), Conjugation of *Paramecium*, *Obelia* colony, Gemmules of Sponges, Ephyra larva, Miracidium larva, Sporocyst larva, Redia larva, Cercaria larva, Trochophore larva, Glochidium larva, Nauplius larva, Zoea larva, Mysis larva, Megalopa larva, Bipinnaria larva, Echinopluteus larva, Ophiopluteus larva, T.S. of earthworm through pharynx, gizzard and typhlosole.

##### 3. Dissection\*subject to approval from UGC

Dissection of digestive, nervous and reproductive system of Earthworm.

Dissection of digestive and nervous system of *Palaemon*.

**4. Temporary Mounting\*subject to approval from UGC**

Temporary Mounting of nephridia and ovary of Earthworm, trachea and salivary glands of *Periplaneta americana*, cephalic appendages of *Palaemon*.

**5. Power Point presentation:** Study of any two animals from two different classes by students (may be included if dissections not given permission).



**Semester-II**  
**Paper– II**  
**[Diversity of Chordates]**

**Full Marks = 75      End Semester: 60)      Internal: 10 + 5**

**Marks: 15(5 Attd.+10 SIE : 1 Hr) + 60 (ESE : 3Hrs) Pass marks: Th (SIE+ESE)=30**

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VBU-MJ-Z-II

Credit-3(45 Hrs)

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**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 proto chordate and vertebrate species.
- ❖ Group animals on the basis of their morphological characteristics/structures.
- ❖ Understand how environmental changes affect morphological traits and cause long-term evolution.
- ❖ 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.

## SEMESTER-II

### MJ-2 DIVERSITY OF CHORDATES

#### VBU-MJ-Z- II

S. NO.	Topics	Hours of Teaching
1	Origin of Chordates	02
2.	General Characters and classification of Chordates upto classes	03
3.	<b>Hemichordates:</b> Characters, systematic position and affinities	03
4.	<b>Urochordates:</b> General features, Life history of <i>Herdmania</i> (Retrogressive metamorphosis)	03
5.	<b>Cephalochordates:</b> General characters and affinities, feeding mechanisms of <i>Brachisostoma</i> , excretory system of <i>Branchiostoma</i>	03
6.	<b>Cyclostomata:</b> General features and classification of upto order, affinities and phylogenetic status Cyclostomes: General organization of <i>Petromyzon</i> and <i>Myxine</i> Ammocete Larva	05
7.	<b>Pisces:</b> General characters and classification of chondrichthyes, General characters of classification of Osteichthyes, General account and affinities of Dipnoi, respiratory and accessory respiration in fishes, Scales in fishes.	07
8.	<b>Amphibia:</b> General features and classification of Amphibia upto order, Origin of tetrapod, General Features of Limbless amphibia and tailed amphibia ( <i>Ichthyophis</i> & <i>Salamader</i> )	05
9.	<b>Reptilia:</b> 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.	05
10.	<b>Aves:</b> General features and classification upto order, Origin of birds, flight muscles, flight adaptation, flightless birds	03
11	<b>Mammalia:</b> General features and classification upto order, Origin of mammals, dentition, in mammals, general features and affinities of Prototheria and Metatheria, adaptations in aquatic mammals and flying mammals, adaptive radiation in primates.	06
	<b>Total Lectures/hours/periods</b>	<b>45</b>

*Books Recommended*

*Diversity of Chordates*

1. Nigam: Biology of Chordates (1997, S. Chand)
2. Young, J.J.: The life of Vertebrates, 3<sup>rd</sup> ed. 1981, ELBS with oxford press
3. Parker and Haswell: A Text Book of Zoology Vol. II (2005, Macmillan)
4. Kotpal, R.L. (2019) Modern textbook of zoology: Vertebrates. 5th edition, Rastogi publication
5. कॉर्डेट जूलॉजी – वसंतिका कश्यप, आकाश चन्द्र मिश्रा

*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

### Practical

#### (MJ-II P): Diversity of Chordates

Full Marks=25

(No internal exam in practical)

Pass Marks: 10

VBU-MJ-Z-IIP

Credit – 1 (30hrs)

S. No.	Practicals	Marks Distribution
1	Dissection bony fish(*subject to approval from UGC)	06
2	Slide Preparation (scales of fishes )	04
3	Spotting: (5 x 2 marks) Permanent Slides 02 Museum Specimen 03	10
4	Class Record, Poster/ Model and PowerPoint presentation	03
5	Viva-voce	02
	<b>TOTAL</b>	<b>25</b>

#### List of Suggested Practicals:

#### **Chordate Diversity: Study with the help of models, Figures or Specimens**

**1 Protochordate:** *Balanoglossus*, *Herdmania*

**2 Agnatha:** *Petromyzon* and *Myxine*

**3 Pisces:** *Scoliodon*, *Torpedo*, *Chimaera*, *Labeo rohita*, *Cirrhinus mrigala*, *Hippocampus*, *Exocoetus*, *Syngnathus*, *Heteropneustes*, *Clarias batrachus*, *Anabas*, *Echeneis*, *Channa*, *Notopterus*

**4 Amphibia:** *Ambystoma*, *Axolotl larva*, *Alytes*, *Hyla*, *Bufo*, *Rana*.

**5 Reptilia:** *Chamelon*, *Draco*, *Naja naja*, *Bungarus*, *Ptyas* (Dhamin)

**6 Aves-** *Columba*, *Psittacula* (Parrot) *Passer* (House Sparrow), *Bubo* (Great Horned Owl), *Aledo* (Kingfisher) Ostrich Model, *Archeopteryx*

**7 Mammals:** Protheria models of Duckbilled Platypus and spiny anteater, *Ptreopus* (Megachiroptera), *Manis* (Pangolin), *Funambulus* (Squirrel), *Cavia* (Guinea Pig), *Rattus ratus* (Rat)

**8 Dissection** (\*subject to approval from UGC): Dissection of Local Bony Fishes: Afferent,

Efferent and Nervous system.

**9. Mounting:** Cycloid and Placoid scales of fish

**10. Power Point presentation:** Study of any two animals from two different classes by students (may be included if dissections not given permission).



## Semester-III

### Paper- III

#### [Comparative anatomy of vertebrates]

**Full Marks = 75      End Semester: 60)      Internal: 10 + 5**

**Marks: 15(5 Attd.+10 SIE : 1 Hr ) + 60 (ESE : 3Hrs) Pass marks: Th (SIE+ESE)=30**

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VBU- MJ-Z- III

Credit-3(45 Hrs)

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#### About the course

The course enlightens how each vertebrate group of organisms 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 higher chordate and species.
- ❖ Group animals on the basis of their morphological characteristics/structures.
- ❖ Understand how environmental changes affect morphological traits and cause long-term evolution.
- ❖ 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.

## SEMESTER-III

### MJ-3 COMPARATIVE ANATOMY OF VERTEBRATES

#### VBU-MJ-Z- III

S.No.	Topic	Teaching Hrs
1.	Comparative functional anatomy of various systems of vertebrates. <b>Comparative account of Integument and its derivatives-</b> Structure of integument from fish to mammals with an account on epidermal and dermal derivatives and their functional significance.	06
2.	<b>Comparative account of Endoskeleton-</b> Skull in different vertebrates, Jaw suspension and Vertebral column.	06
3.	<b>Comparative account of Digestive system-</b> comparative anatomy of oral cavity, teeth (dentition in mammals), Structure and diversity of alimentary canal and digestive glands in vertebrates.	07
4.	<b>Comparative account of Circulatory system-</b> Evolution of aortic arches and their significance in vertebrates, Structure and evolution of heart in vertebrates.	07
5.	<b>Comparative account of Urogenital system-</b> Types and development of kidneys and their ducts in anamniotes and amniotes. Nephrons-structure, types and functions. comparative details of testes and ovaries from fishes to mammals.	08
6.	<b>Comparative account of Brain-</b> Structure and functional evolution of brain and spinal cord in various classes of vertebrates. Structure and function of neurons.	06
7.	<b>Comparative account of Sense organs-</b> vision, hearing, taste, smell and touch in vertebrates.	05
	<b>Total</b>	<b>45</b>

*Books Recommended*

1. Nigam: Biology of Chordates (1997, S. Chand)
2. Young, J.J.: The life of Vertebrates, 3<sup>rd</sup> ed. 1981, ELBS with oxford press
3. Parker and Haswell: A Text Book of Zoology Vol. II (2005, Macmillan)
4. Kotpal, R.L. (2019) Modern textbook of zoology: Vertebrates. 5th edition, Rastogi publication
5. Saxena, R.K. and Saxena, S. (2015) Comparative anatomy of vertebrates (2nd edition)
6. तुलनात्मक शारीरिक रचना और कशेरूक के विकास सम्बन्धी जीवविज्ञान – (NEP-2020) ठाकुर पब्लिकेशन

जीसर्गं सत्यशोधनम्

## Semester -III

### Practical

#### (MJ-III P): Comparative anatomy of vertebrates

Full Marks=25

(No internal exam in practical)

Pass Marks: 10

VBU-MJ-Z-IIIP

Credit – 1 (30hrs)

S. No.	Practicals	Marks Distribution
1	Virtual Dissection/ study of any two animals	06
2	Slide Preparation (rectrices, feathers of birds)	04
3	Spotting: (5 x 2 marks) Permanent Slides 02 Museum Specimen 02 Bones 01	10
4	Class Record, Poster/ Model and PowerPoint presentation	03
5	Viva-voce	02
	TOTAL	25

#### List of Suggested Practical

1. Osteology: Bones of Amphibia, Reptilia, Aves and Mammal (Frog, Varanus, Fowl and Rabbit)- pelvic girdle, pectoral girdle, forelimb, hindlimb, vertebrae.
2. Permanent slide: Slides of Amphibia, Reptilial, Aves and Mammal: T.S. passing through Stomach
3. Whole mount of Feathers
4. Temporary mounts of rectrices
5. Models of Beak in birds
6. Models of Feet in Birds
7. Types of Teeth in mammals
8. Virtual dissection of air sacs in birds
9. **Power Point presentation:** Study of any two animals from two different classes by students (may be included if dissections not given permission).

## Semester-III

### Paper- IV

#### [Cell Biology]

**Full Marks = 75      End Semester: 60)      Internal: 10 + 5**

**Marks: 15(5 Attd.+10 SIE : 1 Hr) + 60 (ESE : 3Hrs) Pass marks: Th (SIE+ESE)=30**

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VBU-MJ-Z-IV

Credit-3(45 Hrs)

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#### 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.

#### 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 signaling 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.
- ❖ Understand how tissues are produced from cells in a normal course and about any malfunctioning which may lead to benign or malignant tumor.

**SEMESTER-III**  
**(MJ-4) CELL BIOLOGY**  
**VBU-MJ- Z- IV**

<b>S. No.</b>	<b>Topics</b>	<b>Hours of Teaching</b>
<b>1</b>	The Cell: Typical structure of animal cell, Comparison of a generalized prokaryotic and eukaryotic cell.	<b>02</b>
<b>2</b>	Methods in Cell Biology: Elementary idea of microscopy and cell fractionation, Light Microscope, Scanning Electron Microscope (SEM), Transmission Electron Microscope (TEM), Fluorescence Microscope	<b>05</b>
<b>3</b>	Structure and function of Plasma membrane, Endo membrane system- Structure and functions of mitochondria, endoplasmic reticulum, golgi complex, lysosome, peroxisome	<b>10</b>
<b>4.</b>	Introduction to cytoskeleton: Microtubules, Microfilament, Intermediate filament, Motor Molecules	<b>04</b>
<b>5</b>	Nuclear organization of cell: Nuclear envelope, nucleolus and biogenesis of ribosome, Ultrastructure of chromosome, introduction to polytene and lamp brush chromosomes.	<b>06</b>
<b>6</b>	Concept of Nuclear Transport	<b>02</b>
<b>7</b>	Cell Junction and its types, Cell-Cell Adhesion molecules	<b>02</b>
<b>8</b>	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.	<b>08</b>
<b>9</b>	Concept of cell signaling (Signal Transduction)	<b>02</b>
<b>10</b>	Concept of necrosis and apoptosis ( Program Cell Death)	<b>02</b>
<b>11</b>	Cancer biology hallmarks in cancer cell, types and cause of cancer, Metastasis	<b>02</b>
	<b>Total Hours</b>	<b>45</b>

*Books Recommended:*

**Cell 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)
6. कोशिका विज्ञान एवं अनुवांशिकी – डॉ पी.के. गुप्ता जनवरी २०१५
7. कोशिका विज्ञान, आण्विक जैविकी एवं अनुवांशिकी – डॉ जे.पी. खान, डॉ ऋषिकेश मीना, डॉ महेंद्र कुमार , डॉ दिलीप गुप्ता, डॉ अमित कटिया – २०२४

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

### Practical

#### (MJ-IV P): Cell biology

Full Marks=25

(No internal exam in practical)

Pass Marks: 10

VBU-MJ-Z-IVP

Credit – 1 (30hrs)

S. No.	Practicals	Marks Distribution
1	Preparation of Idiogram from photographs of given karyotypes and comment on genetic disorder/ Study of cell organelles through photograph	04
2	Osmosis experiment (Isotonic, Hypertonic & Hypotonic)	03
3	Onion root tip's squash preparation /polytene chromosome preparation	04
4	Spotting (03x02) Instrument -01 Cell Division slide -02	06
6	Class Record, Poster/Model and Power Point presentation	04
7	Viva-voce	04
<b>TOTAL</b>		<b>25</b>

#### List of Suggestive Practicals:

1. Study of Instrument : Light microscope and electron microscope
2. Stages of mitosis by squash technique using Onion root tips
3. Study of various stages of meiosis through permanent slide
4. Preparation of polytene chromosomes from *Chironomus* larvae /*Drosophila*
5. Study of bar bodies in cheek epithelium.
6. Study of slides of prokaryotic cell- *Bacteria*.
7. Study of slides of unicellular eukaryotic cell –*Amoeba*, *Paramecium*.
8. Cell Division slides of Mitosis.
9. Demonstration of osmosis in different solution Hypotonic, Isotonic and Hypertonic
10. Study of karyotype and preparation of idiogram.

## Semester-IV

### Paper– V

#### [Indian knowledge system (IKS) in animal science]

**Full Marks = 75      End Semester: 60)      Internal: 10 + 5**

**Marks: 15(5 Attd.+10 SIE : 1 Hr) + 60 (ESE : 3Hrs) Pass marks: Th (SIE+ESE)=30**

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VBU-MJ- Z-V

Credit-3(45 Hrs)

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#### About Course

There's growing interest in integrating IKS with modern veterinary science to promote sustainable animal husbandry, especially under the IKS Division of the Ministry of Education, India, and in veterinary universities. Concerning to this the Indian Knowledge System (IKS) in Animal Science encompasses the traditional, indigenous practices, beliefs, and knowledge related to the care, breeding, health, behavior, and use of animals in India. This body of knowledge has been developed and passed down through generations, especially within rural and tribal communities, and often emphasizes sustainability, local resources, and a deep understanding of animal behavior. Thus, Indian Knowledge System (IKS) as applied to Animal Science offers rich opportunities for documentation, validation, and integration of traditional practices with modern science.

#### Learning Outcome

After completing this course student will be able to

- ❖ Acquaint with the traditional and ancient knowledge about the pet animal rearing which is highly relevant today.
- ❖ Learn the holistic and low cost methods and will be able to standardized the techniques scientifically.
- ❖ Learn how to use the environmentally sustainable of IKS in animal care.
- ❖ Understand the techniques of local breed conservation.
- ❖ Learn about the herbal medicine used by ancient and tribal people.

**SEMESTER-IV**  
**(MJ-5) INDIAN KNOWLEDGE SYSTEM (IKS) IN ANIMAL SCIENCE**  
**VBU-MJ-Z- V**

S.No.	Topic	Hours of Teaching
1.	<b>Indigenous Breeding Practices</b> <ul style="list-style-type: none"> <li>• <b>Selective breeding</b> based on traits like strength, milk yield, drought resistance, and temperament.</li> <li>• Indigenous cattle breed like Gir, Sahiwal, Tharparkar, Hallikar, maintained through traditional methods.</li> <li>• Knowledge of lineage ("gotra") and breeding intervals</li> </ul>	<b>05</b>
2.	<b>Ethnoveterinary Medicine</b> <ul style="list-style-type: none"> <li>• <b>Use of herbal remedies and natural substances to treat common animal diseases.</b> <ul style="list-style-type: none"> <li>○ Turmeric (Haldi) and Neem</li> <li>○ Ashwagandha</li> <li>○ Buttermilk</li> </ul> </li> <li>• Role of local healers <i>Pashu Vaid</i>s or <i>Desi Vaidyas</i> in animal healthcare</li> </ul>	<b>07</b>
3.	<b>Traditional Animal Nutrition</b> <ul style="list-style-type: none"> <li>• <b>Feeding strategies using:</b> <ul style="list-style-type: none"> <li>○ Crop residues</li> <li>○ Tree leaves (e.g., Subabul, Neem, Banyan)</li> <li>○ Oil cakes (mustard, groundnut)</li> <li>○ Minerals from natural sources (e.g., salt licks)</li> </ul> </li> <li>• Balanced diets for work animals and lactating animals</li> </ul>	<b>10</b>
4.	<b>Animal Housing and Management</b> <ul style="list-style-type: none"> <li>• <b>Building of cattle sheds (gaushalas) with proper ventilation and hygiene.</b></li> <li>• <b>Use of cow dung and urine not as disinfectants, fuel, and fertilizers.</b></li> <li>• <b>Shade and water management based on local climate conditions.</b></li> </ul>	<b>06</b>

**Sources and Further Reading:**

5.	<p>Cultural and Religious Integration</p> <ul style="list-style-type: none"> <li>• <b>Role of cows, bulls, elephants, and snakes in rituals and Seasonal festivals (e.g., Pongal, Govardhan Puja, Mattu Pongal)</b></li> <li>• <b>Ethical treatment of animals rooted in Ahimsa (non-violence) philosophy.</b></li> </ul>	05
6.	<p><b>Traditional Knowledge of Animal Behavior</b></p> <p>Deep understanding of animal signs and sounds used for: Predicting illness, detecting esterous in cows and buffaloes, training animals for ploughing, herding, etc., Use of verbal commands, gestures, and rhythmic sounds.</p>	07
7.	<p><b>Sustainable Practices</b></p> <ul style="list-style-type: none"> <li>• Grazing rotation and mixed-species herding (e.g., sheep and goats) to maintain pasture health.</li> <li>• Use of animal power in farming (bullocks for ploughing, dung for biogas and compost).</li> <li>• Circular farming: integrating crop and livestock systems</li> </ul>	05
	<b>Total</b>	<b>45</b>

- Books on **Ethnoveterinary Practices** in India.
- Research papers from **National Bureau of Animal Genetic Resources (NBAGR)**
- Publications from **ICAR (Indian Council of Agricultural Research)**
- IKS Division website: <https://iksindia.org>

## Semester -IV

### Practical

**(MJ-V P): IKS in animal science**

**Full Marks=25**

**(No internal exam in practical)**

**Pass Marks: 10**

VBU-MJ-Z-VP

Credit – 1 (30hrs)

S.No.	Practical	Marks Distribution
1.	Analyse the presence of phytochemicals in given plants extracts	05
2.	Detection of Protein /mineral content in provided oil cake	05
3.	Comment upon spot 1-2 Use Herbal medicine Indigenous breed	05
4.	Practical records	05
5.	Field reports	05
<b>TOTAL</b>		<b>25</b>

#### List of suggested practicals:

##### 1. Herbal Medicine Analysis

- Phytochemical analysis of herbs used in ethnoveterinary treatments.
- Testing antimicrobial, antiparasitic, or anti-inflammatory properties.
- Example: Extracting and testing compounds from *Neem*, *Turmeric*, *Tulsi* for treating wounds or infections in cattle.

##### 2. Microbiological Studies

- Studying the effect of traditional treatments (e.g., cow urine, herbal pastes) on pathogenic bacteria.
- Testing traditional formulations against diseases like mastitis, foot-and-mouth disease, etc.

##### 3. Nutritional Profiling

- Analyzing indigenous feed resources (e.g., oil cakes, tree leaves) for:
  - Protein content
  - Digestibility
  - Mineral composition
- Lab analysis of cow milk/yield when fed with traditional feed recipes.

##### 4. Field work in IKS – animal science

- **Field studies focus on documentation, observation, and participatory research with local communities.**
- **Ethnoveterinary Documentation**

- a. Visiting villages to document: Local names of diseases, Herbal treatments and preparation methods, Treatment success stories
- b. Interviewing folk healers (Pashu Vaidyas) and elderly livestock keepers.
- c. On-Farm Trials
- d. Field-testing of traditional practices under real-world conditions:
- e. Effect of herbal dewormers
- f. Feeding trials using local fodder mixes
- g. Monitoring impact on animal health, reproduction, milk yield.
- h. Breed Surveys
- i. Field identification and registration of indigenous breeds (cattle, buffalo, goat, sheep, poultry).
- j. Use of mobile apps and participatory tools (e.g., PRA, PERT) for data collection.
- k. Behavioral Observation:
  - i.) Studying animal behavior with traditional training methods (e.g., commands, routines).
  - ii.) Recording responses to natural remedies and housing conditions.
- l. IKS Integration Programs:
  - i.) Collaborating with NGOs and government schemes (e.g., Rashtriya Gokul Mission).
  - ii.) Promoting farmer-scientist interface programs to co-develop solutions.

#### Sample Field Work Project Ideas (for students/researchers)

1. "Documentation of Ethnoveterinary Practices in Jharkhand"
2. "Nutritional Evaluation of Traditional Feed Resources in Jharkhand"
3. "Comparative Study of Neem-based and Commercial Tick Repellents"
4. "Breed Characterization of Local Goat Varieties"
5. "Effectiveness of Cow Urine in Controlling Mastitis in Indigenous Cattle"

## Semester-IV

### Paper– VI

#### [Histology and human physiology]

**Full Marks = 75      End Semester: 60)      Internal: 10 + 5**

**Marks: 15(5 Attd.+10 SIE : 1 H r ) + 60 (ESE : 3Hrs) Pass marks: Th (SIE+ESE)=30**

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VBU-MJ-Z- VI

Credit-3(45 Hrs)

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#### 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.

**SEMESTER-IV**  
**(MJ-6) HISTOLOGY AND HUMAN PHYSIOLOGY**  
**VBU-MJ-Z- VI**

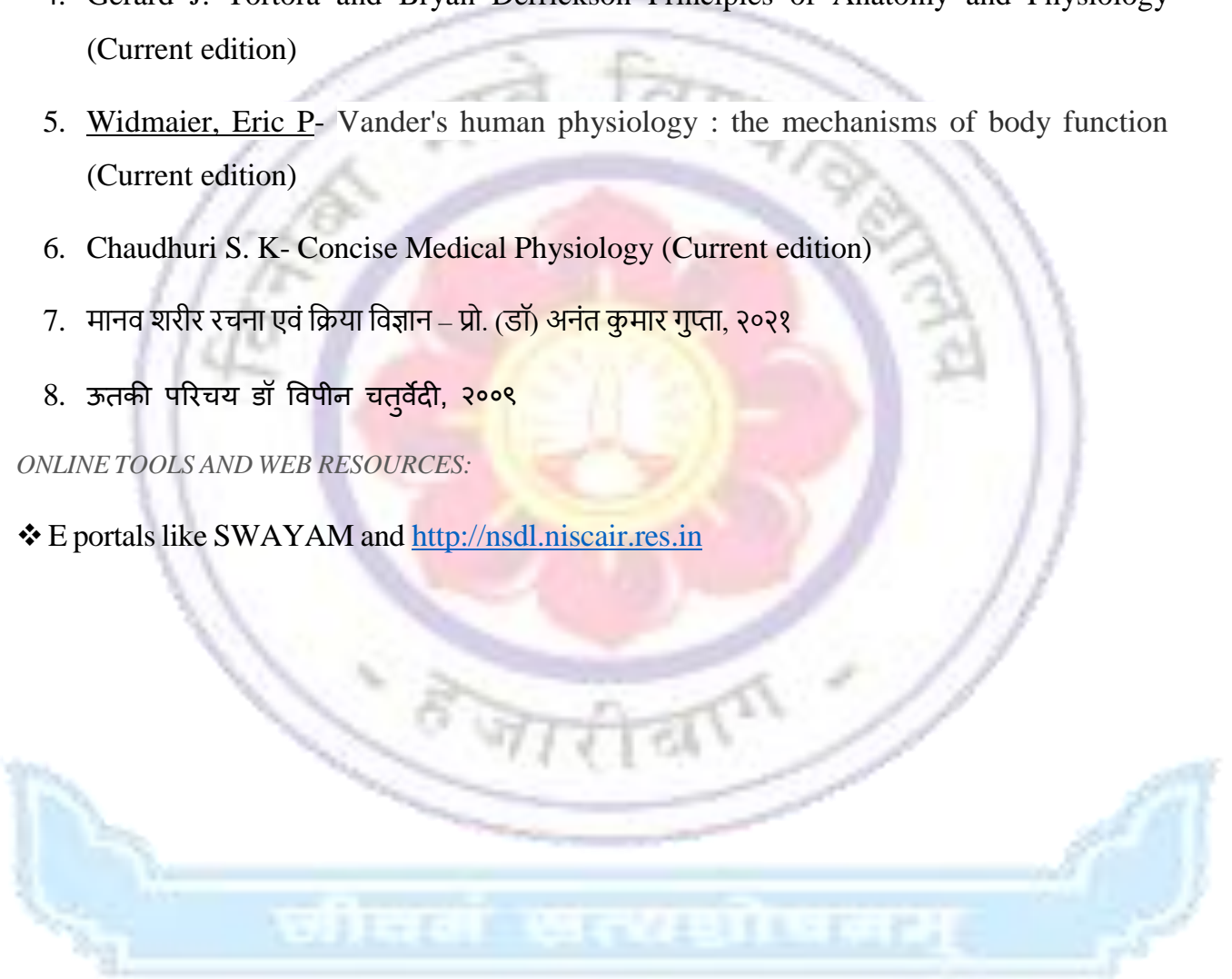
<b>S. No.</b>	<b>Topics</b>	<b>Hours of Teaching</b>
<b>1</b>	Tissue and their functions: epithelial tissue, connective tissue, muscular tissue and nervous tissue.	<b>04</b>
<b>2</b>	Principles of physiology: adaptation, acclimatization, acclimation, homeostasis, acid-base balance, thermoregulation feedback- control systems.	<b>05</b>
<b>3</b>	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).	<b>08</b>
<b>4</b>	Composition and constituents of blood; blood groups and Rh factor in man; factors and mechanism of coagulation; anticoagulants	<b>06</b>
<b>5</b>	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.	<b>05</b>
<b>6</b>	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.	<b>05</b>
<b>7</b>	Neuron: structure and types, nerve impulse: conduction; synaptic transmission and neurotransmitters.	<b>04</b>
<b>8</b>	Muscles: types, mechanism of contraction of skeletal muscles, effects of exercise on muscles. Cori cycle	<b>05</b>
<b>9</b>	Structure of human eye, mechanism of vision and defects. Structure of human ear and hearing mechanisms.	<b>03</b>
	<b>Total Hours</b>	<b>45</b>

*Books recommended:*

1. C. Chatterjee Medical physiology
2. Guyton– A book on medical physiology (Current edition)
3. Stuart Era Fox-Human Physiology (Current edition)
4. Gerard J. Tortora and Bryan Derrickson Principles of Anatomy and Physiology (Current edition)
5. Widmaier, Eric P- Vander's human physiology : the mechanisms of body function (Current edition)
6. Chaudhuri S. K- Concise Medical Physiology (Current edition)
7. मानव शरीर रचना एवं क्रिया विज्ञान – प्रो. (डॉ) अनंत कुमार गुप्ता, २०२१
8. ऊतकी परिचय डॉ विपीन चतुर्वेदी, २००९

*ONLINE TOOLS AND WEB RESOURCES:*

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



## Semester -IV

### Practical

#### (MJ-VI P): Histology and human physiology

Full Marks=25

(No internal exam in practical)

Pass Marks: 10

VBU-MJ-Z-VIP

Credit – 1 (30hrs)

S. No.	Practicals	Marks Distribution
1.	Determination of blood pressure /bleeding time / clotting time /Hb estimation	04
2.	Measurement of lung vital capacity	04
3.	Estimation of casein in milk / glucose in urine	04
4.	Spotting Contraceptive device -01 Histological tissue section -01	04
5.	Records/ Poster/ Model	04
6.	Viva-voce	05
	<b>TOTAL</b>	<b>25</b>

### 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. Estimation of haemoglobin content.
4. Determination of blood groups.
5. Measurement of blood pressure using sphygmomanometer.
6. Determination of oxygen consumption (cockroach).
7. Measurement of lungs vital capacity
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 esophagus, stomach, duodenum, rectum, lung, kidneys and brain cells
12. Study of common instruments used in laboratory- pH meter, Haemocytometer, Haemometer, Stethoscope and Sphygmomanometer.



**Semester-IV**  
**Paper– VII**  
**[Biochemistry]**

**Full Marks = 75      End Semester: 60)      Internal: 10 + 5**

**Marks: 15(5 Attd.+10 SIE : 1 H r ) + 60 (ESE : 3Hrs) Pass marks: Th (SIE+ESE)=30**

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VBU-MJ-Z- VII

Credit-3(45 Hrs)

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**About the course**

The goal of biochemistry is to comprehend fundamental biological processes at the molecular level. Understanding the basic chemical concepts that support intricate biological systems is the course's goal. The curriculum is intended to give students a solid understanding of biochemistry and its real-world applications, to prepare students for further education, including research, or to make the study engaging, relevant, and motivating for them to join the industry.

**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.

**SEMESTER-IV  
(MJ-7) BIOCHEMISTRY**

**VBU-MJ-Z- VII**

S. No.	Topics	Hours of Teaching
<b>1</b>	Biochemistry: Introduction, scope and importance. Water as biological solvent.	<b>02</b>
<b>2</b>	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)	<b>04</b>
<b>3</b>	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.	<b>12</b>
<b>4</b>	Lipids: Structure and Biological significance. Fatty acids: Types and nomenclature (saturated and unsaturated). Classification: Triglycerides, phospholipids, sphingolipids, cholesterol; $\beta$ - oxidation	<b>05</b>
<b>5</b>	Proteins: Composition and biological significance. Amino acids- Structure, classification and properties, Ionization, titration curve, pK and pI. Catabolism of amino acids: Transamination, Deamination, Urea cycle.	<b>08</b>
<b>6</b>	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).	<b>08</b>
<b>7</b>	Nucleotide biosynthesis and metabolism, <i>de Novo</i> pathway and salvage pathways its regulation and diseases	<b>04</b>

8	Vitamins: Characteristics and Types of Fat Soluble and Water-Soluble Vitamins and their related diseases	02
	<b>Total Hours</b>	<b>45</b>

### Books Recommended:

1. Lehninger, Nelson and Cox: Principles of Biochemistry, Current edition.
2. Harper's illustrated biochemistry Current edition, Appleton and Lange
3. Satyanarayan U: Biochemistry, Current edition.
4. जैव रसायन – डॉ एस.पी. सिंह, डॉ विक्रान्त सिंह, २०२३, जैव रसायन – डॉ वी.पी. अग्रवाल, २०२२  
जैव रसायन विज्ञान – डॉ डी. एन. वाजपेयी, २०२२

### ONLINE TOOLS AND WEB RESOURCES

- ❖ CEC Gurukul ([www.cec.nic.in](http://www.cec.nic.in)).
- ❖ <https://www.youtube.com/user/cecedusat/featured>.



## Semester -IV

### Practical

#### (MJ-VII P): Biochemistry

Full Marks=25

(No internal exam in practical)

Pass Marks: 10

VBU-MJ-Z-VIIP

Credit – 1 (30hrs)

S. No.	Practicals	Marks Distribution
1	Preparation of Models of Biomolecules/Effect of pH or temperature on salivary amylase	05
2	Preparation of Haemin Crystal	05
3	Detection of Biomolecules in given sample	05
4	Record	05
5	Viva Voce	05
<b>TOTAL</b>		<b>25</b>

#### List of suggested Practical

1. Detecting adulteration in a) Ghee b) Sugars c) Tea leaves and d) Turmeric.
2. Effect of pH and temperature on salivary amylase
3. Estimation of Lactose in milk.
4. Estimation of casein milk
5. Detection of biomolecules in the unknown sample-
  - a. Benedict's test for reducing sugars.
  - b. Ninhydrin test for  $\alpha$  amino acids.
  - c. Iodine test for starch
6. Group discussion or Seminar presentation.
7. Virtual Labs (Suggestive sites)

<https://www.vlab.co.in>

<https://zoologysan.blogspot.com>

[www.vlab.iitb.ac.in/vlab](http://www.vlab.iitb.ac.in/vlab)

<https://vlab.amrita.edu>

<https://sites.dartmouth.edu>

[www.onlinelabs.in](http://www.onlinelabs.in)

**Semester-V**  
**Paper– VIII**  
**[Genetics]**

**Full Marks = 75      End Semester: 60)      Internal: 10 + 5**

**Marks: 15(5 Attd.+10 SIE : 1 H r ) + 60 (ESE : 3Hrs) Pass marks: Th (SIE+ESE)=30**

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VBU-MJ-Z- VIII

Credit-3(45 Hrs)

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**About the course**

This course attempts to give a general overview of genetics, beginning with Mendel's work and continuing through the present knowledge of several phenomena such as mutations, recombination, transposition, and sex determination. Some key aspects include the mechanism of inheritance, gene structure and function, sex chromosomal and autosomal anomalies, aspects of human genetics, etc. will be covered.

**Learning outcomes**

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

- ❖ Learn about the fundamentals of inheritance.
- ❖ Analyse the pedigree to help students build their critical thinking and analytical abilities so they can explain their findings in a scientific way.
- ❖ Understand how mutations occur, the agents that cause them, and the negative effects of the different chemicals and medications that are used on a daily basis.

**SEMESTER-V**  
**(MJ-8) GENETICS**  
**VBU- MJ-Z- VIII**

S. No.	Topics	Hours of Teaching
1.	Mendel's laws of inheritance, Multiple alleles, genetics of blood groups, hereditary diseases in man (Sickle cell anaemia, Colour blindness, Haemophilia and Albinisms) linkage mapping.	08
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.	05
3.	Mendelian traits in man. Crossing over (Genetic recombination), linkage and linkage group, Sex linkage- limited, influenced and linked	06
4.	Classical and Modern concept of gene (Cistron, muton, recon), housekeeping gene, split gene, overlapping gene).	04
5.	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> Sex determination in <i>Drosophila</i> and man. (Alternate splicing, Role of Sxl and different genes in the determination of sex	06
6.	Concept of Spontaneous and Induced Mutation, Structure and Numerical alterations of Chromosomes.	04
7	Human Genetics: Pedigree analysis; Karyotype, banding and nomenclature of chromosome subdivisions. Genetic disorders: chromosomal aneuploidy (Down, Turner and Klinefelter syndromes).	04
8	Bacterial genetics: Transformation, conjugation and transduction.	03
9	Transposomes and Transposition (Ac and Ds element and IS element)	05
	Total Hours	45

*Books Recommended -Genetics*

1. Gardner *et. al.*, Principles of Genetics (Current edition, John Wiley).
2. Griffith *et. al.*, An Introduction to Genetic Analysis (Current edition Freeman).
3. Snustad and Simmons: John Wiley, Principles of Genetics (Current edition).
4. Principle of Genetics – Tamarin.
5. Klug *et. al.*, Concepts of Genetics (Current edition, Pearson)
6. कोशिका विज्ञान, आण्विक जैविकी एवं अनुवांशिकी – डॉ जे.पी. खान, डॉ ऋषिकेश मीना, डॉ महेंद्र कुमार , डॉ दिलीप गुप्ता, डॉ अमित कटिया – २०२४
7. अनुवांशिकी के आधार - डॉ बी.डी. सिंह (८ दिसम्बर २०२४)
8. कोशिका विज्ञान एवं अनुवांशिकी - डॉ पी.के. गुप्ता 1 जनवरी २०१५

*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

### Practical

#### (MJ-VIII P): Genetics

Full Marks=25

(No internal exam in practical)

Pass Marks: 10

VBU-MJ-Z-VIIP

Credit – 1 (30hrs)

S. No.	Practical	Marks Distribution
1	To Prove Mendels law (Dominant /Independent assortment)	05
2	Construction of genetic Map	05
3	Pedigree analysis / Chromosomal disorder identification	05
4	Class Record, Poster/Model and Power Point presentation	05
5	Viva-voce	05
	<b>TOTAL</b>	<b>25</b>

#### List of suggested Practicals:

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. Study of structural chromosomal aberrations (dicentric, ring chromosomes and inversions in polytene chromosomes) from prepared slides/photographs.
8. Study of human karyotypes and numerical alterations (Down syndrome, Klinefelter

syndrome and Turner syndrome).

9. Gene mapping



**Semester–V**  
**Paper– IX**  
**Evolution and Population Genetics**

**Full Marks = 75      End Semester: 60      Internal: 10 + 5**

**Marks: 15 (5Attd. + 10 SIE:1Hr) + 60 (ESE:3Hrs) = 75      Pass Marks: Th (SIE+ESE) = 30**

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VBU-MJ-Z-IX

Credit-3(45 Hrs)

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**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. Further this course will emphasize the geological era and evolutionary events occurred and the factors promoting the origin of new alleles and gene

**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.

## SEMESTER-V

### ((MJ-9) EVOLUTION AND POPULATION GENETICS

#### VBU-MJ-Z- IX

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	06
3	Theories of evolution; Natural selection, Mutation theory of Evolution, role of mutation in evolution, evolutionary patterns, molecular drive, Synthetic theory of evolution	05
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	05
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.	03
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.	06
10	Zoo-geography- A concept with special reference to Oriental region, Ethiopian and Australian region.	04
	<b>Total Hours</b>	<b>45</b>

*Books Recommended:*

#### **Evolution**

1. Moody: Introduction to Evolution (1978, Kalyani).
2. Veer Bala Rastogi: Organic Evolution (Current edition, Kedarnath & Ramnath)
3. Strickberger: Evolution (2004, Jones & Bartlett)
4. Theodosius Dobzhansky: Evolution

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

### Practical

#### (MJ-9 P): Evolution and Population Genetics

Full Marks=25

(No internal exam in practical)

Pass Marks: 10

VBU-MJ-Z-IX P

Credit – 1 (30hrs)

S. No.	Practical	Marks Distribution
1	Comment on Fossil /Living Fossil /Connecting Links	05
2	Estimation of gene and genotype frequency/ Phylogenetic tree construction	05
3.	Comment upon the serial homology / analogous organ Homologous organ	05
4.	Class Record, Poster/Model and Power Point presentation	05
5.	Viva-voce	05
	<b>TOTAL</b>	<b>25</b>

#### *List of Practicals: Evolution and population genetics*

1. Study of fossil.
2. Study of distribution of gene frequency.
3. Study of adaptive radiations in feet of birds, mouth parts of insects and heterodont dentition.
4. Study of types of fossils. mold, cast.
5. Analogy and homology (wings of birds and insects, forelimbs of bat and rabbit).
6. Serial homology in appendages of *Palaemon*.
7. Construction of phylogenetic tree by UPGMA method.
8. Evolution of man and horse by chart/virtual.

**Semester-V**  
**Paper- X**  
**[Developmental Biology]**

**Full Marks = 75      End Semester: 60)      Internal: 10 + 5**  
**Marks: 15(5 Attd.+10 SIE : 1 Hr) + 60 (ESE : 3Hrs) Pass marks: Th (SIE+ESE)=30**

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VBU-MJ-Z-X

Credit-3(45 Hrs)

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**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

**SEMESTER-V**  
**MJ-10 DEVELOPMENTAL BIOLOGY**  
**VBU-MJ-Z- 10**

S. No.	Topics	Hours of Teaching
1	Gametogenesis: Spermatogenesis, Composition of semen, In vitro and In vivo capacitation of mammalian sperm, Oogenesis, Types of eggs.	08
2	Fertilization: Molecular events of fertilization, Acrosomal reaction. Implantation; Feto-placental unit; Polyspermy and its prevention.	06
3	Morphogenesis and Morphogens, Cleavage, Plane patterns, Types of blastula.	05
4	Organizer concept and embryonic induction	04
5	Fate map, gastrulation in frog and chick	04
6	Extra embryonic membrane in chick	04
7	Placenta in mammals	03
8	Cell lineage, cell to cell interaction	03
9	In vitro fertilization and Embryo Transfer Technology	04
10	Stem cells: Sources, types and their use in human welfare	04
<b>Total hours</b>		<b>45</b>

*Books Recommended:*

**Developmental Biology**

1. Balinsky: An Introduction to Embryology (5<sup>th</sup> ed.)
2. Gilbert: Developmental Biology (10<sup>th</sup> ed., Sinauer)
3. Human Embryology and Developmental Biology by Bruce Carlson, (Elsevier 5<sup>th</sup> ed.)
4. Chordate Embryology Developmental Biology by PS Verma and VK Agarwal (S. Chand & Co.)
5. विकासीय तथा परिवर्धन जैविकी- के.सी. गुप्ता, वैशाली अग्रवाल, २०२०, विकास एवं परिवर्धन जीव विज्ञान - डॉ नीतू शर्मा, डॉ संध्या पाण्डेय (ठाकुर पब्लिकेशन), परिवर्धन जैविकी - डॉ अशोक कुमार सिरिया (रस्तोगी पब्लिकेशन), २०१९

## Semester -V

### Practical

#### (MJ-X P): Developmental Biology

Full Marks=25

(No internal exam in practical)

Pass Marks: 10

VBU-MJ-Z-XP

Credit – 1 ((30hrs)

#### List of suggested practicals

S. No.	Practicals	Marks Distribution
1.	Preparation of window in chick egg	05
2.	Comment on the life cycle of <i>Drosophila</i> / Frog	05
3.	Comment on spot No.1-4 a. WM of Chick embryo -02 b. WM of Frog developmental stage -01 c. Placenta slide	2x4=08
4.	Class record and poster/model/power point presentation	03
5.	Viva-voce	04
<b>TOTAL</b>		<b>25</b>

1. Study of whole mounts and sections of developmental stages of frog through permanent slides: Cleavage stages, blastula, gastrula, neurula (Neural plate, Neural fold and Neural tube stages), tail-bud stage, tadpole (external and internal gill stages)
2. Study of whole mounts of developmental stages of chick through permanent slides (Hamburger and Hamilton Stages): Stage 3 (Intermediate Streak)-13 hours, Stage 4 (Definitive Streak)-18 hours, Stage 5 (Head Process)-21 hours, Stage 7- 24 hours, Stage 8-28 hours, Stage 10-33 hours, Stage 11-40 hours, Stage 13-48 hours, Stage 19- 72 hours and Stage 24-96 hours of incubation
3. In vivo study of chick embryo development by windowing and candling methods. (Demonstration only)
4. Study of indirect development and metamorphosis by rearing any one insect.
5. Study of different sections of placenta (photomicrographs/ slides).
6. Project report on *Drosophila* or any insect culture/Visit to Poultry Farm/IVF Centre
7. Student Presentation: Power point presentation on any topic related to developmental biology.

**Semester-V**  
**Paper– XI**  
**[Molecular Biology]**

**Full Marks = 75      End Semester: 60)      Internal: 10 + 5**

**Marks: 15(5 Attd.+10 SIE : 1 Hr ) + 60 (ESE : 3Hrs) Pass marks: Th (SIE+ESE)=30**

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VBU-MJ-Z-XI

Credit-3(45 Hrs)

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**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 gene and its expression and regulations.

**Learning outcomes**

- ❖ After successfully completing this course, the students will be able to
- ❖ Develop an understanding how the gene expresses through central dogma of molecular Biology DNA expresses.
- ❖ Develop an understanding of concepts, mechanism and evolutionary significance of molecular biology in the current scenario.
- ❖ 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 area 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.

## SEMESTER-V

### MJ-11 MOLECULAR BIOLOGY

#### VBU-MJ-Z- XI

S. No.	Topics	Hours of Teaching
1	<b>Nucleic Acid: DNA:</b> Structure, types and functions; RNA: Structure, types and functions.	05
2	<b>DNA Replication</b> –Conservative, Semiconservative and dispersive mode of DNA Replication, Experimental proof of Semiconservative DNA replication, Properties and Mechanisms of DNA Replication in Prokaryotes.	10
3	<b>Gene Expression:</b> Concept of Genetic Code, Central Dogma, Mechanism of Transcription in Prokaryotes, Mechanism of Translation in Prokaryotes.	10
	<b>Gene regulation:</b> Temporal and spatial gene, Concept of Operon, Positive and Negative gene regulation, Inducible and repressible gene regulation : Lac Operon, Trp Operon	04
5	<b>DNA Damage:</b> Mutagens, types, DNA damage by mutagens	04
6	<b>DNA Repair:</b> Base excision repair, Nucleotide excision repair, Double stranded break repair, Thymine dimer repair.	08
7	Concept of Transposable element	02
8	<b>Proto-oncogene and tumour suppressor gene</b>	02
	<b>Total hours</b>	<b>45</b>

#### Suggested books:

1. Karp: Cell and molecular biology (Current edition, John wiley)
2. Lodish *et al*: Molecular cell biology (Current edition, Freeman)
3. Cooper and Hausman : The cell, a molecular approach (2007, Sinauer)
4. कोशिका विज्ञान, आण्विक जैविकी एवं अनुवांशिकी – डॉ जे.पी. खान, डॉ ऋषिकेश मीना, डॉ महेंद्र कुमार , डॉ दिलीप गुप्ता, डॉ अमित कटिया – २०२४

#### Online tool:

- <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.jove.com/science-education-library/9/cell-biology)
- [https:// www.khanacademy.org/science/biology](https://www.khanacademy.org/science/biology)



## Semester -V

### Practical

**(MJ-11 P): Molecular Biology**

**Full Marks=25**

**(No internal exam in practical)**

**Pass Marks: 10**

VBU-MJ-Z-XIP

Credit – 1 (30hrs)

S. No.	Practical	Marks Distribution
1	Model preparation of Nucleotides with beads and wires	04
2	DNA /Protein estimation by Colorimeter	06
4	Spotting Instrument -01 Drosophila Mutant -02	06
5	Class Record, Poster/Model and Power Point presentation	04
6	Viva-voce	05
	<b>TOTAL</b>	<b>25</b>

#### Suggestive Practicals

1. Photographs of Contributors in Molecular Biology (Watson and Cricks . Barbara McClintoc, Pauling)
2. Photographs of Molecular Biology Importance
3. Lab Instruments : Micropipette , Colorimeter pH meter , Centrifuge , weighing Balance
4. Plasmid DNA isolation
5. Isolation of genomic DNA by ethanol precipitation methods
6. Quantitative Estimation of DNA
7. Estimation of Protein ( Biurette Method)
8. Demonstration of AMES test or reverse mutation
9. Preparation of Ball and stick model of Nucleotides
10. Preparation of solution used in molecular Biology experiment and pH measurement
11. Agarose Gel electrophoresis Demonstration
12. Study of Drosophila Mutant
13. Study of Temporal gene regulation ( Ex- Globin gene expression ) and spatial gene

expression (*Arabidopsis*)



**Semester-VI**  
**Paper– XII**  
**[Animal Behaviour]**

**Full Marks = 75      End Semester: 60)      Internal: 10 + 5**

**Marks: 15(5 Attd.+10 SIE : 1 Hr ) + 60 (ESE : 3Hrs) Pass marks: Th (SIE+ESE)=30**

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VBU-MJ-Z-XII

Credit-3(45 Hrs)

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### 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.



## SEMESTER-XII

### MJ-12 ANIMAL BEHAVIOUR

#### VBU-MJ-Z-XII

S. No.	Topics	Hours of Teaching
1	Introduction to animal behavior, Brief profiles of Karl Von Frisch, Ivan Pavlov, Konrad Lorenz, Niko Tinbergen, Raghavendra Gadagkar, Proximate and ultimate causes of behavior.	04
2	Mechanisms of Behaviour –Innate behaviour, Instinct, Stimulus filtering, Sign stimuli, Code breakers (Fixed action Pattern)	04
3	Patterns of Behaviour Orientation: Primary and secondary orientation; Kinesis - orthokinesis, klinokinesis; Taxis: tropotaxis and klinotaxis, menotaxis (light compass orientation). Learning: Associative learning, Classical and operant conditioning, Habituation, Imprinting; Reasoning: Intelligence and artificial intelligence.	09
4	Communication Importance of communication; Role of Tactile, Chemical, Auditory, Visual stimuli in communication.	04
5	Social Behaviour: Concept of Society; Insects' society; Honey bee: Society organization, polyphenism and polyethism; Foraging in honey bee, round dance, waggle dance; Experiments to prove distance and direction component of dance; Formation of new hive/queen.	08
6	Sexual Behaviour: Asymmetry of sex; Sexual dimorphism, mate choice; Intra-sexual selection (male rivalry); Inter- sexual selection (female choice); Courtship behavior, Courtship behavior in 3-spine stickleback; Infanticide; Parental care in Fish and Amphibia; Sexual conflict in parental care.	05
7	Altruism: Altruism, Inclusive fitness, Hamilton's rule	02
8	Biological Rhythm: Types and characteristics of biological rhythms: Short- and Long- term rhythms; Circadian rhythms; Tidal rhythms and Lunar rhythms; Circannual rhythms; Photoperiod and regulation seasonal reproduction of vertebrates; Significance of biological clocks.	09
<b>Teaching Hours</b>		<b>45</b>

#### Recommended Books-

1. प्राणी व्यवहारिकी – डॉ रीना माथुर
2. John Alcock: Animal Behaviour (Current edition).
3. Reena Mathur: Animal Behaviour (Current edition).
4. Manning, A. and Dawkins, M. S, An Introduction to Animal Behaviour, Cambridge, University Press, UK.
5. Chronobiology Biological Timekeeping: Jay. C. Dunlap, Jennifer. J. Loros, Patricia J. DeCoursey (ed). 2004, Sinauer Associates, Inc. Publishers, Sunderland, MA, USA.

## Semester -VI

### Practical

#### (MJ-12 P): Animal Behaviour

**Full Marks=25**

**(No internal exam in practical)**

**Pass Marks: 10**

VBU-MJ-Z-XIIP

Credit – 1 (30hrs)

S. No.	Practicals	Marks Distribution
1.	Comment upon the given photographs of nest /hive	05
2.	To perform phototaxis or geotaxis behavior in earthworm	05
3.	Comment upon the adaptive behaviour, model of parental Care	05
4.	Class record and poster/model/power point presentation/project	05
5.	Viva-voce	05
	<b>Total</b>	<b>25</b>

#### List of suggested Practical:

1. Study of tools, techniques and methods used in studying animal behavior.
2. Study nests and nesting habits of the birds and social insects.
3. Study of circadian functions in humans (Daily Eating, Sleep and Body temperature patterns).
4. To study geotaxis behaviour in earthworm.
5. Study the phototaxis behaviour in insect larvae.
6. Study different types of animal behaviour such as habituation, social life, courtship behaviour in insects and birds, and parental care from short videos/movies. At least two videos for each behaviour.
7. Visit to Forest/ Wild life Sanctuary/Biodiversity Park/Zoological Park to study behavioural activities of animals and prepare a short report.
8. Visit to Forest/ Wild life Sanctuary/Biodiversity Park/Zoological Park to study behavioural activities of animals and prepare a short report.

**Semester-VI**  
**Paper- XIII**  
**[Environmental Biology]**

**Full Marks = 75      End Semester: 60)      Internal: 10 + 5**

**Marks: 15(5 Attd.+10 SIE : 1 Hr) + 60 (ESE : 3Hrs) Pass marks: Th (SIE+ESE)=30**

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VBU-MJ-Z-XIII

Credit-3(45 Hrs)

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**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.
- ❖ Analyze 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.

## SEMESTER-VI

### MJ-13 ENVIRONMENTAL BIOLOGY

#### VBU-MJ-Z-XIII

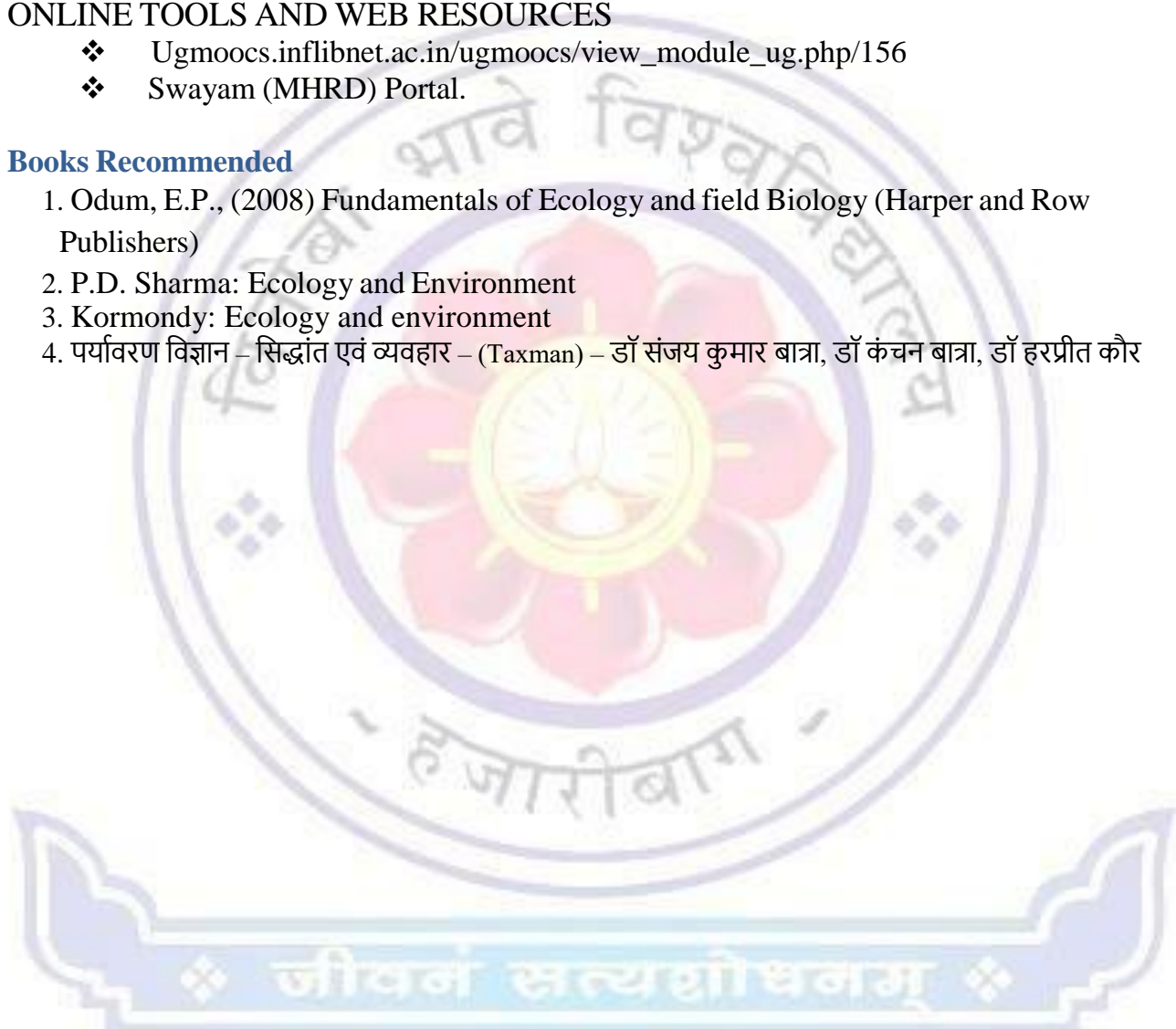
S. No.	Topics	Hours of Teaching
1	<b>Biosphere:</b> Concept of biosphere; biomes. Ecosystem: Concept of ecosystem, structure, function, and types of ecosystems.	03
2	<b>Bio geochemical cycles:</b> Carbon and Nitrogen. Human induced changes in atmosphere including greenhouse gases and mechanism of effect, Ozone Depletion, Acid rain.	06
3	<b>Population:</b> Characteristics, population dynamics, Population stabilization	02
4	<b>Community characteristics:</b> stratification; Dominance, diversity, species richness, abundance, evenness, similarity. Diversity and food-web indices. Ecotone and edge effect.	04
5	<b>Types of interaction:</b> 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	Soil and water conservation	03
9	Renewable and Non-Renewable Sources of Energy	04
10	Wild Life Depletion and conservation; Importance of conservation.	02
11	National Organisations involved in wild life conservation; Wild Life Legislation- Wild Protection Act 1972, its amendments and Implementation.	03
12	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.	02
	<b>Total hours</b>	<b>45</b>

## 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.

## Books Recommended

1. Odum, E.P., (2008) Fundamentals of Ecology and field Biology (Harper and Row Publishers)
2. P.D. Sharma: Ecology and Environment
3. Kormondy: Ecology and environment
4. पर्यावरण विज्ञान – सिद्धांत एवं व्यवहार – (Taxman) – डॉ संजय कुमार बात्रा, डॉ कंचन बात्रा, डॉ हरप्रीत कौर



## Semester -VI

### Practical

#### (MJ-13 P): Environmental Biology

Full Marks=25

(No internal exam in practical)

Pass Marks: 10

VBU-MJ-Z-XIIP

Credit – 1 (30hrs)

S. No.	Practical	Marks Distribution
1.	Estimation of dissolved oxygen/alkalinity/free CO <sub>2</sub>	05
2.	Construction and comment of food chain/food web	05
3.	Soil test /determination of biodiversity indices	05
4.	Class record and poster/model/power point presentation	05
5.	Viva-voce	05
	<b>TOTAL</b>	<b>25</b>

#### List of practical

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 Co<sub>2</sub>.
12. Estimation of Alkalinity.

**Semester-VI**  
**Paper- XIV**  
**[Economic Zoology]**

**Full Marks = 75      End Semester: 60)      Internal: 10 + 5**

**Marks: 15(5 Attd.+10 SIE : 1 Hr) + 60 (ESE : 3Hrs) Pass marks: Th (SIE+ESE)=30**

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VBU-MJ-Z-XIV

Credit-3(45 Hrs)

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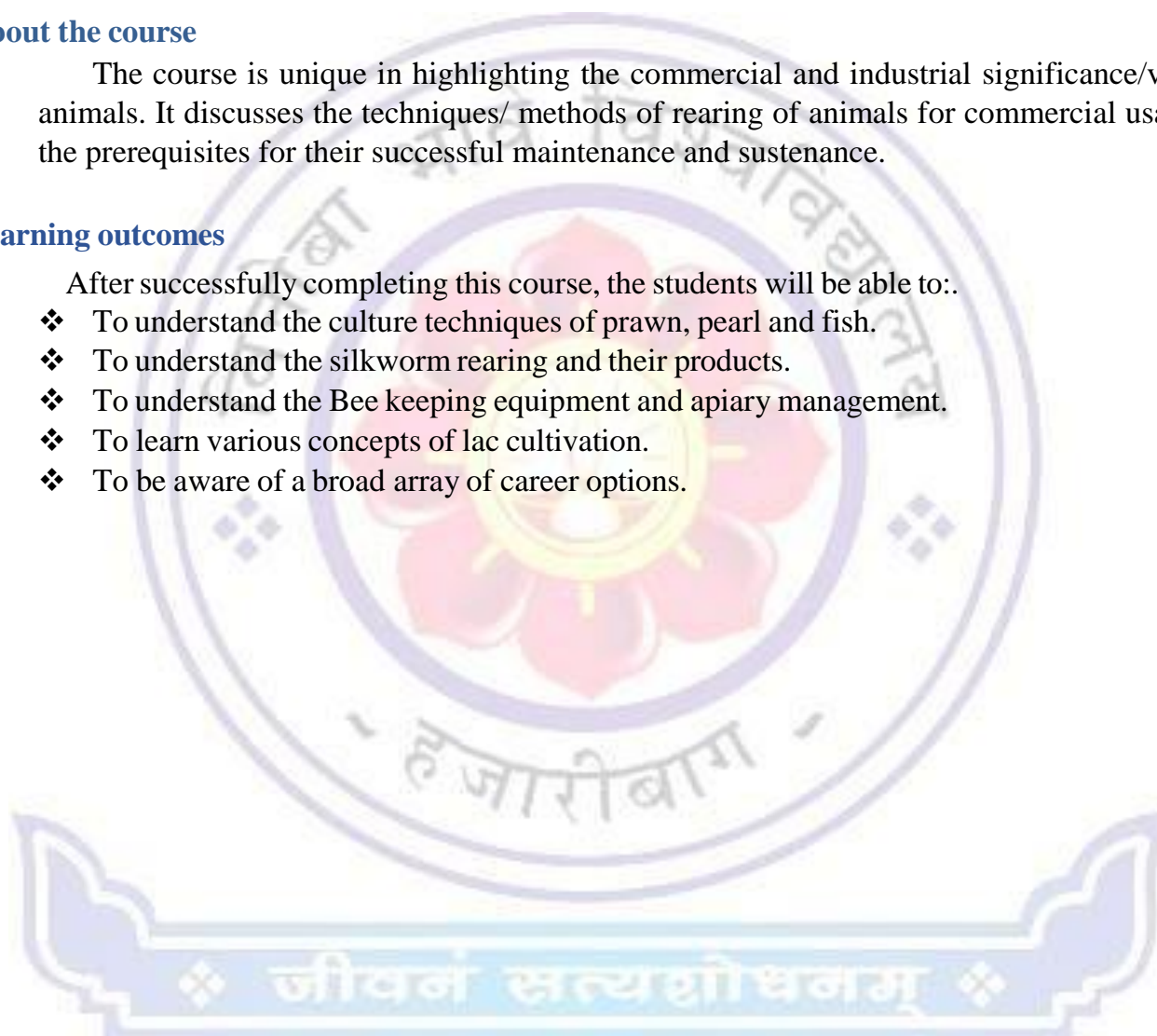
**About the course**

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.

**Learning outcomes**

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

- ❖ 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.



**SEMESTER-VI**  
**MJ-14 ECONOMIC ZOOLOGY**  
**VBU-MJ-Z- XIV**

S. No.	Topics	Hours of Teaching
1.	Animal Husbandry and live stock management, Poultry farming -Breeding and managing chickens for egg and meat, Diseases of Poultry, Dairy farming – Managing cattle for milk production, Animal breeding electing and breeding animals for desirable traits	10
2.	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.	10
3.	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.	09
4.	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.	08
5.	Shrimp culture: Need for Shrimp Farming, Brackish water Shrimp Farming in India, Biology of Indian Shrimps, Cultivable Species for Shrimp Culture. Shrimp Farming Systems:Traditional System, Extensive System Semi- intensive Culture System ,Intensive Culture System. Economics of Shrimp Farming	07
	Total Hours	45

**Recommended Books.**

1. Economic Zoology: Saras Publication.
2. G. S. Shukla, V. B Upadhyay: Economic Zoology.
3. Prost, P. J. (1962). Apiculture. Oxford and IBH, New Delhi.
4. Sericulture, FAO Manual of Sericulture.
5. Sardar Singh, Bee keeping in India, Indian Council of Agricultural Research, New Delhi.
6. N. Arumugam, K.V. Jayashree, C.S. Tharadevi: Bee Keeping in India, Saras publication.
7. Dhyan Singh Bisht, Apiculture, ICAR Publication.
8. Kumar and Nigam-Economic and applied zoology
9. आर्थिक प्राणीशास्त्र - डॉसिंह .डी.बी .डॉ / टंडन .एस.आर ., आर्थिक जंतु विज्ञान - डॉवाजपेयी .एन.डी .

## Semester -VI

### Practical

(MJ-14 P): Economic Zoology

Full Marks=25

(No internal exam in practical)

Pass Marks: 10

VBU-MJ-Z-XIVP

Credit – 1 (30hrs)

S. No.	Practicals	Marks Distribution
1	Comment on the different socio-economic insects	04
2	Comment on the spots (1-4) <b>2X4=8</b> Silk fibroin, Coccon, Bee hive, Lac insect, Pearl producing species	08
3	Records, Poster/Model and Power Point Presentation	08
4	Viva- Voce	05
	<b>Total</b>	<b>25</b>

#### List of practicals

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

**Semester-VI**  
**Paper- XV**  
**[Parasitology]**

**Full Marks = 75      End Semester: 60)      Internal: 10 + 5**

**Marks: 15(5 Attd.+10 SIE : 1 Hr) + 60 (ESE : 3Hrs) Pass marks: Th (SIE+ESE)=30**

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VBU-MJ-Z-XV

Credit-3(45 Hrs)

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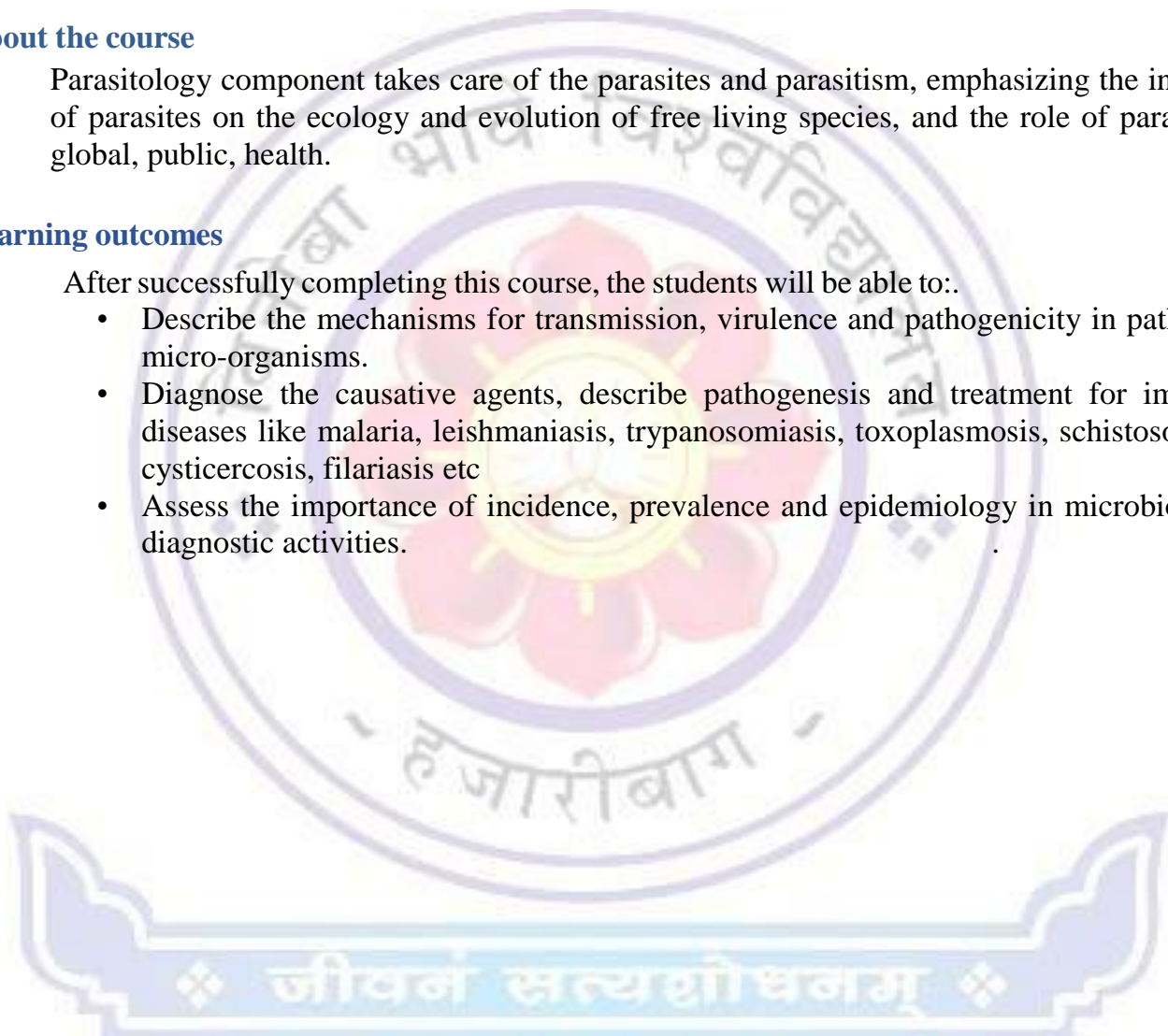
**About the course**

Parasitology component takes care of the parasites and parasitism, emphasizing the influence of parasites on the ecology and evolution of free living species, and the role of parasites in global, public, health.

**Learning outcomes**

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

- Describe the mechanisms for transmission, virulence and pathogenicity in pathogenic micro-organisms.
- Diagnose the causative agents, describe pathogenesis and treatment for important diseases like malaria, leishmaniasis, trypanosomiasis, toxoplasmosis, schistosomiasis, cysticercosis, filariasis etc
- Assess the importance of incidence, prevalence and epidemiology in microbiological diagnostic activities.



## SEMESTER-VI

### MJ-15 PARASITOLOGY

#### VBU-MJ-Z- XV

S. No.	Topics	Hours of Teaching
1	Introduction to Parasitology: Brief introduction of Parasitism: Parasite, Parasitoid and Vectors (mechanical and biological vector) Host parasite Relationship	07
2	Parasitic Protists: Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of <i>Entamoeba histolytica</i> , <i>Leishmania donovani</i> , <i>Plasmodium vivax</i> .	08
3	Parasitic Platyhelminthes: Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of <i>Fasciola hepatica</i> , <i>Taenia solium</i>	08
4	Parasitic Nematodes: Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of <i>Ascaris lumbricoides</i> & <i>Wuchereria bancrofti</i>	08
5	Parasitic Arthropoda: Importance and control of ticks, mites, <i>Pediculus humanus</i> , <i>Cimex lectularius</i>	07
6	Parasitic Vertebrates: A brief account of parasitic vertebrates: Cookicutter Shark and Vampire bat	07
	<b>Total Hours</b>	<b>45</b>

#### Recommended Books

- 1 K. D. Chatterjee (2009). Parasitology: Protozoology and Helminthology. XIII Edition, CBS Publishers & Distributors ( P ) Ltd.
- 2 E.R. Noble and G.A. Noble (1982) Parasitology: The biology of animal parasites. V Edition, Lea & Febiger.
- 3 Ahmed, N., Dawson, M., Smith, C. and Wood, Ed. (2007) Biology of Disease. Taylor and Francis Group
- 4 Parija, S. C. Textbook of medical parasitology, protozoology & helminthology (Text and colour Atlas), II Edition, All India Publishers & Distributors, Medical Books Publishers, Chennai, Delhi
- 5 पारजीवीवाद - EDUARD KOSTYUCK, २०१९

## Semester -VI

### Practical

#### (MJ-15 P): Parasitology

Full Marks=25

(No internal exam in practical)

Pass Marks: 10

VBU-MJ-Z-XVP

Credit – 1 (30hrs)

S. No.	Practicals	Marks Distribution
1	Whole Mount preparation of given parasites	07
2	Spotting (1-4) =2X4 Slide -protozoa Slide -nematodes Slide - platyhelminthes Slides –arthropods	08
3	Practical records	05
4	Viva Voce	05
5	Total	25

#### List of Practicals

1. Study of life stages of *Entamoeba histolytica*, *Leishmania donovani* and *Plasmodium vivax* through permanent slides/micro photographs.
2. Study of adult and life stages of *Taenia solium* through permanent slides/micro photographs
3. Study of adult and life stages of *Ascaris lumbricoides*, *Wuchereria bancrofti* through permanent slides/micro photographs.
4. Study of *Pediculus humanus* (Head louse and Body louse) and *Cimex lectularius* through permanent slides/ photographs).
5. Study of nematode/cestode parasites from the intestines of Poultry bird [Intestine can be procured from poultry/market as a by product.
6. Submission of a brief report on either ecto or endo parasite of humans.

## Semester-VII

### Paper– XVI

#### [Research Methodology]

**Full Marks = 75      End Semester: 60)      Internal: 10 + 5**

**Marks: 15(5 Attd.+10 SIE : 1 Hr) + 60 (ESE : 3Hrs) Pass marks: Th (SIE+ESE)=30**

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VBU-MJ-Z-XVI

Credit-3(45 Hrs)

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#### About the course

This is a course design to get familiar in investigating the new knowledge, understanding or insight in research of biological science and its allied. Moreover, it will dealt with the broad concept of research , formulation and research process

#### Learning outcomes

After successfully completion of this course the student will be able:-

1. To define and formulate the research problems in scientific way
2. Able to design the research and can apply the correct methodology pertain to research problems
3. Able to apply the suitable research methodology for analyzing the results
4. Able to learn the methods to avoid plagiarisms
5. Able to communicate the research findings in suitable journal of high impacts with good citations

## SEMESTER-VII

### MJ-16 RESEARCH METHODOLOGY

#### VBU-MJ-Z- XVI

S. No.	Topics	Hours of Teaching
1	Concept of Research: Meaning and Characteristics of research Need of Research (objective and motivation, Types of Research, Importance of research, Principle & qualities of research work,)	07
2	Research Problems: Problems in research ,. Formulation of objectives- Formulation of Hypotheses-Types of Hypothesis-methods of testing Hypothesis –Research plan and its component, Methods of research (Survey ,Observation ,case study, experimental, historical comparative method, Identification of research problem (Hypothesis); Elements in research methodology: Research design. Parametric and non parametric methods	08
3.	Research Model: Model organisms: Definition, requirement, characteristics and selection.	02
4.	Commonly used Model Organisms Characteristics, establishment and maintenance, specific application of following model organisms in research Bacteria ( <i>Escherichia coli</i> ); Fungi ( <i>Saccharomyces cerevisiae</i> ); Annelids ( <i>Caenorhabditis elegans</i> , <i>Lumricus terrestris</i> ); Arthropods ( <i>Drosophila melanogaster</i> ); Pisces ( <i>Danio rerio</i> ); Amphibians ( <i>Xenopus laevis</i> ); Mammals [Rodents ( <i>Mus musculus</i> ), <i>Rattus rattus</i> (Rat) and Primates]; Plants ( <i>Arabidopsis thaliana</i> ).	06
5	Research ethics: Ethical, legal, social and scientific issues in research; Role of IPR	03
6	Basic Research Techniques: Collection & preservation and identification of species: Types of preservatives & stains Study of histochemistry of different tissue:, Bioassay tests, Study and Analysis of sound pollution in terms of DB, Analysis of Air Sample collection acclimatization & toxicity determinants of the test organisms: Physio-Chemical analysis of water, <i>Drosophila</i> & microbial culture techniques. Study of haematological parameter;	07

7	Citations and Plagiarisms in research ISSN, ISBN, Citation index, H-index Impact factor; Preparation of bibliography, Plagiarism, Plagiarism avoidance (paraphrasing, summary)	06
8	Referencing in Research, Citation styles, Citation elements; APA, MLA, IEEE, AMA, ACS Harvard style	06
	<b>Total Hours</b>	<b>45</b>

### Recommended Books

1. Anthony, M, Graziano, A.M. and Raulin, M.L. 2009. Research Methods: A Process of Inquiry, Allyn and Bacon.
2. Walliman, N. 2011. Research Methods- The Basics. Taylor and Francis, London, New York.
3. Wadhera, B. L.: Law Relating to Patents, Trade Marks, Copyright Designs and Geographical Indications, 2002, Universal Law publishing.
4. C.R. Kothari: Research Methodology, New Age International, 2009.
5. Coley, S.M. and Scheinberg, C.A. 1990, — Proposal writing|. Stage Publication.
6. शोध पद्धति - सी.आर. ठाकुर, २०२३
- 7.



## Semester -VII

### Practical

#### (MJ-16 P): Research Methodology

**Full Marks=25**

**(No internal exam in practical)**

**Pass Marks: 10**

VBU-MJ-Z-XVIP

Credit – 1 (30hrs)

S. No.	Practicals	Marks Distribution
1	Comment upon the given research Model -02	06
	Write down the two references based on two research paper provided in APA style /power point presentation or preparation of five slides	04
2	Determine the given haematological indices from the data provided	05
3	Practical records	05
4	Viva Voce	05
5	Total	25

#### List of suggested practicals

- 1 Preparation of power point presentation
- 2 Study of different soft and hard components of computer.
- 3 Preparation of bacterial culture media.
- 4 Preparation of *Drosophila* culture media.
- 5 Determination of physical and chemical water parameters.
- 6 Determination of various haematological indices.
- 7 Preparation of research design.

**Semester-VII**  
**Paper– XVII**  
**[Immunology]**

**Full Marks = 75      End Semester: 60)      Internal: 10 + 5**

**Marks: 15(5 Attd.+10 SIE : 1 Hr) + 60 (ESE : 3Hrs) Pass marks: Th (SIE+ESE)=30**

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VBU-MJ-Z-XVII

Credit-3(45 Hrs)

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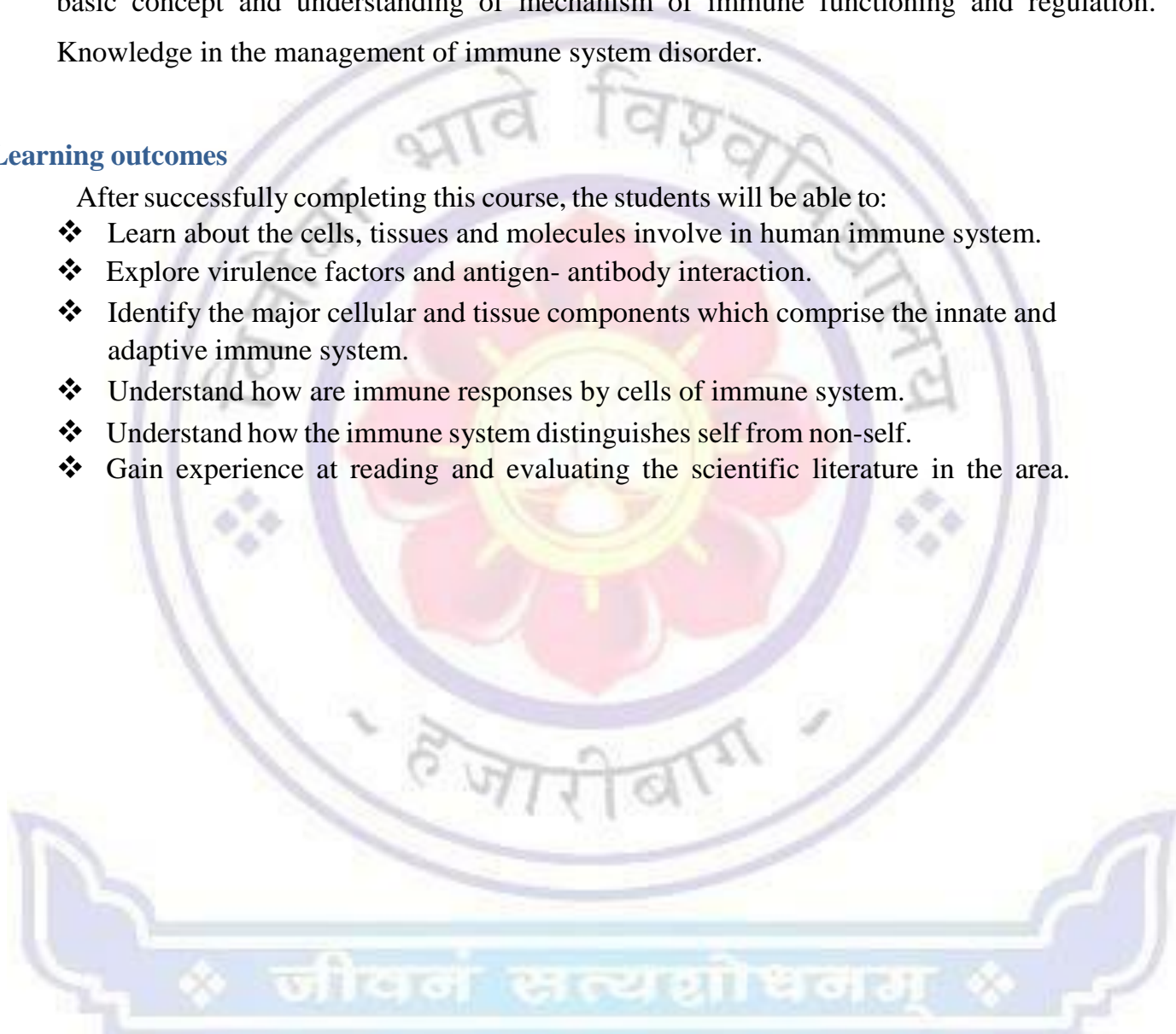
**About the course**

This course is intended to provide a solid grounding in immunology. It starts with the basic concept and understanding of mechanism of immune functioning and regulation. Knowledge in the management of immune system disorder.

**Learning outcomes**

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

- ❖ Learn about the cells, tissues and molecules involve in human immune system.
- ❖ Explore virulence factors and antigen- antibody interaction.
- ❖ Identify the major cellular and tissue components which comprise the innate and adaptive immune system.
- ❖ Understand how are immune responses by cells of immune system.
- ❖ Understand how the immune system distinguishes self from non-self.
- ❖ Gain experience at reading and evaluating the scientific literature in the area.



**SEMESTER-VII**  
**MJ-17 IMMUNOLOGY**  
**VBU-MJ-Z- XVII**

S. No.	Topics	Hours of Teaching
1	<b>Introduction to Immune System and Immunity:</b> Types of Immunity: Innate Immunity, Acquired Immunity	06
2	<b>Cells and Organs of Immune System:</b> 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.	08
3	<b>Antigens, antigenicity, and immunogenicity.</b> B and T cell epitopes.	06
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)	02
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
8.	<b>Autoimmunity</b> : response to self-antigen, transplant rejection-responses to alloantigen, autoimmune diseases	04
9.	<b>Immunodeficiency syndrome-</b> SCID, AIDS, ADA deficiency, tumour immunology- malignant transformation of cell, oncogenes and cancer induction	04
10	<b>Vaccines-</b> Active and passive immunization, whole organism vaccine, recombinant vector vaccine, DNA vaccine, synthetic peptide vaccine	03
	<b>Total hours</b>	<b>45 hrs</b>

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*Suggested Books*

1. Abbas *et al*: Cellular and Molecular Immunology.
2. Alberts *et al*: Molecular Biology of the Cell (Current edition, Garland)
3. Kubey – Principles of Immunology
4. Pathak *et al*: Immunology essential and fundamentals 3<sup>rd</sup> edition 2011.
5. Delves *et al*: essential immunology 13<sup>th</sup> edition, 2017.
6. प्रतिरक्षा विज्ञान – डॉ निमिषा वर्मा और डॉ जया शर्मा (३० सितम्बर २०२४)



## Semester -VII

### Practical

#### (MJ-17 P): Immunology

Full Marks=25

(No internal exam in practical)

Pass Marks: 10

VBU-MJ-Z-XVIIP

Credit – 1 (30hrs)

S. No.	Practicals	Marks Distribution
1	Blood grouping- ABO & Rh factor	05
2	Preparation of blood film and identification of different immune cells.	05
3	Spotting:-(2X3) Lymphocyte T.S of lymphoid organ: thymus, spleen, tonsil. Different stages of <i>Plasmodium</i> Different types of bacteria	06
4	Practical record/ Poster/ Model	04
5	Viva Voce	05
	Total	25

#### List of suggested practicals

1. Study of lymphoid cells and organs in rat/mouse
2. Study of spleen, thymus and lymph nodes through slides/photomicrographs.
3. Study various types of white blood cells using Leishman's/Giemsa/Crystal violet stained blood smear.
4. Study of antigen and antibody interactions by-
  - a. Ouchterlony's double immune-diffusion method.
  - b. ABO Blood group antigen determination by hemagglutination test.
  - c. Demonstration of ELISA.
  - d. Demonstration of Immunoelectrophoresis.

- e. RIA
- f. Elispot 154
- 5. Study of lab instrument used in microbiology Autoclave, Incubator, Laminar flow, Colony counter, Shaker Incubator.
- 6. Sterilization technique.
- 7. Media preparation and plating, Inoculation , Incubation and study of morphology
- 8. Study of slides – Stages of *Plasmodium*, *Candida*.
- 9. Different types of bacteria
- 10. Antibiotic sensitivity test.
- 11. Widal test
- 12. Project on any topic/ Project report on visit to any research institute/laboratory to study the immunological techniques.



## Semester-VII

### Paper– XVIII

#### [Biostatistics]

**Full Marks = 75      End Semester: 60)      Internal: 10 + 5**

**Marks: 15(5 Attd.+10 SIE : 1 Hr ) + 60 (ESE : 3Hrs) Pass marks: Th (SIE+ESE)=30**

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VBU-MJ-Z-XVIII

Credit-3(45 Hrs)

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#### About the course

The course is aimed at introducing the application of statistics in biology. It provides foundation on statistical methods to enable students to compute and interpret basic statistical parameters.

#### Learning outcomes

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

- ❖ Better understand the basic concepts of Biostatistics and its various applications in different fields of biological sciences.
- ❖ Know basic concepts of probability and statistics.
- ❖ Describe statistical methods and probability distributions relevant for molecular biology data.
- ❖ Apply the knowledge in future course of their career development in higher education and research
- ❖ Apprise students to the various statistical methods and software tools for understanding data analysis in biological sciences.
- ❖ Familiarize students with basic training and develop skills required for analysis of experimental data in biological sciences.
- ❖ Encourage students to pursue higher studies or career in biostatistics as Data Analyst, Data Scientist, Software Developer, Machine Learning Analyst, Research Scientist, Academicians, etc.
- ❖ Acquire basic skills to set up hypothesis and design research studies.
- ❖ Enable students to differentiate among various experimental designs and apply appropriate statistical tests.
- ❖ Develop the skills to collect and represent data in tabular and graphical forms
- ❖ Analyze data and interpret experimental results using calculator, spread sheets software and online/offline software tools.

**SEMESTER-VII**  
**MJ-18 BIOSTATISTICS**  
**VBU-MJ-Z- XVIII**

S. No.	Topics	Hours of Teaching
1.	Introduction to Biostatistics and its significance in Biology.	02
2.	<b>Statistical Data:</b> Sample and Sampling ,Primary and Secondary Data., Discrete and continuous data ,Frequency Distribution, Classification and Tabulation.	04
3.	<b>Representation of Data:</b> Diagrammatic representation- Histogram and Pie diagram, Ogive curve and Polygon curve.	04
4.	<b>Measures of Central Tendency:</b> Mean, Median and Mode	04
5.	<b>Measurement of Variation:</b> Standard Deviation, Standard Error of Mean, Coefficient of Variation.	04
6.	<b>Testing of Hypothesis:</b> Null and Alternative hypotheses; Concepts of statistical errors - Type I and Type II errors; Confidence Intervals and Confidence levels.	04
7.	Chi Square Test, Sign test and Student's t-test	04
8.	Measures of Dispersion.	03
9.	Probability and Distributions Normal, Binomial and Poisson; Skewness and Kurtosis.	06
10.	Correlation, its types and methods of calculation. Karl Pearsons Coefficient correlation, Rank Correlation.	05
11.	Regression analysis, line of Regression $Y = mx + c$ , Regression equation (Y on X and X on Y).	05
	<b>Total hours</b>	<b>45</b>

*Books Recommended:*

1. Statistics Theory and Practice by Bagavathi Pillai, R.S. N. (Current edition)
2. Fundamentals of biostatistics by Veer Bala Rastogi.
3. Fundamentals of Statistics by Gupta S.C. (Current Edition) Himalaya Publishing House
4. Statistics by VK Kapoor DC Sancheti (Current edition)
5. Introductory Statistics C-P. Mann (Wiley, Current edition)
6. Statistical Methods for Psychology David C. Howell (Current Edition)
7. Biostatistics by Khan and Khanum.
8. Daniel, W.W. and Cross, C.L. (2018) Biostatistics: Basic Concepts and Methodology for the Health Sciences 11th Edition, John Wiley & Sons, Inc.
9. Motulsky, H. (2016) Essential Biostatistics: A Non-mathematical Approach Oxford University Press
10. Zar, Jerrold H. (1999). Biostatistical Analysis, IV Edition, Pearson Education Inc and Dorling Kindersley Publishing Inc. USA
11. प्राणी व्यवहार एवं जैव सांख्यिकी – जया शर्मा, श्रृष्टि चौरसिया (NEP BASED)
12. प्रायिकता और सांख्यिकी (NEP) – डॉ एच.के. पाठक, 1 जनवरी २०२३

## Semester -VII

### Practical

#### (MJ-18 P): Biostatistics

Full Marks=25

(No internal exam in practical)

Pass Marks: 10

VBU-MJ-Z-XVIIIIP

Credit – 1 (30hrs)

S. No.	Practicals	Marks Distribution
1	Graphical representation of statistical data.	05
2	Generate data from the instruction given and calculate mean, median and mode.	05
3	Determine the test of significance in the data given /probability /correlation in the data provided	05
4	Practical records	05
5	Viva Voce	05
<b>TOTAL</b>		<b>25</b>

#### List of Practicals:

1. Sampling, Data collection, tabulation and graphical representation.
2. To learn calculation and graphical representation of data with computers (e.g. MS Excel/SPSS/SigmaStat/Prism).
3. Measurement of central tendencies
4. Measures of deviation
5. Test of significance- chi square test
6. Co-relation and regression analysis of data
7. Calculation of Probability.

## Semester-VIII

### Paper– XIX

#### [Biotechnology]

**Full Marks = 75**

**End Semester: 60)**

**Internal: 10 + 5**

**Marks: 15(5 Attd.+10 SIE : 1 Hr) + 60 (ESE : 3Hrs) Pass marks: Th (SIE+ESE)=30**

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VBU-MJ-Z-XIX

Credit-3(45 Hrs)

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#### 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. Students will explore the ethical legal and social implication of biotechnology, as well as current trends and emerging technologies in the field.

#### Learning outcomes

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

- ❖ understand the fundamental molecular tools and their applications of DNA modification and cloning.
- ❖ 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.
- ❖ Gain a comprehensive understanding of key concepts in biotechnology
- ❖ Apply their knowledge with problem solving approach to recommend strategies of genetic engineering for possible applications in Biotechnology and allied industry.

## SEMESTER- VIII

### MJ-19 Biotechnology

### VBU-MJ-Z- XIX

S. No.	Topics	Hours of Teaching
1	Introduction to Biotechnology, branches and its application.	02
2	<b>RDT:</b> 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.	07
3	<b>Cloning Vectors:</b> Plasmids and Cosmids. Yeast plasmid, Ti plasmid	05
4.	Screening and identification of recombinant DNA clone from gene library/Transformants	03
5	Concept of Protein engineering.	04
6.	Introduction of gene in to cell: Electroporation and Calcium Chloride method. Gene Gun , Microinjection	03
7	Cloned animal: Concept and Creation of Dolly.	02
8	<b>Transgenic animals:</b> basic concept. Production of transgenic animals: Retroviral method, DNA microinjection method, Nuclear Transplantation: Dolly and Polly.	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.	08
	<b>Total Hours</b>	<b>45</b>

#### *Books Recommended:*

1. Glick, B.R. and Pasternak, J.J. (2009). Molecular Biotechnology- Principles and Applications of Recombinant DNA. IV Edition, ASM press, Washington, USA.
2. R. Ian Freshney (2021) Freshney's Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications; Wiley-Blackwell.
3. Griffiths, A.J.F., J.H. Miller, Suzuki, D.T., Lewontin, R.C. and Gelbart, W.M. (2009). An Introduction to Genetic Analysis. IX Edition. Freeman and Co., N.Y., USA.

4. Watson, J.D., Myers, R.M., Caudy, A. and Witkowski, J.K. (2007). Recombinant DNA-Genes and Genomes-A Short Course. III Edition, Freeman and Co., N.Y., USA.
5. Mathur, J.P. and Barnes, D. (1998) Methods in Cell Biology: Animal Cell Culture Methods. Academic Press.
6. Primrose, S.B. and Twyman, R. (2006) Principles of Gene manipulation and Genomics (7<sup>th</sup> ed.) Black well Publishing.
7. Nicholl, D.S.T. (2008) An introduction to Genetic Engineering (3<sup>rd</sup> edition) Cambridge University Press.
8. Watson, J.D. (2006) Recombinant DNA (3<sup>rd</sup> edition) Cold Spring Harbor Laboratory Press.
9. Brown, T.A. (2001) Gene Cloning and DNA Analysis: An Introduction.
10. A PBS Documentary entitled, "Playing God" [History of Genetic Engineering]
11. B. D Singh, A text of Biotechnology.



## Semester -VIII

### Practical

(MJ-19 P): Biotechnology

Full Marks=25

(No internal exam in practical)

Pass Marks: 10

VBU-MJ-Z-XIXP

Credit – 1 (30hrs)

S. No.	Practicals	Marks Distribution
1	Isolation of genomic DNA/Plasmid DNA from E coli	06
2	Construction of Restriction map	06
3	Comment upon the Instrument (1-2)	04
4	Practical records	04
5	Viva- Voce	05
	Total	25

#### List of suggested Practical

1. Study of Lab instrument used in Biotechnology Lab- Micropipette, Centrifuge, Bioreactor (photograph), Transilluminator PCR, Electrophoresis apparatus
2. Study of Photographs of Biotechnological importance – Cloned animal, Transgenic animal, Knock out animal.
3. Genomic DNA isolation from E. coli.
4. Plasmid DNA isolation (pUC 18/19) from E. coli
5. Restriction digestion of plasmid DNA
6. Calculation of transformation efficiency from the data provided.
7. To study following techniques through photographs
  - i. Southern Blotting
  - ii. Northern Blotting
  - iii. Western Blotting
8. DNA Sequencing (Sanger's Method).
9. Qualitative and quantitative analysis of biomolecules (Protein and DNA)
10. Demonstration of PCR.
11. Project report on animal cell/tissue culture.
12. Molecular size determination of DNA separated from gel (through photograph)

**Semester-VIII**  
**Paper- XX**  
**[Bioinformatics]**

**Full Marks = 75      End Semester: 60)      Internal: 10 + 5**

**Marks: 15(5 Attd.+10 SIE : 1 Hr) + 60 (ESE : 3Hrs) Pass marks: Th (SIE+ESE)=30**

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VBU-MJ-Z-XX

Credit-3(45 Hrs)

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**About the course**

Bioinformatics is the emerging branch in Biological science .The course is aimed at introducing the application of bioinformatics 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. 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 the applications and limitations of different bioinformatics tools
- ❖ Perform and interpret bioinformatics 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

❖ जीवनं सत्यशोधनम् ❖

## SEMESTER-VIII

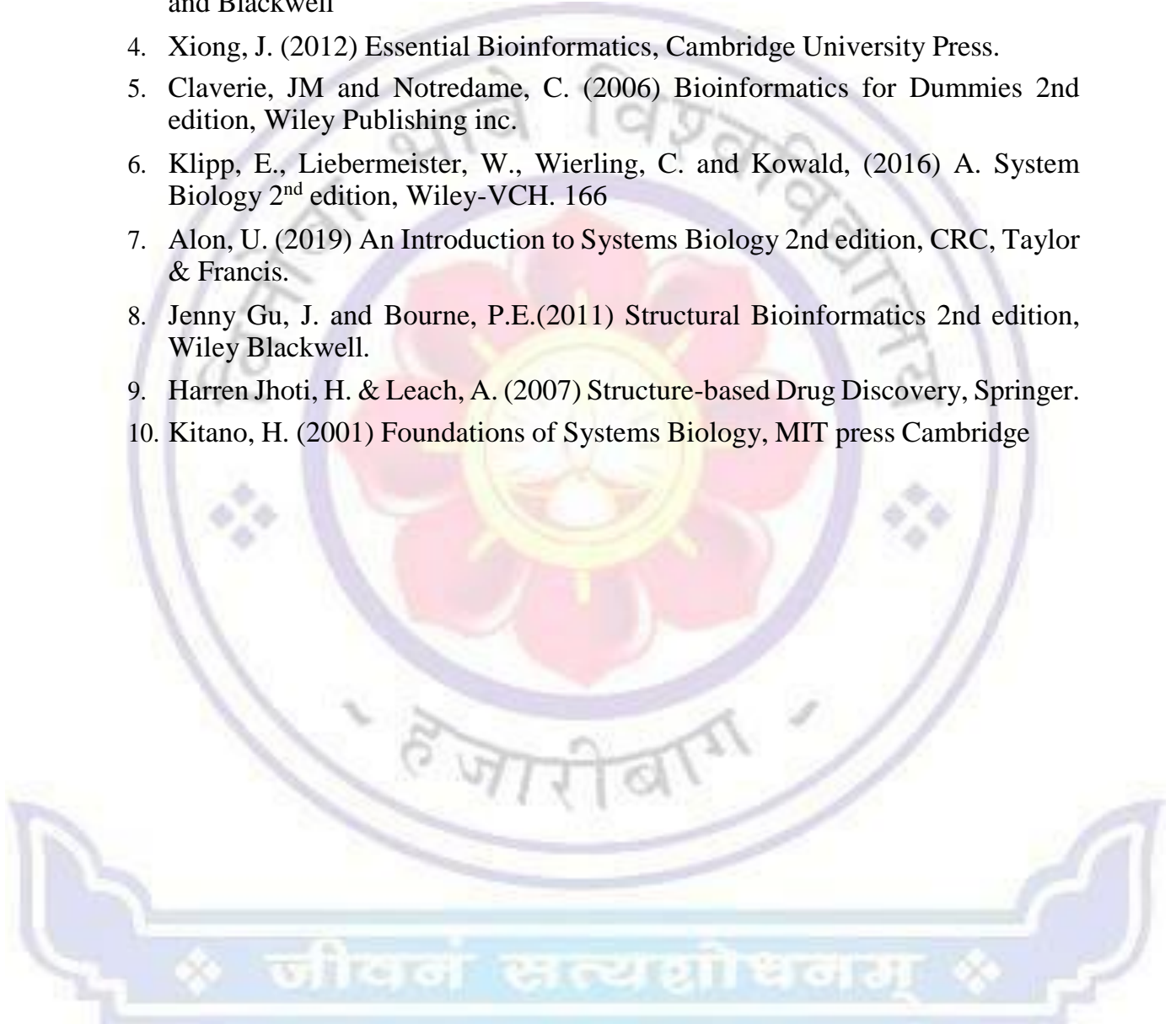
### MJ-20 BIOINFORMATICS

#### VBU-MJ-Z- XX

S. No.	Topics	Hours of Teaching
1.	Introduction and scope of bioinformatics: Bioinformatics, Genomics, Proteomics, Transcriptomics, Metabolomics, Scope and their applications.	04
2.	Concept of Digital Laboratory and Digital Library.	02
3.	Introduction to data archiving systems (FASTA format, Accession, and GI- Number). GENBANK	04
4.	<b>Biological database:</b> Nucleic acid sequences databases, Genome databases, Protein database sequence, structures and interacting proteins databases, Literature databases (OMIM and PUB MED)	10
5.	Introduction to data retrieval systems, Search engines, Entrez, sequence retrieval system (SRS)	06
6.	Secondary structure prediction by SOPMA -Prediction of motifs, folds and domains	04
7.	Sequence alignments (BLAST and Clustal W) and phylogenetic trees (PHYLIP).	04
8.	Sequence Alignment and Phylogeny, BLAST and CLUSTAL W; Local and global alignment, pair wise and multiple sequence alignments	04
9.	Phylogenetic tree construction using PHYLIP	02
10.	Molecular docking using AUTODOCK VINA for protein ligand Interaction	05
	<b>Total hours</b>	<b>45</b>

*Recommended Books:*

1. Barnes, M.R. and Gray, I.C. (2003) Bioinformatics for geneticists, Wiley.
2. Mount, D.W. (2006) Bioinformatics (2<sup>nd</sup> edition) CBS.
3. Pevsner, J. (2015) Bioinformatics and Functional Genomics, 3rd edition, Wiley and Blackwell
4. Xiong, J. (2012) Essential Bioinformatics, Cambridge University Press.
5. Claverie, JM and Notredame, C. (2006) Bioinformatics for Dummies 2nd edition, Wiley Publishing inc.
6. Klipp, E., Liebermeister, W., Wierling, C. and Kowald, (2016) A. System Biology 2<sup>nd</sup> edition, Wiley-VCH. 166
7. Alon, U. (2019) An Introduction to Systems Biology 2nd edition, CRC, Taylor & Francis.
8. Jenny Gu, J. and Bourne, P.E.(2011) Structural Bioinformatics 2nd edition, Wiley Blackwell.
9. Harren Jhoti, H. & Leach, A. (2007) Structure-based Drug Discovery, Springer.
10. Kitano, H. (2001) Foundations of Systems Biology, MIT press Cambridge



## Semester -VIII

### Practical

#### (MJ-20 P): Bioinformatics

Full Marks=25

(No internal exam in practical)

Pass Marks: 10

VBU-MJ-Z-XXP

Credit – 1 (30hrs)

S. No.	Practicals	Marks Distribution
1	Create a file format of given gene / protein	06
2	Interpret the secondary structure of given protein / <b>perform BLAST</b>	06
3	Comment upon the home page given.	04
4	Practical records/ Poster/ Model	04
5	Viva Voce	05
	Total	25

List

of Practicals :

1. Creating a file format for Protein and Nucleic acid (Genbank & FASTA)
2. To perform experiment with BLAST
3. Prediction of Secondary structure by using SOPMA
4. Study of home page: NCBI, BLAST & ENTREZ
5. Perform pairwise and multiple sequence alignments from the generated datasets in Experiment.
6. Protein structure prediction through homology modelling using Swiss Modeller.  
Molecular docking (Protein-ligand) using AutodockVina/ SwissDock/  
PatchDock/ZDock (anyone).
7. Project related to topics covered in theory/ project report based on visit to labs/institutions/industry etc

**Semester-VIII**  
**Paper– AMJ I**  
**[Applied Entomology]**

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

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

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VBU-AMJ-Z-I

Credit-4(60Hrs)

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**About course**

This course is designed to make the students aware of the detailed biology of insects belonging to different taxa. Moreover, it will also be able to provide the knowledge of the morphology and physiology of insects. It will also enable the students to see, appreciate, and understand the highly diversified fauna of insects.

**Learning Outcomes**

By studying this course, students will be able to: -

- better appreciate the diversity of insects.
- better understand the physiology of Insects which has made them the most successful animals in terms of numbers and variety of species.
- get acquainted with the highly organized social life of insects.
- to make the students aware about the possible scope of the subject which includes research and applied aspects, including entrepreneurial skill.



## SEMESTER-VIII

### AMJ-1 APPLIED ENTOMOLOGY

#### VBU-AMJ-Z- I

Sl. No.	Topic	Hours of Teaching
1.	<b>Introduction:</b> General features of insects and their diversity; classification of insects up to orders with examples.	06
2	<b>General Morphology of Insects:</b> Head: Eye (compound and ocelli , image formation), Types of antennae, Mouthparts w.r.t. feeding habits; Thorax: wings- Typical structure of insect wing and its modifications, Types of Legs; Abdomen: Typical structure.	12
3	<b>Physiology of Insects:</b> General aspects of the Integumentary (structure of integument and process of moulting), digestive, excretory, circulatory, respiratory, reproductive, and nervous system (using cockroach as the type representative); Metamorphosis: Types & hormonal control.	12
4	<b>Sense organs and perception:</b> Mechanoreceptors, Auditory organs, Chemoreceptors, Thermoreceptors. Humidity receptors and visual organs Effector organs : The sound and light producing organs	05
5	<b>Insect behavior:</b> Insect-Plant Interactions: Host-plant selection by phytophagous insects.	06
6	Insects as plant pests, Bionomics and control of any two phytophagous insect pests of fruits, vegetables, cash crops and stored grains.	06
7	<b>Pest control:</b> Chemical control : Insecticides - nomenclature, formulae and different types of formulations. Common insecticides used in pest control. Mode of action of insecticides and toxicity to humans. Definition of Biological control, agents of Biological Control Parasites, Parasitoids, Predators and Pathogenic microorganisms. Advantages and disadvantages of Biological control.	10

	Integrated Pest Management (IPM), Management of Insect Pests by Sterile-Insect Technique (Chemosterilants) Attractants, Repellants, Antifeedants and Pheromones.	
8	Concept of forensic entomology: Insects of forensic importance, Collection of entomological evidence during legal investigations.	03
	<b>Total hours</b>	<b>60</b>

### Suggestive readings

1. Snodgrass, R. E. Principles of Insect Morphology. Cornell Univ. Press, USA.
2. Borror, D. J., Triplehorn, C. A., and Johnson, N. F. Introduction to the Study of Insects. M Saunders College Publication, USA.
3. Gullan, P.J. and Cranston P.S. The Insects: An Outline of Entomology. Blackwell Publishing. 3rd edition
4. Ragumoorthi, K.N., Balasuramani, V., Srinivasan, M.R. and Natarajan, K. N. Insecta an Introduction. 2019 edition.
5. Byrd, J. H. and Tomberlin, J.K. Forensic Entomology: The Utility of Arthropods in Legal Investigation. CRC Press. 3rd edition.



## Semester-VIII

### Paper– AMJ II

#### [Mammalian Endocrinology and Assisted Reproductive Technology (ART)]

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

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

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VBU-AMJ-Z-II

Credit-4(60 Hrs)

#### About course

The course is designed to get acquainted with the various scientific facts about reproduction in humans. With respect to deep knowledge of male and female reproductive systems as well as factors responsible for maintaining reproductive health. Also, students understand the new technologies in assisted reproduction as well as contraceptive methods. Further, students will get aware of the social and public health issues related to family planning and the possible scope of the subject, which includes research and applied aspects, including entrepreneurial skills.

#### Learning Outcomes

After persuing this course, students will be able to:

- get an in-depth understanding of morphology, anatomy, and histology of male and female reproductive organs.
- know different processes in reproduction starting from germ cell formation to fertilization and consequent pregnancy, parturition, and lactation.
- compare estrous and menstrual cycles and their hormonal regulation.
- comprehend the interplay of various hormones in the functioning and regulation of the male and female reproductive systems.
- know about the diagnosis and management of infertility, including the latest methods, technologies, and infrastructure in assisted reproduction.
- better understand the modern methods of contraception and their use in family planning strategies.
- contribute to drug discovery programs as well as neonatal and maternal health programmes and work with family planning teams to understand the needs and preferences of individuals belonging to lower socioeconomic groups.

## SEMESTER-VIII

### AMJ-2 Mammalian Endocrinology and Assisted Reproductive Technology (ART)

#### VBU-AMJ-Z- II

S. no.	Topics	Hours of Teaching
1	Overview of endocrine system, classification of hormones. Mechanism of hormone action, hormone receptor, transduction and regulation of hormone action at molecular level.	08
2	<b>Hypothalamus:</b> structure of hypothalamus, hypothalamic nuclei and their functions, feedback mechanism. Pituitary gland: Structure of pituitary gland, hormones and their functions. Hypothalamo-hypophyseal portal system, Disorders of pituitary gland.	10
3	<b>Thyroid gland:</b> Functional histology and Regulation of Thyroid, its hormones and disorders related to Thyroid dysfunction. (Simple goitre, Exophthalmic goitre –Graves' Disease)	06
4	<b>Adrenal gland:</b> Functional histology and Regulation of Adrenal gland and its hormones. Disorders related to Adrenal Dysfunction.	05
5	<b>Pancreas:</b> Functional histology and Regulation of endocrine Pancreas (Islet of Langerhans; Disorders related to hypersecretion and hyposecretion of hormones.	06
6	<b>Gonads:</b> Functional histology and Regulation of endocrine Gonads. Hormones and their function.	08
7	Hormonal regulation of gestation; Parturition and its hormonal regulation.	07
8	<b>Reproduction</b> : Modern contraceptive methods; Infertility in males and females - causes and diagnosis. Assisted Reproductive Technologies (ART): sperm banks, IVF, frozen embryos, ET, EFT,	10

	IUT, GIFT, ICSI, PROST. Ethical issues in ART.	
		<b>Total Hours</b> <b>60</b>

### Recommended Books:

1. Johnson, M.H. and Everitt, B.J. (2018) Essential reproduction. IV Edition, London, Blackwell Science.
2. Jones, R.E. and Lopez, K.H. (2014) Human Reproductive Biology. IV Edition, Elsevier.
3. Franklyn F. Bolander (2012) Molecular Endocrinology. III Edition, USA, Academic Press.
4. De-Groot, L.J. and Jameson, J.L. (eds) (2001) Endocrinology. W.B. Saunders and Company

### Suggestive readings

5. Knobil, E. and Neil, JD (eds) (2014) The Physiology of Reproduction. IV Edition, Elsevier.
6. Robert Martin (2013) How We Do It: The Evolution and Future of Human Reproduction. Basic Books.
7. Austin, C.R. and Short R.V. (Eds) (2012) Reproduction in Mammals. Cambridge University Press.
8. अन्तः स्राव विज्ञान - डॉ धीरज कुमार, डॉ अंजलि कुमारी, डॉ आकृति रानी (NEP)

## Semester-VIII

### Paper– AMJ III

#### [Bioinstrumentation and Biotechniques]

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

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

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VBU-AMJ-Z-III

Credit-4 (60 Hrs)

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#### 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.

**SEMESTER-VIII****AMJ-3 BIOINSTRUMENTATION AND BIOTECHNIQUES****VBU-AMJ-Z- III**

<b>S. No.</b>	<b>Topics</b>	<b>Hours of Teaching</b>
<b>1</b>	<b>General Laboratory Practices</b> 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.	<b>10</b>
<b>2</b>	<b>Laboratory Instruments</b> Working principles, basic operation and application of Microtome, weighing balance, pH meter, colorimeter, Spectrophotometer, Oven and Water Baths. Principle of asepsis and sterilization technique.	<b>08</b>
<b>3</b>	<b>Tissue Micro-Techniques</b> 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.	<b>08</b>
<b>4</b>	<b>Methods to Study Tissue Structure</b> 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	<b>08</b>
<b>5</b>	<b>Understanding statistical concepts</b> 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	<b>06</b>
<b>6</b>	<b>Sequencing</b> : Nucleotide and protein sequencing	<b>05</b>
<b>7</b>	<b>Chromatography</b> : Principles and applications of gel filtration, ion-exchange, affinity, thin layer, gas chromatography and high-pressure liquid chromatography (HPLC). Application of chromatographic technique in biology.	<b>10</b>
<b>8</b>	<b>Electrophoresis and centrifugation</b> : Principles and applications of agarose and polyacrylamide gel electrophoresis; ultracentrifugation (velocity and buoyant density).	<b>05</b>
	<b>Total hours</b>	<b>60</b>

## Recommended Books:

1. Experimental biochemistry: A Student Companion by Rameshwar Nath
2. Biophysics: An introduction by Cotterill. John Wiley & Sons.
3. Practical Manual of Biochemistry: Sattanathan G.
4. Lab manual in Biochemistry, Biotechnology and Molecular Biology
5. Practical Biochemistry by V.P. Agarwal
6. Biotechnology: A laboratory courses
7. Instrumentation in Biotechnology by R.K Suri

## Online tools:

1. <https://skyfox.co/wp-content/uploads/2020/12/Practical-Manual-of-Biochemistry.pdf>



**Semester-VIII**  
**Paper– AMJ IV**  
**[Applied Fish & Fisheries]**

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

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

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VBU-AMJ-Z-IV

Credit-4 (60 Hrs)

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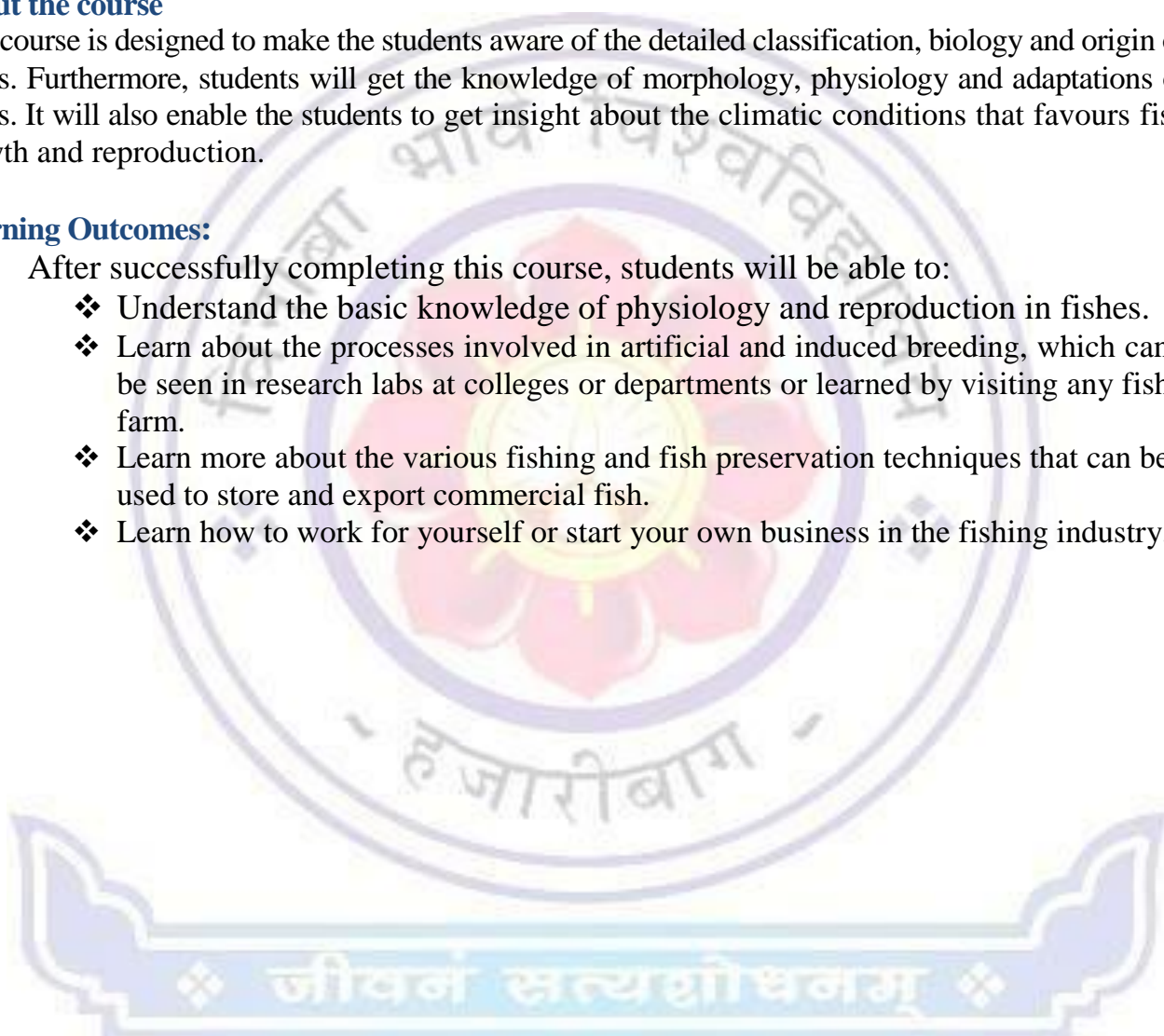
**About the course**

This course is designed to make the students aware of the detailed classification, biology and origin of fishes. Furthermore, students will get the knowledge of morphology, physiology and adaptations of fishes. It will also enable the students to get insight about the climatic conditions that favours fish growth and reproduction.

**Learning Outcomes:**

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

- ❖ Understand the basic knowledge of physiology and reproduction in fishes.
- ❖ Learn about the processes involved in artificial and induced breeding, which can be seen in research labs at colleges or departments or learned by visiting any fish farm.
- ❖ Learn more about the various fishing and fish preservation techniques that can be used to store and export commercial fish.
- ❖ Learn how to work for yourself or start your own business in the fishing industry.



## SEMESTER-VIII

### AMJ-4 APPLIED FISH & FISHERIES

#### VBU-AMJ-Z- IV

S. no.	Topics	Hours of Teaching
1.	General description of fish; Account of systematic classification of fishes (upto classes); Classification based on feeding habit, habitat and manner of reproduction.	06
2.	Locomotion in fishes; hydrodynamics; types of scales, types of fins and their modifications. Gills and gas exchange.	04
3.	Swim bladder: types and roles in respiration, Buoyancy; osmoregulation in elasmobranch	03
4.	Schooling; parental care; migration.	04
5.	Digestive system and its modification in teleost in relation to food and feeding habits.	03
6.	Respiration: Respiratory organs and respiration in teleosts, Accessory respiratory organs.	04
7.	Brief introduction to transgenic fishes.	03
8.	Fishing technology – nets, crafts, gears, acoustic and other recent techniques.	03
9.	Construction and maintenance of fish farm- selection of site, layout and arrangement of fish pond. Pond maintenance- control of aquatic vegetation, liming and control of various physical and chemical factors. Prevention of fish diseases, control of aquatic insects	06
10.	Sustainable Aquaculture; Extensive, semi-intensive and intensive culture of fish; Pen and cage culture; Composite fish culture; Brood stock management	06
11.	Induced breeding of fish; Preparation of compound diets for fish; Role of water quality in aquaculture; Post harvest handling techniques and Fishery by-products.	08
12.	Sewage fed fisheries, Integrated fish farming- paddy, poultry, cattle	05
13.	<b>Freshwater aquarium-</b> common freshwater aquarium fishes, equipments used, common diseases, maintenance routine	05
	<b>Total Hours</b>	<b>60</b>

## Books Recommended

1. Brown, M.E. Physiology of fishes, Vols. 1 and 2, Academic press, 1957
2. Hoar, W.S. & Randall, O.J. Fish Physiology, Vols I-X, Academic Press, 1969- onwards
3. Lagler, K. F., Bardach J.E., Miller R.R. and May Passino, D.R. Ichthyology, John Wiley, 2003.
4. Norman and Greenwood: A History of Fishes, Third Ed., Ernest Bvenn Limited, 1975.
5. S.S. Khanna and H. R. Singh. A textbook of Fish Biology and Fisheries, Narendra Publishing House, 2003.
6. मत्स्य एवं मत्स्यपालन - डॉसिंह .डी.बी .डॉ / टंडन .एस.आर ., २०२३
7. मत्स्य विज्ञान - डॉवाजपेयी .एन.डी ., २०२२



**Group discussion or Seminar presentation on one or two related topics from the below list:-**

1. Mutation and cancer
2. Epithelial tissue and its importance
3. Genome modification or editing
4. Recent advances in gene cloning
5. Epigenetic disorders in human
6. Disease due to chromosomal anomalies
7. Stem cell technology
8. Genetic counseling
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 system
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 hotspot
24. Climate change: threat to food security
25. Stratospheric Ozone depletion and marine productivity
26. Good ozone vs. bad ozone
27. Air pollution and climate change
28. Biodiversity under climate changing scenario
29. Preparing healthy/ fit animal stock for tomorrow; Conventional Breeding
30. Hybrids of transgenic animals
31. Vital body enzymes
32. Hormonal disorders
33. The process of Transcription
34. Advances in DNA hybridization
35. Essential and non-essential amino acids
36. Important body lipids
37. Parental care in animals
38. Learning in birds
39. Instinctive behaviour invertebrates

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

83. Prawn culture, good source of revenue generation
84. In vitro fertilization techniques
85. Phenoplasticity and its relevance

## Suggested List of Supplementary Web Resources for Laboratory Exercises

1. Anatomy of Frog: Pro Dissector (CD)- [www.prodissector.com](http://www.prodissector.com)
2. Physiology of Frog: PhysioEx4.0 (CD)- [www.physioex.com](http://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](http://www.scienclass.com);[www.neosci.com](http://www.neosci.com)
5. Anatomy of shark: Shark dissection and anatomy(video)- [www.neosci.com](http://www.neosci.com)
6. Cockroach dissection- [www.ento.vt.edu](http://www.ento.vt.edu)
7. Mammalian Physiology– [www.biopac.com](http://www.biopac.com)

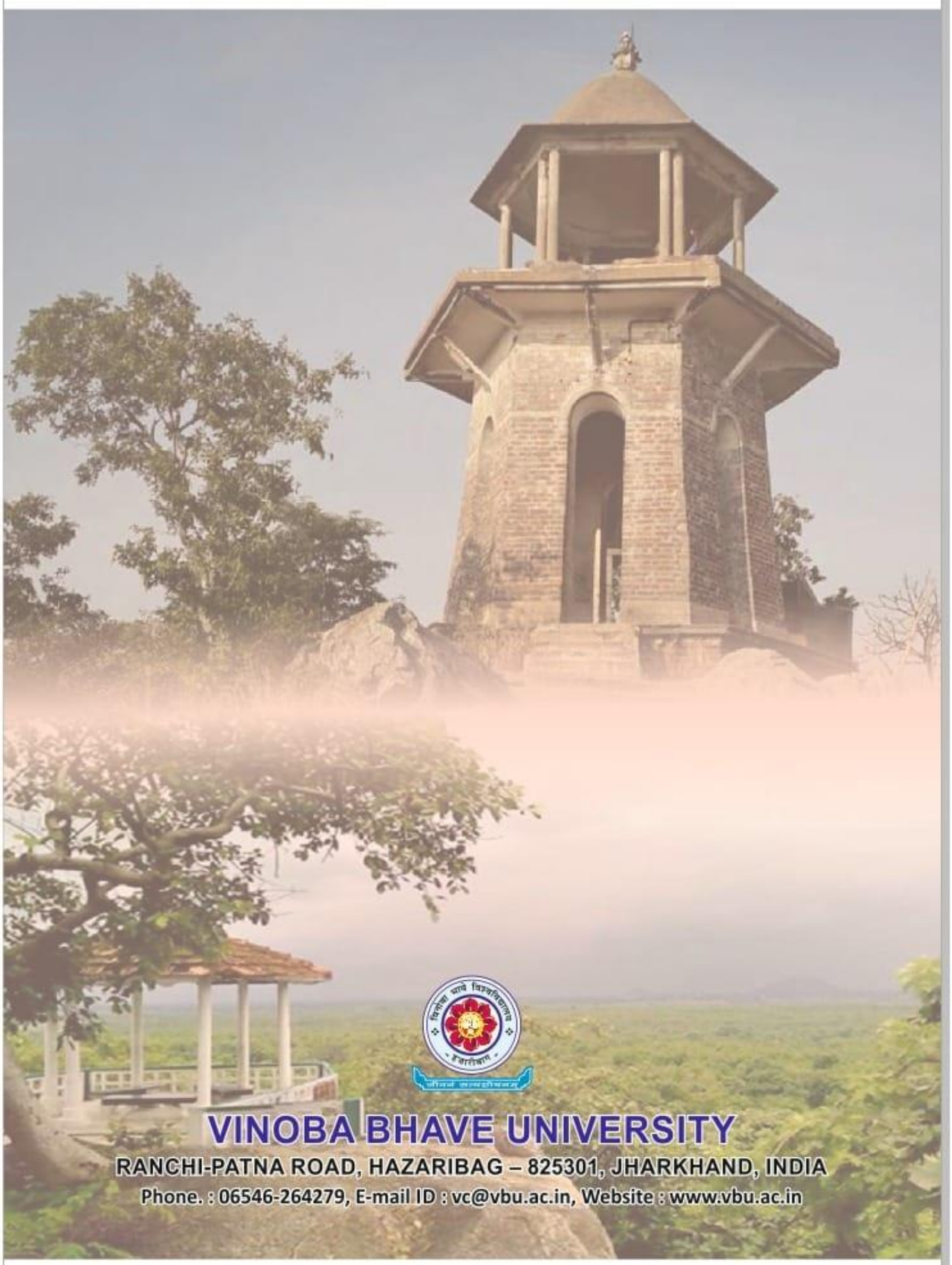
### *Guidelines for Individual/Team Projects and Field Reports*

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 A4 paper, 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.



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