INSTITUTE OF SCIENCE, NAGPUR

(An Autonomous Institute of Government of Maharashtra)

(To be implemented from 2024 -25)

Teaching and Examination Schemes Four Year B.Sc. (of eight semesters) programme

B.Sc. Zoology Semester-I

Sr No	Course Category	Name of the course (Title of the Paper)	Course code	Level	Teaching Scheme (hrs)			Total Credit	Evaluation Scheme			
					Theory	Tutorial	Practical					
					Th	Tu	P		Duration of Examination (Hrs)	Semester End Evaluation (SEE)	Continuous Internal Evaluation (CIE)	Minimum Passing Marks
1	Subject (One will be Major and other Minor in Semster III)	Paper 1: **Life and Diversity of Nonchordates-I (Protozoa to Annelida)**	**B-ZO111T**	4.5	2	--	--	2	2	30	20	25
		Paper 1 Lab	**B-ZO112P**		--	--	2	1	4	30	20	25
		Paper 2:			2	--	--	2	2	30	20	25
		Paper 2 Lab			--	--	2	1	4	30	20	25
2	GE/OE	**Bioinstrumentation**	**B-ZO113T**		2	--	--	2	2	30	20	25
		Economic Entomology	**B-ZO114T**		2	--	--	2	2	30	20	25
3	VSEC (VSC/SEC)	**Vermicomposting**	**B-ZO115P**		--	--	4	2	4 - 6	60	40	50
					--	--	4	2	4 - 6	60	40	50
4	AEC	English Compulsory			2	--	--	2	2	30	20	25
5	VEC	Environmental Studies			2	--	--	2	2	30	20	25
6	IKS	Indian Knowledge System (Yoga for Health)	**B-ZO116T**		2	--	--	2	2	30	20	25
7	CC	NSS /NCC / Sports / Cultural			--	--	4	2	--	--	100	50
Total					14	--	16	22	--	390	360	--

B.Sc. Zoology Semester-II

Sr No	Course Category	Name of the course (Title of the Paper)	Course code	Level	Teaching Scheme (hrs)			Total Credit	Evaluation Scheme			
					Theory	Tutorial	Practical					
					Th	Tu	P		Duration of Examination (Hrs)	Semester End Evaluation (SEE)	Continuous Internal Evaluation (CIE)	Minimum Passing Marks
1	Subject (One will be Major and other Minor in Semster III)	Paper 1: **Life and Diversity of Nonchordates-II (Arthropoda to Hemichordata)**	**B-ZO121T**	4.5	2	--	--	2	2	30	20	25
		Subject 1 Lab	**B-ZO122P**		--	--	2	1	4	30	20	25
		Subject 2:			2	--	--	2	2	30	20	25
		Subject 2 Lab			--	--	2	1	4	30	20	25
2	GE/OE	**Avian Biology**	**B-ZO123T**		2	--	--	2	2	30	20	25
		Inland Fish culture	**B-ZO124T**		2	--	--	2	2	30	20	25
3	VSEC (VSC/SEC)	**Aquarium-Fish-Keeping**	**B-ZO125P**		--	--	4	2	4 - 6	60	40	50
		Refer VSC Basket (related to Subject 2)			--	--	4	2	4 - 6	60	40	50
4	AEC	English Compulsory			2	--	--	2	2	30	20	25
5	VEC	Constitution of India			2	--	--	2	2	30	20	25
6	IKS	Indian Knowledge System (Yoga for better Lifestyle)	**B-ZO126T**		2	--	--	2	2	30	20	25
7	CC	NSS /NCC / Sports / Cultural			--	--	4	2	--	--	100	50
Total					14	--	16	22	--	390	360	--

B.Sc. Zoology Semester-III

Sr No	Course Category	Name of the course (Title of the Paper)	Course code	Level	Teaching Scheme (hrs)			Total Credit	Evaluation Scheme			
					Theory	Tutorial	Practical					
					Th	Tu	P		Duration of Examination (Hrs)	Semester End Evaluation (SEE)	Continuous Internal Evaluation (CIE)	Minimum Passing Marks
1	DSC	Paper 1: **Life and Diversity of Chordates-I (Protochordata to Amphibia)**	**B-ZO231T**	5.0	2	--	--	2	2	30	20	25
		Paper 2: **Basics of Genetics**	**B-ZO232T**		2	--	--	2	2	30	20	25
		DSC Lab (based on Paper 1+ 2)	**B-ZO233P**		--	--	4	2	4 - 6	60	40	50
2	Minor	Paper 1: **Life and Diversity of Chordates-I (Protochordata to Amphibia)**	**B-ZO234T**		2	--	--	2	2	30	20	25
		Paper 2: **Basics of Genetics**	**B-ZO235T**		2	--	--	2	2	30	20	25
		Minor Lab (based on Paper 1 OR 2)	**B-ZO236P**		--	--	4	2	4 - 6	60	40	50
3	GE/OE	**Animal behaviour**	**B-ZO237T**		2	--	--	2	2	30	20	25
4	VSEC (VSC/SEC)	**Honey bee Keeping**	**B-ZO238P**		--	--	4	2	4 - 6	60	40	50
5	AEC	Second Language			2	--	--	2	2	30	20	25
6	FP	Field Project			--	--	4	2	4 - 6	--	100	50
7	CC	NSS / NCC / Sports / Cultural			--	--	4	2	--	--	100	50
Total					12	--	20	22	--	360	440	--

B.Sc. Zoology Semester-IV

Sr No	Course Category	Name of the course (Title of the Paper)	Course code	Level	Teaching Scheme (hrs)			Total Credit	Evaluation Scheme			
					Theory	Tutorial	Practical					
					Th	Tu	P		Duration of Examination (Hrs)	Semester End Evaluation (SEE)	Continuous Internal Evaluation (CIE)	Minimum Passing Marks
1	DSC	Paper 1: **Life and Diversity of Chordates-II (Reptilia to Mammalia)**	**B-ZO241T**	5.0	2	--	--	2	2	30	20	25
		Paper 2: **Molecular Biology**	**B-ZO242T**		2	--	--	2	2	30	20	25
		DSC Lab (based on Paper 1+ 2)	**B-ZO243P**		--	--	4	2	4 - 6	60	40	50
2	Minor	Paper 1: **Life and Diversity of Chordates-II (Reptilia to Mammalia)**	**B-ZO244T**		2	--	--	2	2	30	20	25
		Paper 2: **Molecular Biology**	**B-ZO245T**		2	--	--	2	2	30	20	25
		Minor Lab (based on Paper 1 OR 2)	**B-ZO246P**		--	--	4	2	4 - 6	60	40	50
3	GE/OE	**Ecosystems**	**B-ZO247T**		2	--	--	2	2	30	20	25
4	VSEC (VSC/SEC)	**Water Quality Analysis**	**B-ZO248P**		--	--	4	2	4 - 6	60	40	50
5	AEC	Second Language			2	--	--	2	2	30	20	25
6	CEP	Community Service			--	--	4	2	4 - 6	0	100	50
7	CC	NSS / NCC / Sports / Cultural			--	--	4	2	--	0	100	50
Total					12	--	20	22	--	360	440	--

B.Sc. Zoology Semester-V

Sr No	Course Category	Name of the course (Title of the Paper)	Course code	Level	Teaching Scheme (hrs)			Total Credit	Evaluation Scheme			
					Theory	Tutorial	Practical					
					Th	Tu	P		Duration of Examination (Hrs)	Semester End Evaluation (SEE)	Continuous Internal Evaluation (CIE)	Minimum Passing Marks
1	DSC	Paper 1: **Advanced Genetics**	**B-ZO351T**	5.5	3	--	--	3	3	45	30	38
		Paper 2: **Basics of Immunology**	**B-ZO352T**		3	--	--	3	3	45	30	38
		DSC Lab (based on Paper 1+ 2)	**B-ZO353P**		--	--	6	3	6	90	60	75
		Paper 3: **Principles of Ecology**	**B-ZO354T**		2	--	--	2	2	30	20	25
		DSC Lab	**B-ZO355P**		--	--	2	1	4	30	20	25
2	DSE	Elective 1: **Reproductive biology** Elective 2**: Parasitology**	**B-ZO356T** **B-ZO357T**		2	--	--	2	2	30	20	25
		DSE Lab	**B-ZO358P**		--	--	4	2	4 - 6	60	40	50
3	Minor	Paper 1: **Principles of Ecology**	**B-ZO359T**		2	--	--	2	2	30	20	25
		Minor Lab	**B-ZO3510P**		--	--	2	1	4	30	20	25
4	VSEC (VSC/SEC)	**Haematological Techniques**	**B-ZO3511P**		--	--	4	2	4 - 6	60	40	50
5	CEP	Community Service			--	--	2	1	--	--	50	25
					12	--	20	22		450	350	--

B.Sc. Zoology Semester-VI

Sr No	Course Category	Name of the course (Title of the Paper)	Course code	Level	Teaching Scheme (hrs)			Total Credit	Evaluation Scheme			
					Theory	Tutorial	Practical					
					Th	Tu	P		Duration of Examination (Hrs)	Semester End Evaluation (SEE)	Continuous Internal Evaluation (CIE)	Minimum Passing Marks
1	DSC	Paper 1: **Genetic Engineering**	**B-ZO361T**	5.5	3	--	--	3	3	45	30	38
		Paper 2: **Advanced Immunology**	**B-ZO362T**		3	--	--	3	3	45	30	38
		DSC Lab (based on Paper 1+ 2)	**B-ZO363P**		--	--	6	3	6	90	60	75
		Paper 3: **Cell Biology**	**B-ZO364T**		2	--	--	2	2	30	20	25
		DSC Lab	**B-ZO365P**		--	--	2	1	4	30	20	25
2	DSE	Elective 1: **Developmental biology** Elective 2**: Biomolecules**	**B-ZO366T** **B-ZO367T**		2	--	--	2	2	30	20	25
		DSE Lab	**B-ZO368P**		--	--	4	2	4 - 6	60	40	50
3	VSEC (VSC/SEC)	**Basic Health Care**	**B-ZO369P**		--	--	4	2	4 - 6	60	40	50
4	OJT	Internship / Apprenticeship (Related to DSC)			--	--	8	4	--	--	200	100
					10	--	24	22		390	460	--

B.Sc. Zoology Semester-VII (Honors)

Sr No	Course Category	Name of the course (Title of the Paper)	Course code	Level	Teaching Scheme (hrs)			Total Credit	Evaluation Scheme			
					Theory	Tutorial	Practical					
					Th	Tu	P		Duration of Examination (Hrs)	Semester End Evaluation (SEE)	Continuous Internal Evaluation (CIE)	Minimum Passing Marks
1	DSC	Paper 1: **Biotechnology**	**B-ZOH471T**	6.0	4	--	--	4	3	60	40	50
		Paper 2: **Biotechniques and Biostatistics**	**B-ZOH472T**		4	--	--	4	3	60	40	50
2	DSE	Elective1:**Animal Physiology-I (Physiology of Digestion & Excretion)** Elective2**:Fish & Fisheries-I (Fish Biology)** Elective3:**Mammalian Reproductive Physiology-I (Reproductive process in Male)**	**B-ZOH473T** **B-ZOH474T** **B-ZOH475T**		4	--	--	4	3	60	40	50
3	DSC /DSE	Lab (Based on Paper1+2+Elective)	**B-ZOH476P**		--	--	12	6	6 - 8	180	120	150
4	RM	Research Methodology	**B-ZOH477T**		4	--	--	4	3	60	40	50
					16	--	12	22		420	280	--

B.Sc. Zoology Semester-VIII (Honors)

Sr No	Course Category	Name of the course (Title of the Paper)	Course code	Level	Teaching Scheme (hrs)			Total Credit	Evaluation Scheme			
					Theory	Tutorial	Practical					
					Th	Tu	P		Duration of Examination (Hrs)	Semester End Evaluation (SEE)	Continuous Internal Evaluation (CIE)	Minimum Passing Marks
1	DSC	Paper 1: **Biodiversity & Conservation**	**B-ZOH481T**	6.0	4	--	--	4	3	60	40	50
		Paper 2: **Microtechnique**	**B-ZOH482T**		4	--	--	4	3	60	40	50
2	DSE	Elective1:**Animal Physiology-II (Physiology of Circulation)** Elective2**:Fish & Fisheries-II (Applied Fisheries)** Elective3:**Mammalian Reproductive Physiology-II (Reproductive process in Female)**	**B-ZOH483T** **B-ZOH484T** **B-ZOH485T**		4	--	--	4	3	60	40	50
3	DSC /DSE	Lab (Based on Paper1+2+Elective)	**B-ZOH486P**		--	--	12	6	6 - 8	180	120	150
4	OJT	Internship / Apprenticeship (Related to DSC)			--	--	8	4	--	--	200	100
					12	--	20	22		360	440	

B.Sc. Zoology Semester-VII (Honors with Research)

Sr No	Course Category	Name of the course (Title of the Paper)	Course code	Level	Teaching Scheme (hrs)			Total Credit	Evaluation Scheme			
					Theory	Tutorial	Practical					
					Th	Tu	P		Duration of Examination (Hrs)	Semester End Evaluation (SEE)	Continuous Internal Evaluation (CIE)	Minimum Passing Marks
1	DSC	Paper 1: **Biotechnology**	**B-ZOR471T**	6.0	4	--	--	4	3	60	40	50
		Paper 2: **Biotechniques and Biostatistics**	**B-ZOR472T**		4	--	--	4	3	60	40	50
2	DSE	Elective1:**Animal Physiology-I (Physiology of Digestion & Excretion)** Elective2**:Fish & Fisheries-I (Fish Biology)** Elective3:**Mammalian Reproductive Physiology-I (Reproductive process in Male)**	**B-ZOR473T** **B-ZOR474T** **B-ZOR475T**		4	--	--	4	3	60	40	50
3	DSC /DSE	Lab (Based on Paper1+2+Elective)	**B-ZOR476P**		--	--	4	2	4 - 6	60	40	50
4	RM	Research Methodology	**B-ZOR477P**		4	--	--	4	3	60	40	50
5	RP	Research Project / Dissertation (Core)			--	--	8	4	--	--	200	100
					16	--	12	22		300	400	--

B.Sc. Zoology Semester-VIII (Honors with Research)

Sr No	Course Category	Name of the course (Title of the Paper)	Course code	Level	Teaching Scheme (hrs)			Total Credit	Evaluation Scheme			
					Theory	Tutorial	Practical					
					Th	Tu	P		Duration of Examination (Hrs)	Semester End Evaluation (SEE)	Continuous Internal Evaluation (CIE)	Minimum Passing Marks
1	DSC	Paper 1: **Biodiversity & Conservation**	**B-ZOR481T**	6.0	4	--	--	4	3	60	40	50
		Paper 2: **Microtechnique**	**B-ZOR482T**		4	--	--	4	3	60	40	50
2	DSE	Elective1:**Animal Physiology-II (Physiology of Circulation)** Elective2**:Fish & Fisheries-II (Applied Fisheries)** Elective3:**Mammalian Reproductive Physiology-II (Reproductive process in Female)**	**B-ZOR483T** **B-ZOR484T** **B-ZOR485T**		4	--	--	4	3	60	40	50
3	DSC /DSE	Lab (Based on Paper1+2+Elective)	**B-ZOR486P**		--	--	4	2	4 - 6	60	40	50
4	RP	Research Project / Dissertation 1 (Core)			--	--	8	4	--	--	200	100
		Research Project / Dissertation 2 (Core)			--	--	8	4	--	--	200	100
					12	--	20	22		240	560	--

Total Credits:

1. Three-Year UG Degree Program: 132
2. Four-Year UG Degree Program: 176

Table showing course category wise credit distribution semester wise

Exit Point / Course Category	**Certificate in Science**	**Diploma in Science**	**Three Year Bachelor of Science**	**Bachelor of Science (Honors) Degree**	**Bachelor of Science (Honors with Research) Degree**
Major Credits	6	12	32	36	28
Minor Credits	6	12	3	--	--
GE	8	4	--	--	--
VSEC	8	4	4	--	--
AEC	4	4	--	--	--
VEC	4	--	--	--	--
IKS	4	--	--	--	--
CC	4	4	--	--	--
FP	--	2	--	--	--
CEP	--	2	1	--	--
OJT	--	--	4	4	--
RP	--	--	--	--	12
RM	--	--	--	4	4
Total Credits	44	44	44	44	44

Table showing total marks in theory and Practical semester wise

Semester	Theory	Practical	Total Marks
1	350	400	750
II	350	400	750
III	300	500	800
IV	300	500	800
V	300	500	800
VI	250	600	850
VII (Honors)	400	300	700
VIII (Honors)	300	500	800
VII (**Honors with Research**)	400	300	700
VIII (**Honors with Research**)	300	500	800
For Honors	2550	3700	6250
For Research	2550	3700	6250

INSTITUTE OF SCIENCE, NAGPUR

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ZOOLOGY SYLLABUS

(To be implemented from 2024-25)

B. Sc. Semester-I Zoology

Course code: B-ZO111T

Paper–I: Life and Diversity of Nonchordates-I (ProtozoatoAnnelida)

Total Credits: 2 Hours: 30

Course objectives:

1) To gain a thorough understanding of invertebrate taxonomy and features.
2) To gain a better understanding of the morphological and anatomical characteristics of invertebrates.
3) To raise knowledge about the hazardous parasites that non chordates are susceptible to, as well as their economic value.

Courseoutcomes:

By the end of this programme, the students will get knowledge and they will understand the:

1) General characters and classification of Protozoa, Porifera, Helminthes, Annelida.
2) Structure and reproduction of aramoecium, *Plasmodium, Sycon, Obelia, Ascaris*, Leech.
3) Life cycle of *Plasmodium, Obelia, Ascaris, Taeniasolium*.
4) Parasitic Protozoans of Man-Modeofinfection and its control, Parasitic adaptations in helminthes.
5) Canal system in sponges, Vermiculture and its importance.

Unit–I **(7.5 Hrs)**

1.1 Protozoa: General characters and classification up to classes.
1.2***Paramoecium***: Structure and reproduction.
1.3 ***Plasmodium***: Structure and lifecycle.
1.4 **Parasitic Protozoans of Man:** *Entamoeba, Trypanosoma, Giardia* and *Leishmania*- Mode of infection and its control.

Unit–II **(7.5 Hrs)**

2.1 **Porifera**: General characters and classification up to classes
2.2 ***Sycon***: Structure, reproduction and development, Canal system in sponges.
2.3 **Coelenterata**: General characters and classification up to classes.
2.4***Obelia*:** Structure and lifecycle, Polymorphism in hydrozoa.

Unit–III **(7.5 Hrs)**

3.1 **Helminthes**: General characters and classification up to classes.
3.2 ***Ascaris***: External morphology, reproductive system and lifecycle.
3.3***Taeniasolium***: Structure and lifecycle.
3.4 **Elementary idea of parasitic adaptations in helminthes.**

Unit–IV **(7.5 Hrs)**

4.1 **Annelida**: General characters and classification up to classes
4.2 **Leech**: Morphology, digestive and urinogenital system
4.3 Copulation, fertilization and cocoon formation in leech.
4.4 Peripatus : General characters and Affinities

B. Sc. Semester-I Zoology

Course code: B-ZO112P

LAB

Total Credits: 1 Hours:15

Objectives:

1) To obtain the knowledge about morphology of invertebrates-protozoans to annelids
2) To study the biology of invertebrates
3) To observe histological structure of the organs of invertebrates

Outcomes:

By the end of this programme, the students will be able to:

1) Study and classify invertebrates with the help of museum specimens, permanent slides, diagrams.
2) Prepare temporary and permanent slides.

SectionA: Life and Diversity of Nonchordates-I (ProtozoatoAnnelida)

1. Study of museum specimens by specimen/charts/model (classification of animals up to orders).

i) Protozoa (Slides): *Paramoecium, Euglena, Amoeba, Plasmodiumvivax*
ii) Porifera: *Sycon, Leucosolenia, Hyalonema, Euplectella, Spongilla*
iii) Coelenterata: *Obelia, Aurelia, Tubipora, Fungia, Adamsia*
iv) Platyhelminthes: *Planaria, Fasciola, Taenia*
v) Aschelminthes: *Ascaris, Drancunculus ,Ancylostoma, Wuchereria*
vi) Annelida: *Aphrodite, Nereis, Chaetopteurs, Tubifex, Hirudinaria*

2. Study of permanent slides: by specimen/charts.

Enatmoeba, Giardia, Sponge gemmules, Sponge spicules, V.S. *Sycon,* T.S. *Sycon, Obelia* medusa, Miracidium, Redia and Cercaria larvae of *Fasciola,* T.S. male and female *Ascaris,* Scolex of *Taenia,* Mature and gravid proglottids of *Taenia solium,* T.S. of Leech through crop pockets, Trochophore larva

3. Study of anatomical features with the help of specimen/ charts/ models/ videos.

Digestive, nervous and reproductive system of Earthworm.

4. Mounting:

Zooplankton, Spicules and Gemmules of sponge.

Scheme of Marking for Practical Examination:

Distributionof Marks–	**TotalMarks**	**30**
Q.1. Identification and Comment on Spots (6 Museum specimens+1Env.bio.spot+3slides)		10
Q.2. Study of anatomical features-		08
Q.4. Permanentstainedpreparation		03
Q.5. Submissionofcertifiedpracticalrecord		05
Q.6. Submission ofslides&visitreport		02
Q.7. Viva voce		02

List of Recommended Books for **Life and Diversity of Nonchordates-I (ProtozoatoAnnelida):**

1 **Barnes–Invertebrate Zoology (Halt-Saunders international) Philadelphia, USA**
2 Barradaile L. A. and Potts F.A.–**The Invertebrate**
3 Nigam**–Biology of Nonchordates**
4 Kotpal, Agrawal and Khetrapal**–Modern Text Book of Zoology- Invertebrates,**
5 Rastogi Publication, Meerut
6 Puranik P.G. and Thakur R.S. **– Invertebrate Zoology**
7 Majupuria T.C. **–Invertebrate Zoology**
8 Dhamiand Dhami **–Invertebrate Zoology**
9 Parker and Hashwell, **Textbook of Zoology Vol. I (Invertebrates),** A. Z. T. B. S. Publishers & Distributors, New Delhi
10 S.S. Lal - **Practical Zoology Invertebrates 9th edition,** Rastogi Publication Meerut
11 Barrington EJW –**Invertebrate Structure and Function** ELBS III Edition
12 Kotpal R. L**.– Phylum Protozoa to Echinodermata (series),** Rastogi and Publication, Meerut
13 ParkerJ. And Haswell W.–**Text Book of Zoology**, ELBSE dition
14 Vidyarthi–**Text Book of Zoology**, Agrasia Publishers, Agra
15 JordanE.L. and Verma P.S.– **Chordate Zoology**, S. Chand and Co., New Delhi
16 AyerE.–**Manual of Zoology**
17 M.D. Bhatia –**The Indian Zoological Memories – Leech**
18 Beni Prasad–**The Indian Zoological Memories– Pila**
19 P.K.Gupta–**Vermicomposting for Sustainable Agriculture**, A grobios India Ltd.
20 P.S.Verma**--** A manual of Practical Zoology Invertebrates

B. Sc. Semester-I Zoology

Course category: GE/OE
Course code: B-ZO113T
Paper: Bioinstrumentation

Total Credits: 2 Hours: 30

Course objectives:

1) To study the principle and working of various instruments used in laboratories
2) T obtain the knowledge of different biotechniques

Course outcomes:

1) Students will be able to handle and use the laboratory instruments
2) They can perform experiments independently
3) The will be able to estimate many parameters qualitatively and quantitatively

Unit-I **(7.5 Hrs)**

1.1 Principles and applications of pH Meter and Autoclave
1.2 Principles and applications of Hot air oven and Incubator
1.3 Principles and applications of Laminar air flow chamber / Biosafety cabinets
1.4 Principles and applications of BOD Incubator, Lyophilizer.

Unit-II **(7.5 Hrs)**

2.1 Chromatography: Paper and Thin layer chromatography
2.2 Column and Ion – exchange chromatography
2.3 Gas and High Performance Liquid Cchromatography (HPLC)
2.4 Centrifuge - Types of centrifuge and its application.

Unit-III **(7.5 Hrs)**

3.1 Electrophoresis: Principle working and applications- Paper electrophoresis
3.2 Principle working and applications- SDS-PAGE electrophoresis
3.3 Principle working and applications- Agar gel electrophoresis.
3.4 Principle working and applications- Immuno electrophoresis

Unit-IV **(7.5 Hrs)**

4.1 Principle and working of Colorimetry and Flame photometry
4.2 Spectrometry: Principle and working of UV and Visible spectrophotometer
4.3 Spectroscopy: Principle, construction and uses of IR Spectroscopy and Raman Spectroscopy
4.4 Principle, construction and uses of X ray spectroscopy and NMR spectroscopy

List of Recommended Books for Bioinstrumentation:

1. *Biochemistry*. 6th Edition by Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). Freeman,
2. New York.
3. *Biophysics: An Introduction* by Cotterill, R. M. J. (2002). John Wiley & Sons, England.
4. *Principles of protein X-ray crystallography* by Drenth, J. (2007). 3rd Ed. Springer, Germany.
5. *Biochemistry*. 3rd edition by Garrett, R. H. and Grisham, C. M. (2004). Brooks/Cole, Publishing Company, California.
6. *Understanding NMR Spectroscopy* by Keeler, J. (2002). John Wiley & Sons, England.

7. *Methods in Modern Biophysics.* Second Edition by Nölting, B. (2006). Springer, Germany.
8. *Biophysics* by Pattabhi, V. and Gautham, N. (2002). Kluwer Academic Publishers, NewYork and Narosa Publishing House, Delhi.
9. 9. *Principles and Techniques of Biochemistry and Molecular Biology* by Wilson Keith and Walker John (2005), 6th Ed. Cambridge University Press, New York.
10. *Proteins NMR Spectroscopy: Principles and Practice* by Cavanagh John *et.al.* (1995), Academic Press
11. *Molecular Biophysics: Structures in Motion* by Daune M. and W. J. Duffin (1999), Oxford University Press.
12. *Methods in Modern Biophysics by* Nalting B. and B. Nalting (2003) Springer Verlag
13. *Physical Biochemistry: Applications to Biochemistry and Molecular Biology* by Freilder, D. Freeman, San. Francisco, 1976
14. *Biochemical Techniques: Theory and Practice* by Robyt, John F.; White, Bernard J. Waveland Press, Inc., U.S.A. Published: 1990.
15. *General Biophysics, Vol I&II* by Volkones H.V.
16. *Biophysical Chemistry, Edition III* by Upadhyay, Himalaya Publication
17. *Biophysics* by S. Mahesh (2003), New Age International Private Ltd.
18. *Techniques and Methods in Biology* by Ghatak, K.L (2003), PHI Learning Private Ltd. New Delhi
19. *Biochemistry, 4th Edition* by Zubay, G.L. (1993), WmC. Brown Publishers.

B. Sc. Semester-I Zoology

Course category: GE/OE
Course code: B-ZO114T
Paper: Economic Entomology

Total Credits: 2 Hours: 30

Course objectives:
1) To study mulberry and tasar sericulture
2) To study apiculture and lac culture
Course outcomes: After completion of the course, students willable to-
1) undestandand explain the Mulberry and Tasar sericulture
2) understand and explain apiculture and lac culture
4) involve in the activities of such type of cultures as economic source

Unit-I **(7.5 Hrs)**
1.1 Mulberry sericulture: types of silkworms
1.2 Cultivation of Mulberry
1.3 Life cycle of Mulberry silkworm
1.4 Rearing of silkworms

Unit-II **(7.5 Hrs)**
2.1 Tasar sericulture: Species of Tasar silk worms
2.2 Life cycle of Tasar silkworm
2.3 Rearing of Tasar silkworm
2.4 Post cocoon processing

Unit-III **(7.5 Hrs)**
3.1 Apiculture: Types of honey bees
3.2 Life cycle of honey bee
3.3 Social organization in honey bees
3.4 Modern Beekeeping: Movable frame hive

Unit-IV **(7.5 Hrs)**
4.1 Lac culture: Lac insect distribution and host plants
4.2 Life cycle of Lac insect
4.3 Strains of Lac insect
4.4 Steps of Lac culture and economic importance

List of Recommended Books for Economic Entomology:

1. *General and Applied Entomology* by K.K. Nayar, T. N. Ananth krishan and B.V. Davis. Tata McGraw-Hill Co. Ltd., pp. 589.
2. *Destruction and Useful Insect, Their Habits and Control* by C. L. Metcalf, W. P. Flint and R. I. Metcalf. McGraw HillCo. New York.
3. *Agriculture Entomology* by H.S. Dennis. TimberPressInc.
4. *Text Book of Agriculture Entomology* by Alford V. David. Blackwell Science.
5. *Modern book of Zoology Invertebrates* by R. L. Kotpal (2011). Rastogi Publications, Meerut.
6. *Modern Entomology, 2nd edition* by D. B. Tembhare (2009). Himalaya Publishing House, Delhi.
7. *Elements of Entomology* by Rajendra Singh (2010). Rastogi Publications, Meerut.

B. Sc. Semester-I Zoology

Course category: VSEC (VSC/SEC)
Course code: B-ZO115P
LAB: Vermicomposting

Total Credits: 2 Hours: 30

Course objectives:
To study the biology of earthworm
2) To study the various species of earthworm
3) To study the culture method of earthworm

Course outcomes: After completion of this course, student will–
1) Get acquainted with hand on training of vermicomposting.
2) Get acquainted with hand on training of vermiwash.
3) Able to understand and learn about the vermicompost marketing.
4) Able to do internship in any commercial vermicompost or vermiwash unit.

Practicals:
1) Collection of Biodegradable wastes (Solidwaste) and their segregation and processing
2) Bed Preparation for Pit/ Windrow method
3) Pit Regulation, its maintenance and precautions
4) Earth worm collection and application on bed
5) Inspection of bed, watering and to pup
6) Vermicompost collection, earthworm separation (Harvesting), air drying of vermicompost, sieving and storage of compost
7) Vermiwash: methods collection and processing
8) Cocoon formation, breeding methods of worms
9) Standardize technique with categorized biodegradable wastes
10) Analysis of vermicompost and vermiwash; soil testing
11) Applications/packaging and marketing of by products
12) Visit to vermiculture farm/setup

Marking Scheme for Practical Examination:

	Max. Marks: 60
Q. 1. Practical based	10
Q. 2. Practical based	10
Q. 3. Practical based	10
Q. 4. Practical based	10
Q. 3. Visit Report	05
Q. 4. Practical record	10
Q. 5. Viva	05

List of Recommended Books for Vermicomposting:
1) Lekshmy MS and Santhi R. Vermitechnology. Saras Publication, p.416.
2) Singh K (2014). Textbook of vermicompost: vermiwash and biopesticides. Astral International, pp. 97.
3) Davies P. (2014). Vermicomposting and vermiculture, pp.49.
4) Das M. (2013). Tools for vermitechnology. IK International Publishing House Pvt. Ltd., 1st ed., pp.196.

B. Sc. Semester-I Zoology

Course category: IKS

Course code: B-ZO116T

Paper: Indian Knowledge System (History of Indian Science)

Total Credits: 2 Hours: 30

Objectives:

The course provides an insight into the status of science in ancient India, its gradual development, innovations and the pioneers in the field of science, reputed research institutions in India and cutting edge research in science.

Outcomes:

On completion of this course, the students will be able to:

1. Develop understanding of various branches of science during different eras
2. Analyze the role played by different Indian organizations in science
3. Appraise the contribution of different Indian Scientists.

Unit –I: Science in Ancient and Medieval India (7.5 Hrs)

1.1 History of development in astronomy, mathematics, engineering and medicine subjects in ancient India.

1.2 Indian traditional knowledge on environmental conservation; Use of copper, bronze and iron in ancient India.

1.3 India'a contribution to science and technology (from ancient to modern).

1.4 Plant and animal science in ancient India; Innovations in the field of agriculture-new crop Introduced, new techniques of irrigation.

Unit –II: Indian Science in before and after Independence (7.5 Hrs)

2.1 Introduction of different surveyors, zoologists and doctors as early scientist in Colonial India.

2.2 Indian perception and adoption for new scientific knowledge in Modern India.

2.3 Establishment of premier research organizations like CSIR, DRDO and ICAR and ICMR, IIT's, establishment of Atomic Energy Commission, Launching of the space satellites, ISRO's accomplishments.

2.4 Zoological survey of India and Fishery survey of India.

Unit –III: Prominent Indian scientists (7.5 Hrs)

3.1 Eminent scholars in mathematics and astronomy: Baudhayana, Aryabhatta, Brahmgupta, Bhaskaracharya, Varahamihira, and Nagarjuna.

3.2 Medical science of Ancient India (Ayurveda and Yoga): Susruta, Charak and Kasayapa.

3.3 Ayueveda for life, health and well-being.

3.4 Inspiring lives of Scientists of modern India and their contribution-Sriniwas Ramanujan, C. V. Raman, Jagdish Chandra Bose, Homi Jehangir Bhabha, Vikram Sarabhai, A. P. J. Abdul Kalam, Salim Ali, M. S. Swaminathan.

Unit –IV: Prominent research in Animal Sciences in Republic of India (7.5 Hrs)

4.1 History of animal tissue culture with context to India.

4.2 Green, white and pink revolutions in India: causes, details, and outcomes.

4.3 The pioneers associated with-First gene cloning and First genome sequencing from India.

4.4 Premier Research institutes and current eminent scientists in India, Genetically modified organisms (GMOs).

References:

1. Kuppuram, G. (1990) History of Science and Technology in India, South Asia Books.
2. Handa, O.C. (2014) Reflections on the history of Indian Science and Technology, Pentagon Press.
3. Basu, A. (2006) Chemical Science in Colonial India: The Science in Social History, K.P. Bagchi & Co.
4. Habib, I. (2016) A people's history of India 20: Technology in Medieval India, 5th Edition, Tulika Books.
5. Rahman, A. *et al* (1982) Science and Technology in Medieval India – A Bibliography of Source Materials in Sanskrit, Arabic and Persian, New Delhi: Indian National Science Academy.
6. Subbarayappa, B.V. & Sarma, K.V. (1985), Indian Astronomy -– A Source Book, Bombay.
7. Srinivasan, S., Ranganathan, S. (2013) Minerals and Metals heritage of India, National Institute of Advanced Studies.
8. Srinivasiengar, C.N. (1967) The History of Ancient Indian Mathematics, World Press Private Ltd. Calcutta.
9. Bhardwaj, H.C. (2000) Metallurgy in Indian Archaeology. Tara Book Agency

INSTITUTE OF SCIENCE, NAGPUR

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ZOOLOGY SYLLABUS

(To be implemented from 2024-25)

B. Sc. Semester-II Zoology

Course code: B-ZO121T

Paper –I: Life and Diversity of Nonchordates-II (Arthropoda to Hemichordata)

Total Credits: 2 Hours: 30

Objectives:

1) To gain a thorough understanding of invertebrate taxonomy and features.
2) To gain a better understanding of the morphological and anatomical characteristics of invertebrates.
3) To raise knowledge about the hazardous parasites that non chordates are susceptible to, as well as their economic value.

Outcomes:

1) By the end of this programme, the students will be able to understand:
2) General characters and classification up to classes: Arthropoda, Mollusca, Echinodermata, Hemichordata
3) Study the Morphology and anatomy of Cockroach ,Pila, Asterias, Balanoglossus.
4) Insects as vectors, Social behavior in honey bees & Pearl formation in Mollusca
5) Study the larval forms - crustacea, Mollusca, Echinoderms.
6) Affinities of Balanoglossus.

Unit–I **(7.5 Hrs)**

1.1 **Arthropoda**: General characters and classification up to classes.
1.2 **Cockroach**: Mouthparts, digestive system, male and female reproductive systems.
1.3 **Insects as Vectors**: Mosquito, Housefly, Sandfly, Tse-Tsefly.
1.4 **Study of crustacean larvae** : Nauplius, Zoea and Megalopa.

Unit–II **(7.5 Hrs)**

2.1 **Mollusca:** General characters and classification up to classes.
2.2 ***Pila*:** Morphology and digestive system.
2.3 **Pila**: Respiratory and reproductive system.
2.4 **Molluscan larvae:** Glochidium and Veliger.

Unit–III **(7.5 Hrs)**

3.1 **Echinodermata**: General characters and classification up to classes
3.2 ***Asterias***: External features and digestive system
3.3 Water vascular system in starfish.
3.4 **Echinodermlarvae**: Bipinnaria and Auricularia

Unit–IV **(7.5 Hrs)**

4.1 **Hemichordata**:General characters and phylogeny
4.2 ***Balanoglossus***:External features and digestive system
4.3 Reproduction in *Balanoglossus*, Tornarialarva
4.4 Affinities of *Balanoglossus*

B. Sc. Semester-II Zoology

Course code: B-ZO122P

LAB

Total Credits: 1 Hours: 15

Objectives:

1) To study the structures of invertebrates-arthropoda to hemichordates
2) To observe the larval forms of invertebrates
3) To achieve the anatomical information of invertebrates

Outcomes:

By the end of this programme, the students will be able to:

1) Study and classify life and diversity of invertebrates
2) Prepare temporary and permanent slides.

Life and Diversity of Nonchordates-II (Arthropoda to Hemichordata)

1. Study of museum specimens with the help of specimen/charts/models

(Classification of animals up to orders):

i) Arthropoda: *Peripatus, Cyclops, Daphnia, Lepas, Sacculina ,Limulus,* Crab, *Scolopendra, Julus,* Dragonfly, Grasshopper, Moth

ii) Mollusca: *Chiton, Dentalium, Aplysia, Pila, Mytilus, Loligo, Sepia, Octopus*

iii) Echinodermata: *Asterias, Ophiothrix, Holothuria, Antedon ,Echinus*

iv) Hemichordata: *Balanoglossus, Saccoglossus*

2. Study of permanent slides with the help of specimen/charts:

Nauplius, Zoea and Megalopa larva of Arthopoda,Veliger and Glochidium larva of Mollusca, T.S. of arm of star fish, Bipinnaria and Auricularia larva, T.S. *Balanoglossus* through collar and proboscis, Tornarialarva

3. Study of anatomical featureswith the help of charts/models/videos-

i) Digestive system of Cockroach

ii) Reproductive system ofCockroach

iii) Nervous system of *Pila*

4. Mounting-

Crustacean larvae and plankton**;** Mouthparts, trachea and salivary gland of Cockroach; Gilllamella, osphradium and radulla of *Pila.*

Scheme of Marking for Practical Examination:

Distribution of Marks–	**Total Marks: 30**
Q.1. Identification and Comment on Spots (6 Museum specimens+ 4 slides)	10
Q.2. Study of anatomical features-	08
Q.3. Permanent stained preparation	03
Q.4. Submission of certified practical record	05
Q.5. Submission of slides	02
Q.6. Viva voce	02

List of Recommended Books for Life and Diversity of Nonchordates-II (Arthropoda to Hemichordata):

1. Barnes**–Invertebrate Zoology(Halt-Saundersinternational)** Philadelphia, USA
2. Barradaile L.A. & Potts F.A.–**The Invertebrate**

3. Nigam**– Biology of Nonchordates**
4. Kotpal, Agrawal & Khetrapal**– Modern Text Book of Zoology- Invertebrates,**
5. Rastogi Publication, Meerut
6. Puranik P.G.& Thakur R.S. **– Invertebrate Zoology**
7. Majupuria T.C. **– Invertebrate Zoology**
8. Dhami&Dhami**– Invertebrat eZoology**
9. Parker &Hashwell, **Textbook of Zoology Vol. I (Invertebrates)** A.Z.T.B.S.Publishers & Distributors, New Delhi
10. Dr. S.S. Lal **Practical Zoology Invertebrates 9th edition,** Rastogi Publication Meerut
11. EJW Barrington– **Invertebrate Structure and Function** ELBSIIIEdition8
12. R. L. Kotpal**– PhylumProtozoatoEchinodermata(series),**Rastogi and Publication,Meerut
13. Parker J. and Haswell W.–**Text Book of Zoology**, ELBS Edition
14. Vidyarthi– **Text Book of Zoology**,Agrasia Publishers, Agra
15. Jordan E.L. and Verma P.S.– **Chordate Zoology**, S. Chandand Co., NewDelhi
16. Ayer E.– **Manual of Zoology**
17. M.D. Bhatia – **The Indian Zoological Memories –Leech**
18. Beni Prasad– **The Indian Zoological Memories–Pila**
19. P.K.Gupta– **Vermicomposting for Sustainable Agriculture**, Agrobios India Ltd
20. A manual of Practical ZoologyI nvertebrates– P.S.Verma

B. Sc. Semester-II Zoology

Course category: GE/OE
Course code: B-ZO123T
Paper: Avian Biology

Total Credits: 2 Hours: 30

Course objectives:

1) To study the birds around our environment
2) To achieve the knowledge of biology of birds

Course outcomes:

1) Students will be able to identify various birds
2) They will understand distribution and habitat of birds
3) They will understand the ecological importance of birds

Unit-I **(7.5 Hrs)**

1.1 Distinctive characters of Aves
1.2 Classification of birds up to order
1.3 Common birds of India: House sparrow, Crow, Weaver bird, Common myna, Hill myna, Hoopoe, Koel, Large Indian parrot, Kites, Vultures, Owls, Peacock and Wood peckers.
1.4 Flightless birds (Ratitae): distribution and examples.

Unit-II **(7.5 Hrs)**

2.1 Modes of flight in birds
2.2 Aerial or flight adaptations
2.3 Types of beaks in birds
2.4 Types of feet or claws in birds.

Unit-III **(7.5 Hrs)**

3.1 Kinds of migration in birds
3.2 Way-finding or navigation during migration
3.3 Purpose or advantages of migration
3.4 Economic importance of birds- beneficial and injurious birds

Unit-IV **(7.5 Hrs)**

4.1 Breeding and care of young
4.2 Courtship and mating
4.3 Songs and call notes
4.4 Nesting and feeding grounds

List of Recommended Books for Avian Biology:

1. *Modern text book of Zoology: Vertebrates, 3rd edition* (2010) by Kotpal R. L, Rastogi Publications, Meerut, India.
2. *Introduction to Chordates, 4th edition* (1973) by Majupuria T. C, S. Nagin& Company, Delhi.
3. *Encyclopaedia of Birds, 1st edition* (2001) by Shukla A. N. and Tyagi Rajiv, Anmol Publications Pvt. Td, New Delhi.
4. *Text book of Animal Behaviour, 1st edition* (1996) by Gundevia H. S. and Singh H. C, S. Chand & Company td, New Delhi.
5. *Animal Behaviour, 1st edition* (1992) by Arora M. P, Himalaya Publishing House, Delhi.
6. *Economic Zoology & Animal Behaviour, 1st edition* (2011) by Vishwapremi K. K. C, Silver Line Publications, Allahabad.

7. *Common Indian Birds: Apicturealbum* by Salim Ali and Futehally L. (1968). National Book Trust, India, pp.51.
8. *The book of Indianbirds. 13thedition* by Salim Ali (2003). Oxford publication, pp. 326.
9. *Birds of India - A Pictorial Field Guide* by Grewal B, Sen S, Singh S, Devasar Nand Bhatia G.(2016).Om Books International, pp.792.

B. Sc. Semester-II Zoology

Course category: GE/OE
Course code: B-ZO124T
Paper: Inland Fish Culture

Total Credits: 2 Hours: 30

Course objectives:
1) To study the freshwater fish culture activities
2) To study the breeding of carps
3) To study the fishing devices

Course outcomes: After completion of the course, students will able to-
1) understand the culture activities of fish
2) know the cultivable different fish species
3) know the construction of ponds
4) students can convert the achieved knowledge in to action

Unit-I **(7.5 Hrs)**
1.1 Physico-chemical factors influencing fish culture
1.2 Types of ponds for culture
1.3 Construction and layout of a fish farm
1.4 Cultivable species of fish and kinds of fish culture

Unit-II **(7.5 Hrs)**
2.1 Pre stocking and post stocking management of ponds
2.2 Fish seed collection from rivers and their transport
2.3 Induced breeding of Indian major carps and exotic carps by hormones
2.4 Bundh breeding of fishes

Unit-III **(7.5 Hrs)**
3.1 Fishing crafts
3.2 Fishing gear
3.3 Types of nets and their preservation
3.4 Modernization of fishing methods

Unit-IV **(7.5 Hrs)**
4.1 Biochemical composition of raw fish
4.2 Causes of fish spoilage
4.3 Fish preservation methods
4.4 Fish products and by-products

List of Recommended Books for Inland Fish Culture:

1. *A text book of Fish Biology and Fisheries* by S. S. Khanna and H. R. Singh, Narendra Publishing House, Delhi
2. *An Introduction to Fishes, 6th edition* by S. S. Khanna, Silver Line Publications, Allahabads
3. *Fish and Fisheries* by KamleshwarPandey and J. P. Shukla. Rastogi Publications, Meerut
4. *A textbook of Fishery Science and Indian Fisheries* by C. B. L. Srivastava. KitabMahal, Allahabad
5. *A textbook of Fish Biology and Indian Fisheries* by R. P. Parihar. Central Publishing House, Allahabad
6. *General and Applied Ichthyology (Fish and Fisheries)* by S. K. Gupta and P. C. Gupta, S. Chand & Company Ltd. New Delhi

7. *Fish and Fisheries* by B. N. Yadav.
8. *A Manual of Fresh-Water Aquaculture* by R. Santhanam, N. Sukumaran and P. Natarajan. Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi
9. *Fresh Water Fish Culture* by V. R. P. Sinha and V. Ramchandran. Indian Council of Agricultural Research, New Delhi
10. *An Introduction to Indian Fisheries* by Uma Sharma and S. P. Grover. Published by Bishen Singh Mahendra Pal Singh, Dehra Dun
11. *Fish and Fisheries of India, 3rd edition (1991)* by V. G. Jhingran. Hindutan Publishing Corporation, Delhi

B. Sc. Semester-II Zoology

Course category: VSEC (VSC/SEC)
Course code: B-ZO125P
LAB: Aquarium-Fish Keeping

Total Credits: 2 Hours: 30

Course objectives:
1) To study the fabrication of fish aquaria
2) To study setting of aquarium and its maintenance
3) To study breeding activities of aquarium fishes

Course outcomes:
1) Students can construct and design aquaria
2) They can breed aquarium fishes
3) They can prepare artificial food of fishes
4) They will be able to start their own business of aquarium fish keeping.

Practicals:
1) Construction of aquarium tank
2) Aeration and filtration of aquarium water
3) Aquarium setting: Bedding, lighting and decoration of aquarium
4) Buying, transporting and stocking of fishes
5) Tools and accessories/ancillaries used
6) Breeding of Egg-layers and Live-bearers
7) Fish food and feeding
8) Aquarium fishes and plants
9) Common diseases of aquarium fishes and their control
10) Maintenance of aquarium

Marking Scheme for Practical Examination:

	Max. Marks: 60
Q. 1. Practical based	10
Q. 2. Practical based	10
Q. 3. Practical based	10
Q. 3. Practical based	10
Q. 4. Practical record	10
Q. 5. Visit report	05
Q. 5. Viva	05

List of Recommended Books for Aquarium-Fish Keeping:

1. *Handbook for Aquarium Fish Hobbyists* by K. V. Devraj. Sri K. V. Trust, Chikballapur (Karnataka)
2. *Aquarium-Fish Keeping* by C. B. L. Srivastava. KitabMahal, Allahabad
3. *Training manual on Advances in Keeping and Breeding Ornamental Fishes* by Central Institute of Fisheries Education, Mumbai
4. *A text book of Fish Biology and Fisheries* by S. S. Khanna and H. R. Singh, Narendra Publishing House, Delhi
5. *An Introduction to Fishes, 6th edition* by S. S. Khanna, Silver Line Publications, Allahabads
6. *Fish and Fisheries* by Kamleshwar Pandey and J. P. Shukla. Rastogi Publications, Meerut
7. *A textbook of Fish Biology and Indian Fisheries* by R. P. Parihar. Central Publishing House, Allahabad

8. *Fish and Fisheries* by B. N. Yadav.
9. *An Introduction to Indian Fisheries* by Uma Sharma and S. P. Grover. Published by Bishen Singh Mahendra Pal Singh, Dehra Dun
10. *General and Applied Ichthyology (Fish and Fisheries)* by S. K. Gupta and P. C. Gupta, S. Chand & Company Ltd. New Delhi

B. Sc. Semester-II Zoology

Course category: IKS

Course code: B-ZO126T

Paper: Indian Knowledge System (Economic Zoology)

Total Credits: 2 Hours: 30

Objectives:

1. Acquaint the knowledge about basic procedure and methodology of integrated animal rearing.
2. Students can start their own business i.e. self- employments.
3. Get employment in different sectors of Applied Zoology

Outcomes: After completion of this course, students will be able to-

1. Understand the breeding and culture aspects of fish, silk moth, hens, cow buffalo, goat etc.
2. Promote the rearing of these animals as a self employment venture.
3. Set up their own business, i. e. self employments.

Unit –I: Aquaculture (7.5 Hrs)

1.1 Scope, history and present status of aquaculture, Common cultivable fish species- Indigenous and exotic; prawn and pearl culture.

1.2 Different systems of aquaculture: Monoculture, polyculture and monosex culture; extensive, intensive and semi-intensive culture; Pond culture, culture in reservoirs, culture in Bheries or Bhasabadha, culture in tank farms, culture in raceway farms.

1.3 Culture in cage farm: origin, types and layouts of cage farms, advantages and disadvantages of cage culture. Culture in pens and enclosures: sites, area and barriers; types of enclosures, species suitable for pens, merits and demerits of pen culture.

1.4 Integrated farming systems: Paddy cum fish culture, poultry cum fish culture, poultry-piggery cum fish culture; prevention and control of fish diseases.

Unit –II: Sericulture (7.5 Hrs)

2.1 Introduction to Sericulture, Types of mulberry and non-mulberry silkworms,

2.2 Life history of mulberry silk worm, Silk glands and silk synthesis.

2.3 Cultivation of Food plants of Silkworms. Rearing methods of silkworms, Reeling methods.

2.4 Diseases of silkworm and their control, Present status of sericulture in India, Economic importance of Silk.

Unit –III: Poultry Farming (7.5 Hrs)

3.1 Poultry breeds : Indian breeds, exotic breeds- American, Mediterranean and English breeds.

3.2 Food and feeding of fowls, Rearing methods of young chick, systems of breeding.

3.3 Nutritive value, quality, and preservation of eggs; products of poultry farming.

3.4 Diseases of fowl and their prevention.

Unit –IV: Dairy Farming (7.5 Hrs)

4.1 Dairy breed: Capcious udder, pendulus udder, meaty udder; Draft breed, Dual purpose breed. Exotic breeds.

4.2 Crossbreeding work in India, breeds of Buffaloes, food and fodder, balance diet.

4.3 Housing of cattle, management of dairy- care of calves, cows and cattles

4.4 Farming of goats and sheeps: Breeds of goat, diet of goat, sheeps.

REFERENCES:

1) Thomas PC, Rath SC & Mohapatra KD. 2003. Breeding and Seed Production of Finfish and Shellfish. Daya Publ.

2) Chaudhuri S. 2017. Economic Zoology. Kolkata: New Central Book Agency ;PLtd.
3) Chun and Chen Da-Chung ;1988 Silkworm Rearing; Pub. By FAO, Rome.
4) Econ Handbook of Silkworm Rearing: Agriculture and Technical Manual-1, Fuzi Pub. Co. Ltd.,
5) Jolly, M. S: Appropriate Sericultural Techniques
6) Krishnaswamy, Improved Method of Rearing Young age silkworm; 1986 S., Bangalore
7) Narasimhanna MN. 1988. Manual of Silkworm Egg Production;, CSB, Bangalore.
8) Rangaswami G. 1976. Manual on Sericulture; Food and Agriculture Organisation, Rome
9) Sarkar S; Kundu G & Chaki K C - Introduction to Economic Zoology; NCBA, Kolkata
10) Sengupta, K, ;1989 A Guide for Bivoltine Sericulture
11) Ullal SR, Narasimhanna MN. Handbook of Practical Sericulture: CSB, Bangalore
12) Bone Q and R Moore, Biology of Fishes, Talyor and Francis Group, CRC Press, U.K.
13) Chaudhuri. S, 2017: Economic Zoology, NCBS
14) Evans D. H. and J. D. Claiborne, The Physiology of Fishes, Taylor and Francis Group, CRC Press, UK.
15) Khanna S.S. and H.R. Singh, A text book of Fish Biology and Fisheries, Narendra Publishing House
16) Nelson JS. 2006. Fishes of the World, 4th Edn. Wiley.
17) Srivastava, C.B.L. Fish Biology, Narendra Publishing House

INSTITUTEOFSCIENCE, NAGPUR

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ZOOLOGY SYLLABUS

(To be implemented from 2024-25)

B. Sc. Semester-III Zoology

Course category: DSC

Course code: B-ZO231T

Paper–I: Life and Diversity of Chordates-I (Protochordata to Amphibia)

Total Credits: 2 Hours: 30

Course objectives:

1. To learn everything there is to know about chordates, including their taxonomy and traits.
2. To gain a better understanding of chordates' morphological and anatomical characteristics.
3. To investigate the general characteristics, distribution, and economic significance of chordates.

Course outcomes:

By the end of this programme, the students will be able to understand:

1. General characters and classification up to classes: Protochordata, Pisces, Amphibia and Agnatha.
2. The Morphology and anatomy of Herdmania, Amphioxus.
3. Retrogressive metamorphosis of ascidian tadpole of Herdmania.
4. Scales of fishes, origin of paired fins, migration and accessory respiratory organs and embryology.
5. Parental care and Neotony in Amphibia.
6. Frog embryology and development of respiratory organs and aortic arches in frog.

Unit –I **(7.5 Hrs)**

1.1) **Protochordata** : General characters and classification up to order

1.2) ***Herdmania*** : Structure, digestive system, ascidian tadpole and retrogressivemetamorphosis

1.3) ***Amphioxus*** : Structure, digestive system, circulatory system, sense organs- ocelli, infundibular organ and Kollicker's pit andprotonephridia

1.4) **Agnatha** : General characters of Cyclostomata (*Petromyzon* and *Myxine*)

Unit –II **(7.5 Hrs)**

2.1) **Pisces** : Salient features of Chondrichthyes and Osteichthyes, Origin of paired fins in fishes

2.2) Migration and Accessory respiratory organs in fishes

2.3) **Amphibia** : General characters and classification up to order

2.4) Parental care and Neotony in Amphibia

Unit –III **(7.5 Hrs)**

3.1) Gametogenesis and type of eggs

3.2) Fertilization of egg

3.3) Post fertilization development of fish

3.4) Types of scales of fishes, Development of placoid scales

Unit –IV **(7.5 Hrs)**

4.1) Frog Embryology - Cleavage, blastulation and fate map
4.2) Gastrulation: Morphogenetic movements in gastrula of frog
4.3) Development of respiratory organs in frog
4.4) Development of Aortic arches of frog

B. Sc. Semester-III Zoology
Course category: DSC
Course code: B-ZO232T
Paper–II: Basics of Genetics

Total Credits: 2 Hours: 30

Objectives:

1) To understand the concept of gene and heredity.
2) To study the different notations used while studying Genetics.
3) To understand Mendelian genetics.
4) To study human genetics, genetic diseases.
5) To understand Chromosomal aberrations.

Outcomes:

1) The students will be able to understandthe concept of gene and heredity.
2) The students will understand different notations used while studying Genetics and so will understand the subject better.
3) The students will be able to understand Mendelian genetics.
4) The students will understand human genetics, genetic diseases and thus importance of genetic counselling.
5) The student will be able to understand applied genetics.

Unit –I **(7.5 Hrs)**

1.1 Concepts of genes (alleles) – Cistron, muton and recon
1.2 Mendelian Principles: Dominant recessive relationships (Pure dominant and pure recessive, F1&F2 Generation, Phenotype & genotype ratio, Homozygous and Heterozygous), Monohybrid and Dihybrid cross, Mendelian laws
1.3 Monohybrid and Dihybrid test cross its significance, codominance, incomplete dominance. Multiple alleles.
1.4 Genetic Notations: Wild type and mutant alleles (Drosophilaeye), codominant alleles, (MN, ABO blood group system, Sickle cell Variants, Multiple alleles (Coat colour in Rabbits), designation of allelic pairs, bacteria and viruses, Pedigree diagrams.

Unit –II **(7.5 Hrs)**

2.1 Extracellular genome – Presence and functions of mitochondrial DNA, plasmids
2.2 Cytoplasmic inheritance- Kappa particles in Paramecium, CO2 sensitivity in Drosophila, milk factor in mice, Erythroblastosis fetalis in humans.
2.3 Linkage and crossing over – Basic concepts of linkage, kinds of linkage(Complete, Incomplete, linkage groups), Significance of Linkage.
2.4 Chromosomal aberrations (Intrachromosomal): duplications, deletions, and inversions.

Unit –III **(7.5 Hrs)**

3.1 Sex determination – ZZ, XY, XO, ZW pattern, Sex determination in Drosophila – Genic balance theory, Environmental sex determination in Bonellia, Parthenogenesis.

3.2 Sex linked inheritance: Inheritance of X linked genes (Haemophilia and colourblindness in man.)Inheritance of Y linked genes (Hypertrichosis in man),Sex Influenced genes.

3.3 Genetic disorders in human beings – Haemoglobin disorders – Thalassemia and Sickle cell anaemia. Metabolic disorder: Phenylketonuria

3.4 Disorders related to chromosomal number- Turner syndrome, Klinefelter syndrome, Down syndrome, Edward syndrome, Patau syndrome and Cri-du chat Syndrome.

Unit –IV **(7.5 Hrs)**

4.1 Gene mutations- Spontaneous and induced mutations, somatic, gametic, forward and reverse mutations. Mutagenic agents. Lethal genes – Concepts and consequences

4.2 Population genetics: Basic concepts in population genetics, Hardy Weinberg equilibrium and its significance

4.3 Genetic counselling – Introduction, purpose, hereditary diseases and disorders

4.4 Applied genetics - DNA fingerprinting, amniocentesis, sperm banks, karyotyping

B. Sc. Semester-III Zoology
Course category: DSC
Course code: B-ZO233P
DSC LAB: (Based on Paper-I and II)

Total Credits: 2 Hours: 30

Practicals:

Section-A: Life and Diversity of Chordates-I (Protochordata to Amphibia):

1. Identification, classification , distinguishing characters and adaptive features of

i) Urochordata : *Herdmania, Salpa, Doliolum*

ii) Cephalochordata : *Amphioxus*

iii) Cyclostomata : *Petromyzon, Myxine*

iv) Pisces: *Pristis, Torpedo, Notopterus, Exocoetus, Clarius, Ophiocephalus,Catla, Rohu, Mrigal*

v) Amphibia: *Ichthyophis ,Bufo, Salamander*

2. Anatomical observation, demonstration and explanation of following systems of the locally available culturable fish-

i) Digestive system

ii) Reproductive system

iii) Brain

3. Developmental Biology –

Study of permanent slides of Frog embryology: T.S. Blastula, T.S. Gastrula, T.S.Neurula, T.S. tadpole passing through internal and external gill stage

4. Study of permanent slides-

Amphioxus through Pharynx, Intestine, Gonad and Caudal region; V.S. skin, T.S. Testis, T.S. Ovary of Frog; T.S. Stomach, T.S. Intestine, T.S. Liver of fish

5. Permanent stained preparation:

Fish scales– Placoid, cycloid, ctenoid; Hyaline cartilage and striated muscle

Section-B : Basics of Genetics:

1. Study of monohybrid and dihybrid ratio
2. Study of normal human karyotype (male and female)
3. Study of characters and karyotypes of Syndrome like Down, Klinefelter,Turner, Edward, Patau and Cri-du chat Syndrome.
4. Study of the genetic traits (Hardy Weinberg law) in human being (Tongue rolling, ear lobe, PTC taster/ non taster).
5. Study of blood groups in human (ABO and Rh).
6. Study of structural chromosome aberrations (dicentric, ring chromosomes and inversions in polytene chromosomes) from prepared slides / photographs.
7. Study of external characters, life cycle and Rearing of Drosophila.
8. Study of Drosophila mutants.
9. Rearing of Drosophila.

Scheme of Marking for Practical Examination:

Distribution of Marks– Total Marks: 60

1. Anatomical observation and explanation of given system of fish	10
2. Identification and comment on spots (1 to 5)	10
3. Genetics experiment- Monohybrid or dihybrid ratio	10
4. Genetics study- Karyotypes, syndromes, genetic traits in man (any two)	10
5. Permanent stained preparation	05
6. Submission of certified practical record	10
7. Viva voce	05

REFERENCES:

Recommended Books for Chordate study-I (Prtochordata to Amphibia):

1. T. B. of Zoology vol II – Parker & Haswell
2. T. B. of Vertebrate Zoology -S. N. Prasad
3. Chordate Zoology –E. L. Jorden and P. S. Verma
4. Vertebrate Zoology – Vishwanath
5. Zoology of Chordates – Nigam H. C.
6. Phylum: Chordata – Newman H.H.
7. Biology of Vertebrates –Walter & Sayles
8. The Vertebrate Body – Romer A. S.
9. Comparative Anatomy of the Vertebrates – Kingslay J. D.
10. The Biology of Amphibia – Noble G. K.
11. Snakes of India – Gharpura K. G.
12. Life of Mammals – Young J.Z.
13. Vertebrates – Kotpal R. L.
14. Introduction to Chordates – Majupuria T.C.
15. Vertebrate Zoology – Dhami & Dhami
16. T. B. Vertebrate Zoology – Agrawal
17. Protochordates – Chatterjee & Pandey
18. Protochordates – Bhatia

19. T. B. of Chordates – Bhamrah and Juneja
20. Chordate Anatomy – Arora M.P.
21. The Chordates – Alexander.
22. T. B. of Animal Embryology – Puranik
23. T. B. of Chordate Embryology – Dalella & Verma
24. T. B. of Embryology – Sandhu
25. T. B. of Embryology – Armugam

Recommended Books for Basics of Genetics:

1. Principles of Genetics, 1997, P. D. Snustad, M. L. Simmons J. B. Jenkins, John Wiley & Sons, USA
2. Genetics, 2014, 9th Edn., Verma P. S. and Agarwal V. K., S. Chand and Co., New Delhi.
3. Genetics, 2014, 4th Edn. Gupta P. K., Rastogi Publications, Meerut.
4. Principles of Genetics, Gardner, E. J. et al. (2006), John Wiley and Sons Inc.
5. Genetics: A Molecular Approach, 3rd Edn, Russell, P. J., Benjamin Cummings.
6. Principles of Genetics 8th Edition, Gardner, E. J., Simmons, M. J., Snustad, D. P. (2008). John Wiley and Sons Inc.
7. Principles of Genetics. 5th Edn. Snustad, D. P. and Simmons, M. J. (2009). John Wiley and Sons Inc.
8. Concepts of Genetics, 10th Edn. Benjamin Cummings. Klug, W. S., Cummings, M. R. and Spencer, C. A. (2012).
9. An Introduction to Genetic Analysis, 11th Edn. Carroll S. B.; Doebley J., Griffiths, A. J. F. and Wessler, S. R. (2018) W. H. Freeman and Co. Ltd.
10. Genetics, Volume-I, C.B. Powar. Himalaya Publication House.

B. Sc. Semester-III Zoology
Course category: MINOR
Course code: B-ZO234T
Paper–I: Life and Diversity of Chordates-I (Protochordata to Amphibia)

Total Credits: 2 Hours: 30

Course objectives:

1. To learn everything there is to know about chordates, including their taxonomy and traits.
2. To gain a better understanding of chordates' morphological and anatomical characteristics.
3. To investigate the general characteristics, distribution, and economic significance of chordates.

Course outcomes:

By the end of this programme, the students will be able to understand:

1. General characters and classification up to classes: Protochordata, Pisces, Amphibia and Agnatha.
2. The Morphology and anatomy of Herdmania, Amphioxus.
3. Retrogressive metamorphosis of ascidian tadpole of Herdmania.
4. Scales of fishes, origin of paired fins, migration and accessory respiratory organs and embryology.
5. Parental care and Neotony in Amphibia.
6. Frog embryology and development of respiratory organs and aortic arches in frog.

Unit –I **(7.5 Hrs)**

1.1) **Protochordata** : General characters and classification up to order
1.2) ***Herdmania*** : Structure, digestive system, ascidian tadpole and retrogressivemetamorphosis
1.3) ***Amphioxus*** : Structure, digestive system, circulatory system, sense organs- ocelli, infundibular organ and Kollicker's pit andprotonephridia
1.4) **Agnatha** : General characters of Cyclostomata (*Petromyzon* and *Myxine*)

Unit –II **(7.5 Hrs)**

2.1) **Pisces** : Salient features of Chondrichthyes and Osteichthyes, Origin of paired fins in fishes
2.2) Migration and Accessory respiratory organs in fishes
2.3) **Amphibia** : General characters and classification up to order
2.4) Parental care and Neotony in Amphibia

Unit –III **(7.5 Hrs)**

3.1) Gametogenesis and type of eggs
3.2) Fertilization of egg
3.3) Post fertilization development of fish
3.4) Types of scales of fishes, Development of placoid scales

Unit –IV **(7.5 Hrs)**

4.1) Frog Embryology - Cleavage, blastulation and fate map
4.2) Gastrulation: Morphogenetic movements in gastrula of frog
4.3) Development of respiratory organs in frog
4.4) Development of Aortic arches of frog

B. Sc. Semester-III Zoology
Course category: MINOR
Course code: B-ZO235T
Paper–II: Basics of Genetics

Total Credits: 2 Hours: 30

Objectives:

1) To understand the concept of gene and heredity.
2) To study the different notations used while studying Genetics.
3) To understand Mendelian genetics.
4) To study human genetics, genetic diseases.
5) To understand Chromosomal aberrations.

Outcomes:

1) The students will be able to understandthe concept of gene and heredity.
2) The students will understand different notations used while studying Genetics and so will understand the subject better.
3) The students will be able to understand Mendelian genetics.
4) The students will understand human genetics, genetic diseases and thus importance of genetic counselling.
5) The student will be able to understand applied genetics.

Unit –I (7.5 Hrs)

1.1 Concepts of genes (alleles) – Cistron, muton and recon

1.2 Mendelian Principles: Dominant recessive relationships (Pure dominant and pure recessive, F1&F2 Generation, Phenotype & genotype ratio, Homozygous and Heterozygous), Monohybrid and Dihybrid cross, Mendelian laws

1.3 Monohybrid and Dihybrid test cross its significance, codominance, incomplete dominance. Multiple alleles.

1.4 Genetic Notations: Wild type and mutant alleles (Drosophilaeye), codominant alleles, (MN, ABO blood group system, Sickle cell Variants, Multiple alleles (Coat colour in Rabbits), designation of allelic pairs, bacteria and viruses, Pedigree diagrams.

Unit –II (7.5 Hrs)

2.1 Extracellular genome – Presence and functions of mitochondrial DNA, plasmids

2.2 Cytoplasmic inheritance- Kappa particles in Paramecium, CO2 sensitivity in Drosophila, milk factor in mice, Erythroblastosis fetalis in humans.

2.3 Linkage and crossing over – Basic concepts of linkage, kinds of linkage(Complete, Incomplete, linkage groups), Significance of Linkage.

2.4 Chromosomal aberrations (Intrachromosomal): duplications, deletions, and inversions.

Unit –III (7.5 Hrs)

3.1 Sex determination – ZZ, XY, XO, ZW pattern, Sex determination in Drosophila – Genic balance theory, Environmental sex determination in Bonellia, Parthenogenesis.

3.2 Sex linked inheritance: Inheritance of X linked genes (Haemophilia and colourblindness in man.)Inheritance of Y linked genes (Hypertrichosis in man),Sex Influenced genes.

3.3 Genetic disorders in human beings – Haemoglobin disorders – Thalassemia and Sickle cell anaemia. Metabolic disorder: Phenylketonuria

3.4 Disorders related to chromosomal number- Turner syndrome, Klinefelter syndrome, Down syndrome, Edward syndrome, Patau syndrome and Cri-du chat Syndrome.

Unit –IV **(7.5 Hrs)**

4.1 Gene mutations- Spontaneous and induced mutations, somatic, gametic, forward and reverse mutations. Mutagenic agents. Lethal genes – Concepts and consequences

4.2 Population genetics: Basic concepts in population genetics, Hardy Weinberg equilibrium and its significance

4.3 Genetic counselling – Introduction, purpose, hereditary diseases and disorders

4.4 Applied genetics - DNA fingerprinting, amniocentesis, sperm banks, karyotyping

B. Sc. Semester-III Zoology
Course category: MINOR
Course code: B-ZO236P
MINOR LAB: (Based on Paper-I and II)

Total Credits: 2 Hours: 30

Practicals:

Section-A: Life and Diversity of Chordates-I (Protochordata to Amphibia):

1. Identification, classification , distinguishing characters and adaptive features of

i) Urochordata : *Herdmania, Salpa, Doliolum*

ii) Cephalochordata : *Amphioxus*

iii) Cyclostomata : *Petromyzon, Myxine*

iv) Pisces: *Pristis, Torpedo, Notopterus, Exocoetus, Clarius, Ophiocephalus,Catla, Rohu, Mrigal*

v) Amphibia: *Ichthyophis ,Bufo, Salamander*

2. Anatomical observation, demonstration and explanation of following systems of the locally available culturable fish-

i) Digestive system

ii) Reproductive system

iii) Brain

3. Developmental Biology –

Study of permanent slides of Frog embryology: T.S. Blastula, T.S. Gastrula, T.S.Neurula, T.S. tadpole passing through internal and external gill stage

4. Study of permanent slides-

Amphioxus through Pharynx, Intestine, Gonad and Caudal region; V.S. skin, T.S. Testis, T.S. Ovary of Frog; T.S. Stomach, T.S. Intestine, T.S. Liver of fish

5. Permanent stained preparation:

Fish scales– Placoid, cycloid, ctenoid; Hyaline cartilage and striated muscle

Section-B : Basics of Genetics:

1. Study of monohybrid and dihybrid ratio
2. Study of normal human karyotype (male and female)
3. Study of characters and karyotypes of Syndrome like Down, Klinefelter,Turner, Edward, Patau and Cri-du chat Syndrome.
4. Study of the genetic traits (Hardy Weinberg law) in human being (Tongue rolling, ear lobe, PTC taster/ non taster).
5. Study of blood groups in human (ABO and Rh).
6. Study of structural chromosome aberrations (dicentric, ring chromosomes and inversions in

polytene chromosomes) from prepared slides / photographs.

7. Study of external characters, life cycle and Rearing of Drosophila.
8. Study of Drosophila mutants.
9. Rearing of Drosophila.

Scheme of Marking for Practical Examination:

Distribution of Marks– Total Marks: 60

1. Anatomical observation and explanation of given system of fish	10
2. Identification and comment on spots (1 to 5)	10
3. Genetics experiment- Monohybrid or dihybrid ratio	10
4. Genetics study- Karyotypes, syndromes, genetic traits in man (any two)	10
5. Permanent stained preparation	05
6. Submission of certified practical record	10
7. Viva voce	05

REFERENCES:

Recommended Books for Chordate study-I (Prtochordata to Amphibia):

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27. T. B. of Vertebrate Zoology -S. N. Prasad
28. Chordate Zoology –E. L. Jorden and P. S. Verma
29. Vertebrate Zoology – Vishwanath
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38. Vertebrates – Kotpal R. L.
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9. An Introduction to Genetic Analysis, 11th Edn. Carroll S. B.; Doebley J., Griffiths, A. J. F. and Wessler, S. R. (2018) W. H. Freeman and Co. Ltd.
10. Genetics, Volume-I, C.B.Powar. Himalaya Publication House.

B. Sc. Semester-III Zoology
Course category: VSEC (VSC/SEC)
Course code: B-ZO238P
LAB: Honey bee Keeping

Total Credits: 2 Hours: 30

Course objectives:

1. To study the construction of bee hive.
2. To study morphology and life cycle of honey bees.
3. To study handling of artificial bee hive and its maintenance.
4. To study bee enemies and their control.

Course outcomes: After completion of course, student will

1) Able to identify queen, drones and workers of honey bee.
2) Able to handle artificial bee hive.
3) Understand the economic importance of honey bee.
4) Identify and recognized enemies of honey bee.
5) Able to do internship in commercial bee keeping unit.

Practicals:

1. Introduction to Apiculture.
2. To demonstrate construction of bee hive and different species of bees.
3. To study the morphology and anatomy of bee.
4. To study the life cycle and division of labour.
5. To analyse the social behaviour of bees.
6. To study the handling of artificial bee hive and its maintenance.

7. To collect and preserve the bee pasture.
8. To study the seasonal management of colony.
9. Manipulation for honey production.
10. Economics of bee keeping.
11. To study the queen rearing.
12. To find out and study bee enemies and their control.
13. Visit to bee keeping site.

Scheme of Marking for Practical Examination:

Distribution of Marks–	**Total Marks: 30**
1. Identification and comment on spots (1 to 5)	10
2. Comment on the life cycle of honey bee/ handling of artificial bee hive and its maintenance	08
3. Submission of visit report	05
4. Submission of certified practical record	05
5. Viva voce	02

References:

1. Abrol, D. P. (1997). Bees and Beekeeping. Kalyani Publisher, New Delhi.
2. Abrol, D. P. (2010). A Comprehensive guide to Bees and Beekeeping. Scientific Publisher, New Delhi.
3. Withhead, S. B. (2010). Honey bees and their management. Axis books Publisher, Jodhpur.
4. Nagaraja, N. and Rajagopal, D. (2013). Honey bees: Diseases, Parasites, Pests, Predator and their management. M. J. P Publisher, Chennai.
5. DharamsingandSingh ,D. P. A Hand book of Bee keeping, Agrobios India (Publisher), Jodhpur.
6. Goud R (2022). Practical Manual on Apiculture, Sericulture and Lac culture. Jaya Publication House.
7. Jayashree KV, Tharadevi CS, Arumugam N. (2014). Apiculture. Saras Publication, pp.360.
8. Brett J (2012). Apiculture and Bee keeping simplified. Alfa one Publishing Company, pp. 106.
9. Elumalai D, Mohan C, Poovizhiraja B, Ramamurthy R (2012). Principles and practices of apiculture. Jaya Publishing House.
10. Petterson J (2016). Beekeeping: Everything You Need to Know to Start Your First Beehive.Weldon Owen Publisher, pp. 192.
11. Sathe TV (2018). Fundamentals of bee keeping. Daya Publishing House

INSTITUTEOFSCIENCE, NAGPUR

(An Autonomous Institute of Government of Maharashtra)

ZOOLOGY SYLLABUS

(To be implemented from 2024-25)

B. Sc. Semester-IV Zoology

Course category: DSC

Course code: B-ZO241T

Paper–I: Life and Diversity of Chordates-II (Reptilia to Mammalia)

Total Credits: 2 Hours: 30

Course objectives:

1. To learn everything there is to know about chordates, including their taxonomy and traits.
2. To gain a better understanding of chordates' morphological and anatomical characteristics.
3. To investigate the general characteristics, distribution, and economic significance of chordates.

Course outcomes:

By the end of this programme, the students will be able to:

1. Identify, classify and distinguish the characters and adaptive features of animals from Reptilia, Aves and Mammals.
2. To understand poison apparatus of snake.
3. To understand flight adaptations and migration of birds.
4. To understand theories of evolution and genetic basis of evolution.
5. To understand embyology of mammals and chick.
6. To understand the behavior in birds and mammals.

Unit –I **(7.5 Hrs)**

1.1 **Reptilia-** Classification based on temporal vacuities

1.2 Poison apparatus, biting mechanism , snake venom and its importance

1.3 **Aves** – Comparison of Ratitae and Caranitae, Flight adaptations and migration

1.4 **Mammals** – General characters of Prototheria, Metatheria and Eutheria

Unit –II **(7.5 Hrs)**

2.1 Modern theories of evolution : Darwinism and Neo-Darwinism

2.2 Adaptations – Cursorial, Aquatic, Terrestrial, Fossorial and Volant

2.3 Introduction to genetic basis of evolution – Species Deme, Variation

2.4 Races in Man (Caucasoid, Negroid, Mongoloid and Australoid)

Unit –III **(7.5 Hrs)**

3.1 Comparative account of aortic arches and heart in Reptiles, Birds and Mammals

3.2 Structure of hen’s egg

3.3 Development of chick up to premitive streak stage

3.4 Development of extra embryonic membranes in chick and functions

Unit –IV **(7.5 Hrs)**

4.1 Blastocyst and implantation in Mammals; Types of placenta on the basis of morphological and histological structure; functions of placenta

4.2 Stem cells : Sources, types and their use in human welfare

4.3 Biological clock : Diurnal and rhythmic behavior in birds and mammals

4.4 Role of pheromones in reproductive behavior

B. Sc. Semester-IV Zoology
Course category: DSC
Course code: B-ZO242T
Paper–II: Molecular Biology

Total Credits: 2 Hours: 30

Objectives:

1. Molecular biology paper gives the understanding of molecules DNA and RNA and central dogma of molecular biology.
2. Students will learn about the Chromosome structure, DNA supercoiling, its nature.
3. Students will identify the role of DNA Supercoiling, Genetic code, inhibitors of transcription and translation.
4. Students conclude downstream applications of DNA, RNA and protein estimation, PCR, Agarose Gel Electrophoresis in listed practicals.

Outcomes: By the end of this course students will able to-

1. Understand about molecules DNA and RNA.
2. Differentiate between DNA and RNA
3. Demonstrate the knowledge of central dogma of molecular biology.
4. Analyse the use of inhibitors of transcription and translation.
5. Demonstrate proficiency with the principle and protocol involved in the listed practicals.

Unit –I **(7.5 Hrs)**

1.1 DNA structure and function. Forms of DNA(A and Z)

1.2 RNA structure, Types of RNA and their functions

1.3 Eukaryotic and prokaryotic gene structure,Organelle DNAs: mitochondrial and chloroplast

1.4 Recombination in Bacteria:Griffiths experiment, Bacterial transformation, conjugation and transduction

Unit –II **(7.5 Hrs)**

2.1 Components of eukaryotic chromatin-chromatin and chromosome structure.

2.2 DNA supercoiling -Nucleosome,30nm fibre, solenoid fiber, linking number.

2.3 DNA Methylation and Histone acetylation: an overview.

2.4 Cot curve, C value paradox,repetitive DNA, Satellite DNA

Unit –III **(7.5 Hrs)**

3.1 DNA Replication: Modelsof DNA replication (Semiconservative), Meselson Stahl experiments. Mechanism of replication, Enzymes and proteins involved in replication

3.2 Prokaryotic transcription: Mechanism of transcription: initiation, elongation, and termination, regulation and termination.

3.3 Post-transcriptional modification- 5' cap formation- 3' end processing and polyadenylation-splicing

3.4 Inhibitors of transcription: Alfa- Amanitin and actinomycin D.

Unit –IV **(7.5 Hrs)**

4.1 Genetic Code: Characteristics of genetic code

4.2 Prokaryotic translation : Mechanism of Initiation, elongation and termination

4.3 Gene regulation: Lac Operon concept.

4.4 Inhibitors of translation: Tetracycline, Steptomycinacting on prokaryotes, Cycloheximide, Ricin acting on eukaryotes and Puromycin and Actinomycin acting on both.

B. Sc. Semester-IV Zoology
Course category: DSC
Course code: B-ZO243P
DSC LAB: (Based on Paper-I and II)

Total Credits: 2 Hours: 30

Practicals:

Section-A: Life and Diversity of Chordates-II (Reptilia to Mammalia):

1. Identification, classification, distinguishing characters and adaptive features of the following:

i) Reptilia : *Chameleon, Varanus, Pharynosoma, Draco, Tortoise*, Cobra, Krait, Russel's viper, Sea snake

ii) Birds: Owl, Woodpecker, Kingfisher, Kite, Duck, Parrot

iii) Mammals: Squirrel, Mongoose, Bat, Loris, Rabbit

2. Study of skeleton of Rabbit and Fowl.

3. Developmental Biology –

Study of permanent slides of chick embryology W.M.: 18 hrs, 24 hrs, 30 hrs, 36 hrs,72hrs.

4. Study of permanent slides- V.S. skin of Bird, Filoplume of bird, V. S. Skin of Mammal.

Section-B: Molecular Biology:

1. Staining of DNA and RNA in blood smear of fish/human by methyl green pyronin technique.
2. Introduction to basic laboratory instruments and equipments- Autoclave, Centrifuge, pH meter, Micropippettes, Digital balance, Homogenizer, Electrophoresis apparatus .
3. Detection of Barr body in human buccal epithelial cell/Blood.
4. Isolation of DNA(Genomic DNA from any available source like saliva/ onion/banana)
5. Estimation of DNA by colorimetric/ diphenylamine method

6. Estimation of RNA by orcinol method
7. Estimation Protein by biuret/ Lowry method
8. Determination of blood groups (ABO and Rh) in humans
9. Demonstration of Conventional PCR
10. Demonstration of Agarose Gel Electrophoresis

Scheme of Marking for Practical Examination:

Distribution of Marks– **Total Marks: 60**

1. Identification and comment on spots (1 to 10) 20
2. Detection of Barr body in blood/ blood group/ staining of DNA and RNA in blood by Methyl green pyronin method 10
3. Isolation of genomic DNA from given source/ Estimation of DNA by colorimetric or diphenylamine method 05
4. Estimation of protein by biuret or Lowry method/ Demonstration of agarose gel Electrophoresis 10
5. Submission of certified practical record 10
6. Viva voce 05

REFERENCES:

Recommended Books for Life and Diversity of Chordates-II (Reptilia to Mammalia):

1. T. B. of Zoology vol II – Parker & Haswell
2. T. B. of Vertebrate Zoology -S. N. Prasad
3. Chordate Zoology –E. L. Jorden and P. S. Verma
4. Vertebrate Zoology – Vishwanath
5. Zoology of Chordates – Nigam H. C.
6. Phylum: Chordata – Newman H.H.
7. Biology of Vertebrates –Walter & Sayles
8. The Vertebrate Body – Romer A. S.
9. Comparative Anatomy of the Vertebrates – Kingslay J. D.
10. The Biology of Amphibia – Noble G. K.
11. Snakes of India – Gharpura K. G.
12. Life of Mammals – Young J.Z.
13. Vertebrates – Kotpal R. L.
14. Introduction to Chordates – Majupuria T.C.
15. Vertebrate Zoology – Dhami & Dhami
16. T. B. Vertebrate Zoology – Agrawal
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18. Protochordates – Bhatia
19. T. B. of Chordates – Bhamrah and Juneja
20. Chordate Anatomy – Arora M.P.
21. The Chordates – Alexander.
22. T. B. of Animal Embryology – Puranik
23. T. B. of Chordate Embryology – Dalella & Verma
24. T. B. of Embryology – Sandhu
25. T. B. of Embryology – Armugam

Recommended Books for Molecular Biology:

1. Cell and Molecular Biology by De Robertis- E.D.P.I.S.E. Publication
2. Molecular Biology of Gene by Watson J.D.et. al., Benjamin publication
3. Molecular Biology by Laodish H., Berk A., Zipursky S, L., Matsudaira P.
4. Baltimore D. And Darnell J., W.H. Freeman and Co.
5. Molecular Biology by Upadhay A and Upadhay K. Himalaya publication
6. Cell and Molecualr Biology by P.K.Gupta
7. Advanced Molecular Biology byTwyman R.M., Viva Books Pvt. Ltd
8. Molecular Biology by Turner P.C. And Mc Lennon, Viva Books Pvt. Ltd
9. Molecular Biology of the Cell by Alberts B., Bray D. Lewis J., garland publishing Inc.
10. For virtual of practicals: praxilabs.com

B. Sc. Semester-IV Zoology
Course category: MINOR
Course code: B-ZO244T

Paper–I: Life and Diversity of Chordates-II (Reptilia to Mammalia)

Total Credits: 2 Hours: 30

Course objectives:

1. To learn everything there is to know about chordates, including their taxonomy and traits.
2. To gain a better understanding of chordates' morphological and anatomical characteristics.
3. To investigate the general characteristics, distribution, and economic significance of chordates.

Course outcomes:

By the end of this programme, the students will be able to:

1. Identify, classify and distinguish the characters and adaptive features of animals from Reptilia, Aves and Mammals.
2. To understand poison apparatus of snake.
3. To understand flight adaptations and migration of birds.
4. To understand theories of evolution and genetic basis of evolution.
5. To understand embyology of mammals and chick.
6. To understand the behavior in birds and mammals.

Unit –I **(7.5 Hrs)**

1.1 **Reptilia**- Classification based on temporal vacuities
1.2 Poison apparatus, biting mechanism , snake venom and its importance
1.3 **Aves** – Comparison of Ratitae and Caranitae, Flight adaptations and migration
1.4 **Mammals** – General characters of Prototheria, Metatheria and Eutheria

Unit –II **(7.5 Hrs)**

2.1 Modern theories of evolution : Darwinism and Neo-Darwinism
2.2 Adaptations – Cursorial, Aquatic, Terrestrial, Fossorial and Volant
2.3 Introduction to genetic basis of evolution – Species Deme, Variation
2.4 Races in Man (Caucasoid, Negroid, Mongoloid and Australoid)

Unit –III **(7.5 Hrs)**

3.1 Comparative account of aortic arches and heart in Reptiles, Birds and Mammals
3.2 Structure of hen's egg
3.3 Development of chick up to premitive streak stage
3.4 Development of extra embryonic membranes in chick and functions

Unit –IV **(7.5 Hrs)**

4.1 Blastocyst and implantation in Mammals; Types of placenta on the basis of morphological and histological structure; functions of placenta
4.2 Stem cells : Sources, types and their use in human welfare
4.3 Biological clock : Diurnal and rhythmic behavior in birds and mammals
4.4 Role of pheromones in reproductive behavior

B. Sc. Semester-IV Zoology
Course category: MINOR
Course code: B-ZO245T
Paper–II: Molecular Biology

Total Credits: 2 Hours: 30

Objectives:

5. Molecular biology paper gives the understanding of molecules DNA and RNA and central dogma of molecular biology.
6. Students will learn about the Chromosome structure, DNA supercoiling, its nature.
7. Students will identify the role of DNA Supercoiling, Genetic code, inhibitors of transcription and translation.
8. Students conclude downstream applications of DNA, RNA and protein estimation, PCR, Agarose Gel Electrophoresis in listed practicals.

Outcomes: By the end of this course students will able to-

6. Understand about molecules DNA and RNA.
7. Differentiate between DNA and RNA
8. Demonstrate the knowledge of central dogma of molecular biology.
9. Analyse the use of inhibitors of transcription and translation.
10. Demonstrate proficiency with the principle and protocol involved in the listed practicals.

Unit –I **(7.5 Hrs)**

1.1 DNA structure and function. Forms of DNA(A and Z)
1.2 RNA structure, Types of RNA and their functions
1.3 Eukaryotic and prokaryotic gene structure,Organelle DNAs: mitochondrial and chloroplast
1.4 Recombination in Bacteria:Griffiths experiment, Bacterial transformation, conjugation and transduction

Unit –II **(7.5 Hrs)**

2.1 Components of eukaryotic chromatin-chromatin and chromosome structure.
2.2 DNA supercoiling -Nucleosome,30nm fibre, solenoid fiber, linking number.
2.3 DNA Methylation and Histone acetylation: an overview.
2.4 Cot curve, C value paradox,repetitive DNA, Satellite DNA

Unit –III **(7.5 Hrs)**

3.1 DNA Replication: Modelsof DNA replication (Semiconservative), Meselson Stahl experiments. Mechanism of replication, Enzymes and proteins involved in replication

3.2 Prokaryotic transcription: Mechanism of transcription: initiation, elongation, and termination, regulation and termination.

3.3 Post-transcriptional modification- 5' cap formation- 3' end processing and polyadenylation-splicing

3.4 Inhibitors of transcription: Alfa- Amanitin and actinomycin D.

Unit –IV **(7.5 Hrs)**

4.1 Genetic Code: Characteristics of genetic code

4.2 Prokaryotic translation : Mechanism of Initiation, elongation and termination

4.3 Gene regulation: Lac Operon concept.

4.4 Inhibitors of translation: Tetracycline, Steptomycinacting on prokaryotes, Cycloheximide, Ricin acting on eukaryotes and Puromycin and Actinomycin acting on both.

B. Sc. Semester-IV Zoology
Course category: MINOR
Course code: B-ZO246P
MINOR LAB: (Based on Paper-I and II)

Total Credits: 2 Hours: 30

Practicals:

Section-A: Life and Diversity of Chordates-II (Reptilia to Mammalia):

1. Identification, classification, distinguishing characters and adaptive features of the following:

i) Reptilia : *Chameleon, Varanus, Pharynosoma, Draco, Tortoise*, Cobra, Krait, Russel's viper, Sea snake

ii) Birds: Owl, Woodpecker, Kingfisher, Kite, Duck, Parrot

iii) Mammals: Squirrel, Mongoose, Bat, Loris, Rabbit

2. Study of skeleton of Rabbit and Fowl.

3. Developmental Biology –

Study of permanent slides of chick embryology W.M.: 18 hrs, 24 hrs, 30 hrs, 36 hrs,72hrs.

4. Study of permanent slides- V.S. skin of Bird, Filoplume of bird, V. S. Skin of Mammal.

Section-B: Molecular Biology:

1. Staining of DNA and RNA in blood smear of fish/human by methyl green pyronin technique.
2. Introduction to basic laboratory instruments and equipments- Autoclave, Centrifuge, pH meter, Micropippettes, Digital balance, Homogenizer, Electrophoresis apparatus .
3. Detection of Barr body in human buccal epithelial cell/Blood.
4. Isolation of DNA(Genomic DNA from any available source like saliva/ onion/banana)
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Distribution of Marks– **Total Marks: 60**

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2. Molecular Biology of Gene by Watson J.D.et. al., Benjamin publication
3. Molecular Biology by Laodish H., Berk A., Zipursky S, L., Matsudaira P.
4. Baltimore D. And Darnell J., W.H. Freeman and Co.
5. Molecular Biology by Upadhay A and Upadhay K. Himalaya publication
6. Cell and Molecualr Biology by P.K.Gupta
7. Advanced Molecular Biology byTwyman R.M., Viva Books Pvt. Ltd
8. Molecular Biology by Turner P.C. And Mc Lennon, Viva Books Pvt. Ltd
9. Molecular Biology of the Cell by Alberts B., Bray D. Lewis J., garland publishing Inc.
10. For virtual of practicals: praxilabs.co

B. Sc. Semester-IV Zoology
Course category: VSEC (VSC/SEC)
Course code: B-ZO248P
LAB: Water Quality Analysis

Total Credits: 2 Hours: 30

Course objectives:

1) To study methods of water analysis
2) To study the physical parameters of water
3) To study the chemical parameters of water

Course outcomes:

1) Students can study the physico-chemical parameters of water
2) They can understand standard value of various parameters
3) They can take care to maintain the water quality
4) They can understand the significance of micro flora and fauna in water quality
5) Students can analyze water quality at their own

Practicals:

1) Determination of pH of water
2) Determination of transparency of water
3) Estimation of dissolved oxygen by Winkler's method
4) Estimation of free carbon dioxide
5) Estimation of alkalinity (carbonates, bicarbonates and total)
6) Estimation of hardness (total, calcium and magnesium)
7) Estimation of chlorides in water
8) Estimation of Biochemical oxygen demand (BOD)
9) Qualitative analysis of phytoplankton
10) Qualitative analysis of zooplankton
11) Visit to water or sewage treatment plant

Scheme of Marking for Practical Examination:

Distribution of Marks–	**Total Marks: 60**
1. Identification and comment on spots (1 to 10)	20
2. Determination of pH/ transparency/ hardness of water	05
3. Estimation of dissolved oxygen/ alkalinity	10
4. Estimation of BOD/ chlorides in water	10
5. Submission of visit report	05
6. Submission of certified practical report	05
7. Viva voce	05

Recommended Books for Water Quality Analysis:

1. Chemical and Biological Methods for Water Pollution Studies by R. K. Trivedi and P. K. Goyal. Environ publications, Karad
2. Standard Methods for the Examination of Water and Wastewater, 15th edition (1981) by APHA-AWWA-WPCF. American Public Health Association, Washington D. C.
3. Workbook on Limnology by A. D. Adoni
4. Methodology for Water analysis by M. S. Kodarkar. Indian Association of Aquatic Biologists (IAAB), Hyderabad
5. Hand book on The Methods of Water Quality Assessment by Dept. of Limnology and Fisheries, Rajasthan College of Agriculture, Rajasthan Agricultural University, Udaipur
6. A Course Manual on Water and Waste Water Analysis by B. B. Sundaresen. National Environmental Engineering Research Institute, Nagpur
7. Estuarine Biological Methods by K. V. Rama Rao, E. V. Muley, M. B. Raghunathan and A.K. Karmakar. Estuarine Biological Station, Zoological Survey of India, Berhampur (GM), Orissa.
8. Methods of Hydrobiology (Freshwater Biology) by JurgenSchwoerbel. Pergamon Press, Oxford
9. A Manual of Freshwater Ecology by R. Santhanam, P. Velayuthan and G. Jegatheesn. Daya Publishing House, Delhi
10. Fresh Water Animals of India by G. T. Tonapi. Oxford & IBH Publishing Co. Delhi
11. Fresh Water Biology, 2nd edition (1992) by W. T. Edmondson. International Books & Periodicals Supply Service, New Delhi
12. Freshwater Zooplankton of India by S. K. Battish. Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi
13. Chemical and Biological Methods for Water Pollution Studies by R. K. Trivedi and P. K. Goyal. Environ publications, Karad
14. Standard Methods for the Examination of Water and Wastewater, 15th edition (1981) by APHA-AWWA-WPCF. American Public Health Association, Washington D. C.
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16. Methodology for Water analysis by M. S. Kodarkar. Indian Association of Aquatic Biologists (IAAB), Hyderabad
17. Hand book on The Methods of Water Quality Assessment by Dept. of Limnology and Fisheries, Rajasthan College of Agriculture, Rajasthan Agricultural University, Udaipur
18. A Course Manual on Water and Waste Water Analysis by B. B. Sundaresen. National Environmental Engineering Research Institute, Nagpur

19. Estuarine Biological Methods by K. V. Rama Rao, E. V. Muley, M. B. Raghunathan and A.K. Karmakar. Estuarine Biological Station, Zoological Survey of India, Berhampur (GM), Orissa.
20. Methods of Hydrobiology (Freshwater Biology) by JurgenSchwoerbel. Pergamon Press, Oxford
21. A Manual of Freshwater Ecology by R. Santhanam, P. Velayuthan and G. Jegatheesn. Daya Publishing House, Delhi
22. Fresh Water Animals of India by G. T. Tonapi. Oxford & IBH Publishing Co. Delhi
23. Fresh Water Biology, 2nd edition (1992) by W. T. Edmondson. International Books & Periodicals Supply Service, New Delhi
24. Freshwater Zooplankton of India by S. K. Battish. Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi

INSTITUTE OF SCIENCE, NAGPUR

(An Autonomous Institute of Government of Maharashtra)

(To be implemented from 2024-25)

B. Sc. Semester-VII Zoology (Honors)

Course category: DSC

Course code: B-ZOH471T

Paper–I: Biotechnology

Total Credits: 4 Hours: 60

Course objectives:

1) To study biotechnological methods such as gene cloning, recombinant technology, animal cell culture and stem cell culture.
2) To make students aware about vectors, primary cell line, viability and cytotoxicity
3) To study applications of biotechnology

Course outcomes:

1) Students will be able to understand concept of gene cloning and cell culture
2) They will be with required knowledge of biotechnological applications, advantages and disadvantages
3) They will come to know about bioaccumulation and biomagnifications of toxicants and sources of energy

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Unit-I

1.1. Introduction to Biotechnology: Definition, Applications, Advantages and disadvantages.

1.2. Gene cloning: Basic steps of gene cloning- amplification and/or heterologous gene expression, Expression of cloned genes: General features of an expression vector. Expression of a eukaryotic gene in prokaryotes.

1.3. Recombinant technology: Polymerase chain reaction, designing of primers for PCR.

1.4. Vectors: concept, types of vectors (plasmids, phage, virus), Essential qualities that a vector must possess. Types of vectors: pBR322, cosmids, lambdaphage, Transformation and Transfection.

Unit-II

2.1. Animal Cell Culture: Equipments and materials for animal cell culture technology. Various systems of tissue culture, their distinguishing features, advantages and limitations.

2.2. Culture medium: natural media, synthetic media, sera. Introduction to balanced salt solutions and simple growth medium.

2.3. Characteristics of cells in culture: Contact inhibition, anchorage dependence, cell-cell communication etc.; Cell senescence; cell and tissue response to trophic factors.

2.4. Primary Culture: Behavior of cells, properties, utility. Explantculture; suspension culture,

Unit-III

3.1. Established cell line cultures: Definition of cell lines, maintenance and management; cell adaptation.

3.2. Measurement of viability and cytotoxicity. Cell cloning, cell synchronization and cell manipulation. Various methods of separation of cell types, advantages and limitations; flow cytometry.

3.3. Scaling up of animal cell culture. Cell transformation.
3.4. Stem cell cultures, embryonic stem cells and their applications. Somatic cell genetics.

Unit-IV

4.1. Insulin, Somatostatin, production of human proteins and drugs, recombinant vaccines, production of transgenic animals, human gene therapy.
4.2. Xenobiotic and recalcitrant compounds. Bioaccumulation and biomagnification. Assessment of water andwaste water quality: Concept of COD, DO and BOD. Indicators of faecal pollution and MPN and MF technique for coliforms. Significance and principal of IMViC.
4.3. Energy & Biofuels: Non-conventional or renewable sources of energy, Energy from Biomass, Biofertilizers, Biopestisides, Biosensors and biochips, Biofilters, Biofuel cells.
4.4. Bioinformatics: Basic concepts, databases, applications.

B. Sc. Semester-VII Zoology (Honors)

Course category: DSC

Course code: B-ZOH472T

Paper–II: Biotechniques and Biostatistics

Total Credits: 4 Hours: 60

Course objectives:

1) To study various microbial, cell culture and cryotechniques.
2) To study molecular separation, isotope techniques, centrifugation methods.
3) To know about biostatistical applications in biology.
4) To represent the data by table, diagrams and graphs.

Courseoutcomes:

1) Students will be able to handle microbial culture, centrifugation, colorimetry or spectrophotometry operations.
2) By taking random samples they will be able to generate statistical data for estimation
3) They will be able to compute biological data by using various statistical methods.

Unit-I

1.1. Design and functioning of tissue culture laboratory
1.2. Microbial techniques: Sterilization methods, media preparation for microbial culture, inoculation methods and growth monitoring.
1.3. Cell culture techniques: Animal cell & tissue culture-primary culture, celllines, cell quantification, growth kinetics of cells in culture, cryopreservation of cells
1.4. Cryotechniques: Cryopreservation of cells, tissues and organs, cryotechniques for microscopy, Freeze drying techniques, lyophilization.

Unit-II

2.1. Basic principle of sedimentation and centrifugation, centrifugation methods
2.2. Basic Principle and Application of Colorimetry and Spectrophotometry, Beer-Lambert's Law.
2.3. Radioactive isotopes and mass isotope techniques in biology, sample preparation for radioactive counting. Autoradiography, Metabolic labeling.

2.4. Separation techniques in biology: Molecular separation by chromatography, electrophoresis, cell separation by flow cytometry.

Unit-III

3.1. Introduction to biostatistics: definition, scope, sources of data, collection of data,

3.2. Sampling theory and Sampling methods: non probability (convenience, purposive & quota) and probability or random (simple, stratified, systematic, cluster & multistage) sampling methods.

3.3. Representation of data by Frequency distribution table, diagrams (simple bar, component bar, multiple bar & pie) and graphs (histogram, frequency polygon, frequency curve & ogive curves).

3.4. Measures of Central tendency-mean, mode and median; Measures of Dispersion- range, mean deviation, variance and standard deviation. Standard error (SE).

Unit-IV

4.1. Correlation and regression: scatter diagram, simple correlation, simple linear regression, multiple linear regression

4.2. Probability and probability distribution: Basic concepts and types of probability and probability distributions- binomial, Poisson and normal distribution.

4.3. Hypothesis testing- Steps, significance tests: z-test, t-test, Chi square test and F- test (Analysis of variance-ANOVA)

4.4. Basic Experimental designs: basic principles, commonly used basic designs- CRD, RBD & LSD

References for Biotechnology:

1. George Patrinos and Wilhelm Ansorage, Molecular Diagnostics, 1st Edition, Academic Press, 2005.
2. Willey J. Prescott, Harley, and Klein's Microbiology-7th international ed./ Joanne M. Willey, Linda M. Sherwood, Christopher J. Woolverton. NewYork: McGraw-Hill Higher Education; 2008.
3. Lela Buchingham and Maribeth L Flawsm, Molecular Diagnostics: Fundamentals ,Methods and Clinical Applications, 1st Edition, FA Davis Company, Philadelphia, USA, 2007.
4. Campbell, M.A and Heyer L. J. ,Discovering Genomics, Proteomics and Bioinformatics, 2nd Edition, CSHL Press, Pearson/ Benzamin Cummings San Francisco, USA, 2007.
5. Andrew Readand Dian Donnai, New Clinical Genetics, Scion Publishing Ltd, Oxfordshire, UK, 2007.
6. Pamela Greenwell, Michelle McCulley, Molecular Therapeutics: 21st century medicine, 1st Edition, Sringer, 2008.
7. Primrose S & Twyman R, Principles of Gene Manipulation and Genomics, 7th Edition, Blackwell, 2006.
8. H. Rehm, Protein Biochemistry and Proteomics, 4th Edition, Academic Press, 2006.
9. Norris, Deborrah. Clinical Research Coordinator Handbook. Plexus Pub, 2009.
10. Portney, Leslie Gross, and Mary P. Watkins. Foundations of clinical research: applications to practice.Vol. 2. Upper Saddle River, NJ: Prentice Hall,2000.
11. Stone, Judy. Conducting clinical research: Apractical guide for physicians, nurses, study coordinators, and investigators. Mountainside MD Press, 2006.
12. Glasser, Stephen P., and P. Glasser. Essentials of clinical research. Springer, 2008.

References for Biotechniques and Biostatistics:

Biotechniques-

1. Boyer, R. (2000) Modern Experimental Biochemistry (3rd edition) Benjamin-Cummings.
2. Pearse, A.G.E. (1980-1993) Histochemistry - Theoretical and applied, Volume I-III, Churchill-Livingstones.
3. Plummer, D. (2017) An Introduction to Practical Biochemistry (3rd edition) McGraw Hill.
4. Wilson, K. and Walker, J. (2010) Experimental Biochemistry, Cambridge.

Biostatistics-

1. Banergee, P. K. (2013). Introduction to Biostatistics- A textbook of Biometry. S. Chand & Company Ltd. New Delhi.
2. Rao. K. S. (2010). Biostatistics for Health and Life Sciences. Himalayta Publishing House, New Delhi.
3. Jasra P. K. and Gurdeep Raj (2000). Biostatistics. KRISHNA Prakashan Media 9P) Ltd. Meerut, U. P.
4. Dutta N. K. (2002). Fundamentals of Biostatistics- Practical Approach. Kanishka Publishers & Distributors, New Delhi.

B. Sc. Semester-VII Zoology (Honors)

Course category: DSE

Course code: B-ZOH473T

Paper–Elective1: Animal Physiology-I (Physiology of Digestion & Excretion)

Total Credits: 4 Hours: 60

Course objectives:

To understand the anatomy and physiology of digestive and excretory system.

Courseoutcomes:

After completing this course, students will know-

1) Histology of salivary gland and other glands of digestive system.
2) Histology of intestine and intestinal glands.
3) Mechanism and physiology of digestion.
4) Functional anatomy of kidney and mechanism of urine formation.
5) Regulation of urine and body fluid concentration and volume.

Unit-I

1.1. Histology of salivary glands, Mechanism of salivary secretion, composition and functions of saliva.

1.2. Histology of stomach, mechanism of secretion of gastric juice, composition and functions of gastric juice.

1.3. Histology of pancreas, mechanism of pancreatic secretion, composition and functions of pancreatic juice.

1.4. Histology of liver, bile secretion, its composition and functions.

Unit-II

2.1. Histology of small and large intestine, intestinal glands, its secretion and control, intestinal bacteria.

2.2. Neural and endocrine regulation of gastrointestinal movements and secretions.

2.3. Gastrointestinal hormones- Synthesis, chemical structure and functions**.**
2.4. Digestion and absorption of proteins, carbohydrates and fats in the gastrointestinal tract.

Unit-III
3.1. Functional anatomy of kidney.
3.2. Mechanism of formation of urine.
3.3. Normal and abnormal constituents of urine.
3.4. Mechanism of concentration and dilution of urine– The Counter current system.

Unit-IV
4.1. Regulation of urine and body fluid concentration and volume, hormonal mechanism of Antidiuratic hormone ,Aldosterone and Renin– Angiotensin system in renal physiology.
4.2. Regulation of water, electrolytes and acid base, renal clearance.
4.3. Physiology of nitrogen excretion
4.4. Renal failure.

B. Sc. Semester-VII Zoology (Honors)

Course category: DSE

LAB Elective1: Animal Physiology-I (Physiology of Digestion & Excretion)

Practicals:

I. Physiology Experiments

1 Effect of pH, temperature, and incubation on human salivary amylase activity.
2 Determination of:-
   a) Clotting time, bleeding time.
   b) Erythrocyte sedimentation rate and
   c) Haemoglobin concentration.
3 Determination of protein, glucose in Urine.

II. Quantitative Analysis

1 Estimation of blood Glucose (Source of blood: Local recognized pathology laboratory)
2 Estimation of blood proteins (Source of blood: Local recognized pathology laboratory)
3 Estimation of blood cholesterol (Source of blood: Local recognized pathology laboratory)
4 Estimation of blood Sodium, potassium, Calcium (Source of blood: Local recognized pathology laboratory)

III. Qualitative Analysis

1 Normal & abnormal constituents of human urine.
2 Blood group detection by antisera.
3 Preparation and study of Urine crystals.

IV. Histological Study of Stomach, Liver, Small intestine, Large intestine, Pancreas, Kidney, with the help of already available permanent slides /ICT tools/ charts/ photographs etc.

REFERENCES:

1. A. G. Giese: "Cell Physiology" (3rd Ed) Saunders, Toppan
2. Gerald Karp: "Cell Biology" McGraw Hill Kogakusha Ltd.
3. Darnell, Loddish, Baktimore: "Molecular Cell Biology" Scientific American Books.
4. C. A. Keil, E. Neil & E.N. Joeb (1982): "Samson Wright, Applied Physiology" Oxford Univ. Press.
5. R. Eckert & D. Randall (1982): "Animal Physiology: 2nd Ed." W. H. Freeman & Co.
6. W. A. Hoar (1982): "General & Comparative Animal Physiology 3rd Ed." Prentice Hall Inc.
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B. Sc. Semester-VII Zoology (Honors)

Course category: DSE

Course code: B-ZOH474T

Paper–Elective2: Fish and Fisheries-I (Fish Biology)

Total Credits: 4 Hours: 60

Course objectives:

1) To study the origin, evolution, classification, and general characters of fishes.
2) To know the accessory respiratory organs in fishes.

Courseoutcomes:

After completion of this course students will gain the knowledge about:

1) Origin and evolution of fishes.
2) Classification, general characters and affinities of Elasmobranchs, Chondrichthyes, Holocephali, Actinopterygii and Crossopterygii.
3) Classification, general characters and affinities of Dipnoi.
4) Accessory respiratory organs and mechanism of air breathing in fishes.

Unit-I

1.1. Origin and Evolution of fishes: Evolutionary classification, ostracoderms and cyclostomes, placoderms, Cartilaginous fishes, Bony fishes
1.2. Jaw suspension and origin of paired fins.
1.3.Classification and general characters of Placoderms: Acanthodii, Coccostei, Pterychthyes, Stegoselachii, Palaeospondyli.
1.4. Affinities of Ostracoderms and Cyclostomes

Unit-II

2.1.Classification and general characters of Elasmobranch /Chondrichthyes: Sharks and Rays, Holocephali
2.2. Affinities and specialized characters of Holocephali.
2.3. Classification and general characters of Actinopterygii/ Ray finned fishes: Palaeonisciformes, Polypteriformes, Acipenseriformes, Amiiformes,Teleostea (Osteoglossomorpha, Elopomorpha, Clupeomorpha, Euteleostei)
2.4. Affinities of Crossopterygians.

Unit-III

3.1. Dipnoi: General characters, classification, fossil Dipnoians and distribution of Dipnoians.
3.2. Specialized characters and affinities of Dipnoians, Blood vascular system of Protopterus.
3.3. Respiratory system: Structure of gillsin fishes, gillhistology
3.4. Blood supply of a gill and mechanism of respiration in teleosts.

Unit-IV

4.1. Accessary respiratory organs: skin, buccopharynx, alimentary canal, opercular cavity and air bladder. Origin of and significance of air breathing organs.
4.2. Mechanism of air breathing, function of accessory respiratory organ.
4.3. Airbladder: Origin and evolution, types of air bladder-physostomous, physoclistous, structure of bladder wall and gas secreting complex.
4.4. Blood supply to air bladder and functions of air bladder

B. Sc. Semester-VII Zoology (Honors)
Course category: DSE
LAB Elective2: Fish and Fisheries-I (Fish Biology)

Practicals:

1. Identification of commercially important fishes up to species.
2. Anatomical observations, demonstration and detailed explanation of general anatomy of fish, urino-genital system and Endocrine glands with the help of ICT tools/ models/ charts/ photographs etc.
3. Study of cranial nervesin *Wallago* and *Labeo* with the help of already available permanents lides/ ICTtools/ models/ charts/ photographs etc.
4. Identification of various developmental stages of carps- spawn, fry and fingerlings of major carps with the help of already available preserved material, permanent slides/ charts/ models / photographs/ ICT tools etc.
5. Study of morphometric and meristic characteristics of fish (Source of fish blood: Local recognized fish markets).

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B. Sc. Semester-VII Zoology (Honors)

Course category: DSE

Course code: B-ZOH475T

Paper–Elective3: Mammalian Reproductive Physiology-I

(Reproductive Process in Male)

Total Credits: 4 Hours: 60

Course objectives:

To introduce students to the physiology of male reproductive system.

Courseoutcomes:

Students on completion of this course, will be able to:

1) Understand the structure, functions of Sertoli cells, Leydig cells , Epididymis and sperm.

2) Students will understand Spermatogenesis and spermiogenesis, Sperm capacitation, decapacitation.

3) Understand the structure and function of vas deferens, seminal vesicle, prostate gland, Cowper's gland and Penis.

4) Male reproductive behavior.

5) Infertility causes and remedy

Unit-I

1.1. Development, descent and structure of the testis.

1.2.Spermatogenesis: Molecular changes, hormonal regulation, and spermiogenesis.

1.3. Sertolicells: Structure, functions, blood testis barrier.

1.4. Leydig cells: Structure, functions and interaction with peritubular and Sertoli cells.

Unit-II

2.1. Epididymis: Structure and function.

2.2. Structure of spermatozoa and anomalies.

2.3. Sperm capacitation: molecular and biochemical changes, decapacitation.

2.4. Vasdeferens: Structur eand function.

Unit-III

3.1. Seminal Vesicle: Structure, function and regulation.

3.2. Prostategland: Structure, function and prostatic cancer.

3.3. Cowpers gland: Structure, function and anomalies.

3.4. Penis: Structure and mechanism of erection.

Unit-IV

4.1. Male reproductive behaviour: Mating system, neural and hormonal control.

4.2. Pheromones:types, structure and function.

4.3. Infertility: causes and remedy.

4.4. Andrologically relevant diseases inadvancedage.

B. Sc. Semester-VII Zoology (Honors)

Course category: DSE

LAB Elective3: Mammalian Reproductive Physiology-I

(Reproductive Process in Male)

Practicals:

1. Demonstration of surgical operation in rat/ mice Orchidectomy or Vasectomy or Epididymoctomy with the help of ICT tools
2. Anatomical observations, demonstration and detailed explanation of the male reproductive system of rat/ mice with the help of ICT tools/ models/ charts/ photographs etc.
3. Sperm count for the assessment of fertility (Source of semen: Government artificial insemination centre).
4. Study of spermatogenesis and identification of its various stages with the help of already available permanent slides /ICT tools/models/ charts/ photographs etc.
5. Estimation of fructose/ sialic acid in reproductive tissue using animal wastes from recognized slaughter houses /poultry farm setc.
6. Experimental studies (histological slides for identification) of the following with the help of already available permanents lides/ ICT tools/ models/ charts/ photographs etc.
   a. Effects of castration and androgen replacement on sex accessory glands
   b. Effects of anti-androgen on testis and sex-accessory glands
   c. Effect of anti-cancer drugs on testis and sex-accessory glands, different duration and different regimen studies
   d. Effect of heavy metals on testis and sex accessory glands
7. Histology: Histological changes in male reproductive organs and sex accessories during active and inactive stage with the help of already available permanent slides/ ICT tools/models/ charts/photographs etc.
8. Study of following endocrine glands with the help of already available permanent slides /ICT tools/ models/ charts /photographs etc.
   a. Pituitary gland: anatomy, cell types and identification of cell types
   b. Thyroid gland: Histology of active and inactive glands, effects of anti thyroid drugs
   c. Adrenal: Normal histology and effects of meta pyrone and cortico steroids administration
9. Field Work:Visit to Artificial insemination centre and submission of report.

REFERENCES:

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B. Sc. Semester-VII Zoology (Honors)

Course category: DSC/DSE

Course code: B-ZOH476P

LAB: (Based on Paper-I + II + Elective)

Total Credits: 6 Hours: 30

Course objectives:

1) To design the biotechnological laboratory.
2) To perform the experiments on microbial culture, cell culture and molecular separation techniques.
3) To represent the data by diagram and graphs by using computer.

Courseoutcomes:

1) Students can perform their practical work related to techniques in biology independently.
2) They will be liable to analyse the biostatistical data at their own.
3) They will understand and apply various significance tests.

Section A: Biotechnology

1) Preparation of animal cell culture media.
2) Immobilization of cells/ enzymes

3) Antigen–antibody reaction– determination of Blood group
4) Agarosegel electrophoresis of tissue extract.
5) Estimation of proteins by Lowry's and Bradford method.
6) Demonstration of technique of PCR Demonstration of DNA: Feulgen's reaction (Source of tissue: Animal wastes from local recognized slaughterhouses/ poultry forms/ fish markets etc.)
7) Demonstration of DNA: RNA: Methyl Green- Pyronin reaction (Source of tissue: Animal wastes from local recognizeds laughter houses/ poultry forms /fish markets etc.)
8) Histochemical analysis of alkaline phosphatase (Source of tissue: Animal wastes from local recognized slaughter houses/ poultry forms /fish markets etc.)
9) Histochemical analysis of acid phosphatase (Source of tissue: Animal wastes from local recognizeds laughter houses/ poultry forms/ fish markets etc.)
10) Demonstration of separation of amino acids by paper chromatography and TLC
11) Computer aided statistic alanalysis
12) Computer presentation of statistical data, charts and diagrams

Section B: Biotechiques and Biostatistics

Biotechniques-

1) Section cutting of tissue by using freezing microtome.
2) Preparation of media and cultivation of microorganisms.
3) Observation of various microbial colonies on culture plates
4) Demonstration of Gram positive and Gram-negative bacteria.
5) Bacterial motility test by hanging drop method.

Biostatistics-

1) Representation of given data by frequency distribution table
2) Calculation of mean, mode and median from given data
3) Calculation of range, mean deviation, sample variance, standard deviation and standard error from given data.
4) Representation of given data by diagrams
5) Representation of given data by graphs
6) Numerical problems on binomial,Poisson and normal distribution.
7) Numerical problems on z- test, t- test, Chi square test and F- test

Scheme of Marking for Practical Examination:

Distribution of Marks: **Max. Marks: 180**

1. Demonstration of electrophoresis of tissue extract/ Paper chromatography 25
2. Antigen-antibody reaction/ Estmation of proteins by Lowry's method 25
3. Statistical analysis of given data/ Representation of given data by diagrams & graphs 25
4. Demonstration of Gram positive and negative bacteria 25
5. Experiment from elective paper 25
6. Experiment from elective paper 15
7. Certified practical record 30
8. Viva voce 10

B. Sc. Semester-VII Zoology (Honors)

Course category: RM

Course code: B-ZOH477T

Paper: Research Methodology

Total Credits: 4 Hours: 60

Course objectives:

1) To familiarize students with basics of research and research process
2) To provide an introduction to research methods and report writings
3) To give insight into various kinds of research design and sampling

Course outcomes:

At the end of the course the students will be able to:

1) Understand the concept of research and different types of research in the context of biology.
2) Have basic awareness of data analysis and hypothesis testing procedures.
3) Develop laboratory experiment related skills.
4) Have basic knowledge on qualitative research techniques.
5) Develop competence on process of scientific documentation.
6) Analyze the ethical aspects of research.
7) Evaluate the different methods of scientific writing and reporting.

Unit-I

1.1. Research Methodology: meaning and objectives of research, types of research, research process, problems encountered by researchers in India.
1.2. Defining Research Problem: definition, selecting the problem, necessity of defining the problem, techniques involved in defining a problem.
1.3. Research Design: meaning, features of good design, various concepts relating to research design, different research designs.
1.4. Experimental Designs: concepts, basic principles of experimental designs, important experimental designs and their uses.

Unit-II

2.1. Sampling: definition, sampling theory, types of sampling, concept of standard error, sample size and its determination.
2.2. Analysis of Data: types of analysis, role of statistics in research, correlation concept and types, coefficient of correlation, regression concept and types, time series analysis-components, methods of measuring trend.
2.3. Hypothesis Testing: meaning of hypothesis, basic concepts of hypothesis testing, procedure for hypothesis testing.
2.4. Tests of Hypothesis (Tests of Significance): parametric and nonparametric tests, important parametric tests: z-test, t-test, chi-square test and F-test.

Unit-III

3.1. Analysis of Variance (ANOVA): meaning, basic principle of ANOVA, Techniques of analysis of variance, working procedure or steps for ANOVA.
3.2. Probability: definition, basic concepts, theorems of probability, important theoretical distributions and their applications.
3.3. Measures of central location, objectives and types of averages, Measures of variation or variability.
3.4. Analysis of frequencies, graphical representation of ungrouped and grouped data, advantages of graphical representation.

Unit-IV

4.1. Interpretation and Report Writing: precautions for correct interpretation, significance of report writing, different steps in writing report, types of reports, oral presentation, set rules and precautions for writing reports.

4.2. Computers in Research: classification and generations of computers, important applications of computers in research, basics of word processing software-MS Office, internet, mail and file transfer protocol (FTP).

4.3. Intellectual Property Rights (IPR): intellectual property rights and patent law, commercialization, copy right, royalty, trade related aspects of intellectual property rights.

4.4. Ethics in research: ethical issues, ethical committees, CPCSEA guidelines for animals use in research, Plagiarism- definition, different forms, consequences, unintentional plagiarism.

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INSTITUTE OF SCIENCE, NAGPUR

(An Autonomous Institute of Government of Maharashtra)
(To be implemented from 2024-25)
B. Sc. Semester-VIII Zoology (Honors)
Course category: DSC
Course code: B-ZOH481T
Paper–I: Biodiversity and Conservation

Total Credits: 4 Hours: 60

Course objectives:
1) To orient students about rich heritage of Biodiversity of India and make them understand significance of its conservation.
2) To generate qualified students who can directly get jobs in the allied fields of Biodiversity, Conservation and Wildlife Management.
3) To generate a team of postgraduates who can take up jobs related to the environment in educational institutions.
4) To create awareness about Biodiversity and Nature Conservation.

Course outcomes:
Students would appreciate treasure of Biodiversity, its importance and hence would contribute their best for its conservation.

UNIT I
1.1. Biodiversity: Definition, Concept, Types and Values.
1.2. Indian Biodiversity: Zones of Faunal distribution, Major protected areas & their importance.
1.3. Natural History of Fauna of India- Major flora & Fauna Natural History of Western Ghats - Major Fauna Methods of recording Natural History of a place. Resident, Migrant, Vagrant species
1.4. Global Biodiversity: Major Biodiversity areas of the world and Biodiversity Hot Spots

UNIT II
1.1 Human –wildlife interactions: Conservation Vsprotection; Concept of Buffer zones, Wildlife corridors Strategies to reduce human-wildlife interactions.
2.2. Role of Government and NGOs in controlling human-wildlife interactionsSocio-economicissuesrelatedtohuman-wildlife interactions
2.3. Wildlife parks, wildlife reserves, privately owned wildlife reserves & Biosphere reserves Single species / single habitat-based conservation programmes (e.g. Project tiger)
2.4. Ex-situ & in-situ conservation. Conservation Breeding (e.g.Vulture, Pygmy hog, Gharial etc.)

UNIT III

3.1. Role of NGOs in conservation: International NGOs; UNEP, GEF, WCS, Bird Life International Important NGOs in India & their contributions WWF, ATREE, BNHS, WTI, Kalpavriksha etc.

3.2. Molecular Techniques – Genomics (General concepts & applications): Extraction of DNA from samples PCR & RTPCR DNA sequencing DNA fingerprinting Southern Blotting and its applications

3.3. Molecular Techniques – Proteomics (General concepts & applications) Extraction & Evaluation of Proteins, Protein Fingerprinting (e.g.Venomproteins, Plantproteins) Western Blotting and its applications

3.4. Analysis of Animal tracks & signs (General concepts): Tracking Large mammals Studying & analyzing Animal Tracks & signs

UNIT IV

4.1. Management of Protected areas: Principles of wildlife management, Wildlife management techniques

4.2. People's participation in managing protected areas: Integrating Local Community in conservation (e.g. Kaziranga, Eagle's Nest).

4.3. Wildlife Tradeand Laws: Wildlife protection Act of India CITES, TRAFFIC, RED Data Book, Measures to control poaching & wildlife trade

4.4. Regulations & Acts related to protected areas: General concepts of Private forests, Reserve forests, Sanctuaries, National Parks,Wildlife reserves, Coastal Regulation Zone, Protected Areas Network

B. Sc. Semester-VIII Zoology (Honors)
Course category: DSC
Course code: B-ZOH482T
Paper–II: Microtechnique

Total Credits: 4 Hours:60

Course objectives:

1) To study the process of microtechnique for organ histology of animals.

Courseoutcomes:

After completion of this course, students will-

1) Perform microtechnique process independently.
2) Able to work in pathological laboratory
3) Know the idea about histological structure

Unit-I

1.1. Introduction and importance of microtechnique.

1.2. Collection and preparation of material.

1.3. Laboratory procedures for the use of collected material.

1.4. Fixation and fixatives: Formalin, acetone, Carnoy's fluid, Bouin's fluid,

Unit-II

2.1. Washing and dehydration of material, preparation of alcoholic grades
2.2. Clearing and clearing agents: Xylol, benzene, clove and cedar wood oil
2.3. Wax embedding, block making and trimming of block.
2.4. Microtomes-Rocking, Rotary and Freezing microtomes

Unit-III

3.1. Section cutting, Honing and stropping of knife,
3.2. Affixing, processing and spreading sections; labeling slides.
3.3. Difficulties encountered during section cutting- their causes and remedies
3.4. Dehydration of sections for staining

Unit-IV

4.1. Staining: Principles of staining, types of stains, vital staining, H-E staining
4.2. Histochemical techniques for carbohydrates (PAS), proteins (bromophenol blue) and lipids (Sudan black-B).
4.3. Mounting agents: types; DPX, Canada balsam
4.4. Camera lucida drawing

References for Biodiversity and Conservation:

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B. Sc. Semester-VIII Zoology (Honors)
Course category: DSE
Course code: B-ZOH483T
Paper–Elective1: Animal Physiology-II (Physiology of Circulation)

Total Credits: 2 Hours: 30

Course objectives:
1) To learn the anatomy, histology and physiology of heart and cardiac cycle.
2) To know composition, function of blood and lymph, disorders of blood.

Courseoutcomes: By the end of the course, the students should be able to:
1) Understand structure and functioning of heart.
2) Cardiac cycle and cardiac failure.
3) Cellular composition and functions of blood, blood disorders.
4) Lymph – composition, formation and functions, Haemostasis.

Unit-I
1.1. Types of heart (Myogenic and Neurogenic).
1.2. Anatomy, histology and nerve innervations of the heart, heart valves.
1.3. Pacemaker and specialized conducting fibers.
1.4. Blood pressure and factors affecting blood pressure.

Unit-II
2.1. Cardiac cycle, Electrocardiogram (ECG).
2.2. Cardiac output, heart sound.
2.3. Haemodynamics.
2.4. Cardiac Failure.

Unit-III
3.1. Cellular composition and functions of blood.
3.2. Blood groups and Blood transfusion.
3.3. Blood sugars–Causes and control of hypoglycemia and hyperglycemia
3.4. Blood lipids-Causes and control of hypolipidimia and hyperlipidimia

Unit-IV
4.1. Plasmaproteins- Albumins, globulins.
4.2. Haemostasis, Cascade of biochemical reactions in valves in coagulation of blood.
4.3. Transport of O_2 & CO_2 by blood.
4.4. Lymph–composition, formation and functions.

B. Sc. Semester-VIII Zoology (Honors)
Course category: DSE
LAB Elective1: Animal Physiology-II (Physiology of Circulation)

Total Credits: 2 Hours:30

Practicals:

I. Physiology Experiments

1 Study of structure of RBCs invertebrates with the help of already available permanent slides/ ICT tools/ models /charts/ photographs etc.
2 Determination of protein, glucose in Urine from diabetic patient.
3 Total leukocyte count and differential leukocyte count.
4 Total erythrocyte count.

II. QuantitativeAnalysis

1 Estimation of blood triglycerides (Source of blood: Local recognized pathology laboratory)
2 Estimation of blood alkaline & acid phosphates (Source of blood: Local recognized pathology laboratory).
3 Blood amino-acid separation by TLC Paper chromatography (Source of blood: Local recognized pathology laboratory).

III. QualitativeAnalysis

1 Estimation of serum urea (Source of blood: Local recognized pathology laboratory)
2 Preparation and study of haemin crystals.

IV. Histological Study of Thyroid, Pituitary, Blood smear, Heart, T.S. Vein, T.S. Arterywith the help of alreadyavailablepermanentslides/ICTtools/charts/photographsetc.

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B. Sc. Semester-VIII Zoology (Honors)
Course category: DSE
Course code: B-ZOH484T
Paper–Elective2: Fish and Fisheries-II (Applied Fisheries)

Total Credits: 2 Hours: 30

Course objectives:
1) To make students aware about the applications and economic importance of Fishery Science.

Courseoutcomes: After studying this course the students will be able to:
1) Learn the various fisheries of India and breeding of carps.
2) Understand the culture of Indian and exotic fishes.
3) Know the methods of culture of air breathing fishes, crab, ornamental fishes, sea weeds and Spirulina.
4) Learn the techniques of pearl culture, prawn culture, frog culture.

Unit-I
1.1. Fresh water fisheries of India, Riverine and Reservoir fisheries.
1.2. Estuarine and Marine fisheries of India.
1.3. Breeding of Indian Major carps: i) Natural breeding, ii) Induced breeding, iii) Methods of obtaining fish seed from natural resources.
1.4. Neuroendocrine control of carp reproduction.

Unit-II
2.1. Culture of Indian and exotic fishes– Composite culture, Common carp culture
2.2. Monoculture, Monosex culture.
2.3. Integrated Fish farming with –Poultry, Duck, Pig and Paddy.
2.4. Sewage fed fisheries

Unit-III
3.1. Culture of air breathing fishes
3.2. Troutculture
3.3. Ornamental fish culture: i) Oviparous, ii) Live bearers.
3.4. Culture of sea weeds and Spirulina.

Unit-IV
4.1. Pearlculture: fresh water and marine pearl oysters, culture methods.
4.2. Crabculture.
4.3. Prawn culture (Life cycle and breeding)
4.4. Frog culture

B. Sc. Semester-VIII Zoology (Honors)
Course category: DSE
LAB Elective2: Fish and Fisheries-II (Applied Fisheries)

Total Credits: 2 Hours: 30

Practicals:

1. Permanent preparation of various scales using wastes from recognized fish markets.
2. Estimation of dissolve oxygen in water sample.
3. Estimation of CO_2 in water sample.
4. Estimation of chloride in water sample.
5. Estimation of protein in muscles / blood of fish (Source of fish blood: Local recognized fish markets).
6. Determination of free fatty acids (FFAs) in fish oil.

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B. Sc. Semester-VIII Zoology (Honors)
Course category: DSE
Course code: B-ZOH485T
Paper–Elective3: Mammalian Reproductive Physiology-II
(Reproductive Process in Female)

Total Credits: 2 Hours: 30

Course objectives:
To introduce students to the physiology of female reproductive system.

Courseoutcomes: Students on completion of this course will be able to:
1) Study the ovary and female genital tract, the process of folliculogenesis.
2) Understand the oestrous cycle in mammals, menstrual cycle and menopause in female.
3) Study the histology and function of corpus luteum and structure of oviduct, uterus.
4) Understand the structure, functions of cervix and vagina.
4) Study the role of prostaglandins in reproduction, anatomy and growth of mammary glands.

Unit-I
1.1. Differentiation of the ovary and female genital tract.
1.2. The process of folliculogenesis and its hormonal control.
1.3. Recruitment, selection, dominance of follicle and signaling for ovulation.
1.4. Follicle wall: Theca, differentiation, steroid hormone synthesis (2-gonadotropin, 2-cellconcept).

Unit-II
2.1. Estrous cycle in mammals.
2.2. Menstrual cycle and Menopause.
2.3. Mechanism and hormonal control of ovulation.
2.4. Corpusluteum: histogenesis, function, maintenance and luteolysis.

Unit-III
3.1. Oviduct: structure, regional differentiation, and function.
3.2. Uterus: Types, abnormalities.
3.3. Cervix- structure, functions.
3.4. Vagina- structure, function, detection of various stages of oestrous cycle by vaginalcytology, vaginalplug.

Unit-IV
4.1. Onset of puberty and delayed puberty.
4.2. Prostaglandins and their role in reproduction.
4.3. Anatomy and growth of mammary glands.
4.4. Lactogenesis and galactopoiesis.

B. Sc. Semester-VIII Zoology (Honors)
Course category: DSE
LAB Elective3: Mammalian Reproductive Physiology-II
(Reproductive Process in Female)

Total Credits: 2 Hours: 30

Practicals:

1. Demonstration of surgical operation in rat/ mice Ovariectomy or Tubectomy with the help of ICT tools
2. Anatomical observations, demonstration and detailed explanation of the female reproductive system of rat/ mice with the help of ICT tools/ models/ charts/ photographs etc.
3. Study of Oogenesis and identification of its various stages with the help of already available permanent slides/ ICT tools/ models/ charts/ photographs etc.
4. Experimental studies (histological slides for identification) of the following with the help of already available permanent slides /ICT tools/ models /charts/ photographs etc.
   a. Effect of anti-cancer drugs on ovary
   b. Effect of heavy metals on ovary
5. Histology: Histological changes in female reproductive organs and sex accessories duringactive and inactive stage with the help of already available permanent slides/ ICT tools /models/ charts/ photographs etc.
6. Study of following organs with the help of already available permanent slides/ ICT tools/ models/ charts/ photographs etc.
   a. Uterus: anatomy, cell types and identification of estrous types
   b. Mammary glands: Histology of active and inactive glands

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B. Sc. Semester-VIII Zoology (Honors)
Course category: DSC/DSE
Course code: B-ZOH486P
LAB: (Based on Paper-I + II + Elective)

Total Credits: 6 Hours: 30

Practicals:

Section A: Biodiversity and Conservation

1. Field visits to nearby Zoo, Museum, Forest, Nursery, Aquaria or any other relevant site must be arranged. The report of these visits to be submitted.
2. Adaptations in animals: use pictures or photographs with suitable labels.
3. Application of transacts and quadrants in Simulated pictures/ photographic sheets for data collection. Record & tabulate the data.
4. 4. Using a suitable hand-held camera photograph wild animals, birds and insects to record diagnostic features and Take 5"X 7" prints on photo papers.
5. Collect matured leaves (minimum hundred for a class) from two different plants (e.g. Mango tree & False Ashoka). Measure and record the length (in cm.) along the midrib using a flexible thread. Tabulate the data, make frequency polygon, apply "t" test to the data and comment on the significance of the deference in leaf length between the two plant species.
6. Using photographs/ paintings/ coloured drawings identify and study ecological role of characteristic animal species (major representative species only) of various Biomes.
7. Study of animal architecture (photographs/ diagram/ abandoned specimen); Hive of honeybee, nest of paper wasp, nest of potter wasp, Mount of termite, Nests of Weaver Bird and tailor bird.
8. On a geographic map of India locate & demarcate major sanctuaries/ national parks.

Section B: Microtechnique

1. Collection and fixation of tissue
2. Washing, dehydration and clearing of tissue
3. Wax embedding and block making
4. Trimming of block, section cutting and spreading of sections on slides
5. Double staining by Haematoxylin and Eosin, permanent preparation of slides
6. Vital staining of mitochondria
7. Histochemical demonstration of carbohydrates, proteins and lipids
8. Camera lucida drawing

Scheme of Marking for Practical Examination:

Distribution of Marks	**Max. Marks: 180**
1. Numerical problem on t-test	20
2. Study of vegetation by Quadrat method	20
3. Permanent preparation of H-E staining	20
4. Histochemical demonstration of carbohydrates/ proteins/ lipids	20
5. Experiment from elective paper	15
6. Experiment from elective paper	15
7. Identification and comment on spots (1 to 10)	30
8. Submission of certified practical record and stained slides	30
9. Viva voce	10

INSTITUTE OF SCIENCE, NAGPUR

(An Autonomous Institute of Government of Maharashtra)

(To be implemented from 2024-25)

B. Sc. Semester-VII Zoology (Honors with Research)

Course category: DSC

Course code: B-ZOR471T

Paper–I: Biotechnology

Total Credits: 4 Hours: 60

Course objectives:

1) To study biotechnological methods such as gene cloning, recombinant technology, animal cell culture and stem cell culture.
2) To make students aware about vectors, primary cell line, viability and cytotoxicity
3) To study applications of biotechnology

Course outcomes:

1) Students will be able to understand concept of gene cloning and cell culture
2) They will be with required knowledge of biotechnological applications, advantages and disadvantages
3) They will come to know about bioaccumulation and biomagnifications of toxicants and sources of energy

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Unit-I

1.1. Introduction to Biotechnology: Definition, Applications, Advantages and disadvantages.

1.2. Gene cloning: Basic steps of gene cloning- amplification and/or heterologous gene expression, Expression of cloned genes: General features of an expression vector. Expression of a eukaryotic gene in prokaryotes.

1.3. Recombinant technology: Polymerase chain reaction, designing of primers for PCR.

1.4. Vectors: concept, types of vectors (plasmids, phage, virus), Essential qualities that a vector must possess. Types of vectors: pBR322, cosmids, lambdaphage, Transformation and Transfection.

Unit-II

2.1. Animal Cell Culture: Equipments and materials for animal cell culture technology. Various systems of tissue culture, their distinguishing features, advantages and limitations.

2.2. Culture medium: natural media, synthetic media, sera. Introduction to balanced salt solutions and simple growth medium.

2.3. Characteristics of cells in culture: Contact inhibition, anchorage dependence, cell-cell communication etc.; Cell senescence; cell and tissue response to trophic factors.

2.4. Primary Culture: Behavior of cells, properties, utility. Explantculture; suspension culture,

Unit-III

3.1. Established cell line cultures: Definition of cell lines, maintenance and management; cell adaptation.

3.2. Measurement of viability and cytotoxicity. Cell cloning, cell synchronization and cell manipulation. Various methods of separation of cell types, advantages and limitations; flow cytometry.

3.3. Scaling up of animal cell culture. Cell transformation.
3.4. Stem cell cultures, embryonic stem cells and their applications. Somatic cell genetics.

Unit-IV

4.1. Insulin, Somatostatin, production of human proteins and drugs, recombinant vaccines, production of transgenic animals, human gene therapy.
4.2. Xenobiotic and recalcitrant compounds. Bioaccumulation and biomagnification. Assessment of water andwaste water quality: Concept of COD, DO and BOD. Indicators of faecal pollution and MPN and MF technique for coliforms. Significance and principal of IMViC.
4.3. Energy & Biofuels: Non-conventional or renewable sources of energy, Energy from Biomass, Biofertilizers, Biopestisides, Biosensors and biochips, Biofilters, Biofuel cells.
4.4. Bioinformatics: Basic concepts, databases, applications.

B. Sc. Semester-VII Zoology (Honors with Research)

Course category: DSC

Course code: B-ZOR472T

Paper–II: Biotechniques and Biostatistics

Total Credits: 4 Hours: 60

Course objectives:

1) To study various microbial, cell culture and cryotechniques.
2) To study molecular separation, isotope techniques, centrifugation methods.
3) To know about biostatistical applications in biology.
4) To represent the data by table, diagrams and graphs.

Courseoutcomes:

1) Students will be able to handle microbial culture, centrifugation, colorimetry or spectrophotometry operations.
2) By taking random samples they will be able to generate statistical data for estimation
3) They will be able to compute biological data by using various statistical methods.

Unit-I

1.1. Design and functioning of tissue culture laboratory
1.2. Microbial techniques: Sterilization methods, media preparation for microbial culture, inoculation methods and growth monitoring.
1.3. Cell culture techniques: Animal cell & tissue culture-primary culture, celllines, cell quantification, growth kinetics of cells in culture, cryopreservation of cells
1.4. Cryotechniques: Cryopreservation of cells, tissues and organs, cryotechniques for microscopy, Freeze drying techniques, lyophilization.

Unit-II

2.1. Basic principle of sedimentation and centrifugation, centrifugation methods
2.2. Basic Principle and Application of Colorimetry and Spectrophotometry, Beer-Lambert's Law.
2.3. Radioactive isotopes and mass isotope techniques in biology, sample preparation for radioactive counting. Autoradiography, Metabolic labeling.

2.4. Separation techniques in biology: Molecular separation by chromatography, electrophoresis, cell separation by flow cytometry.

Unit-III

3.1. Introduction to biostatistics: definition, scope, sources of data, collection of data,

3.2. Sampling theory and Sampling methods: non probability (convenience, purposive & quota) and probability or random (simple, stratified, systematic, cluster & multistage) sampling methods.

3.3. Representation of data by Frequency distribution table, diagrams (simple bar, component bar, multiple bar & pie) and graphs (histogram, frequency polygon, frequency curve & ogive curves).

3.4. Measures of Central tendency-mean, mode and median; Measures of Dispersion- range, mean deviation, variance and standard deviation. Standard error (SE).

Unit-IV

4.1. Correlation and regression: scatter diagram, simple correlation, simple linear regression, multiple linear regression

4.2. Probability and probability distribution: Basic concepts and types of probability and probability distributions- binomial, Poisson and normal distribution.

4.3. Hypothesis testing- Steps, significance tests: z-test, t-test, Chi square test and F- test (Analysis of variance-ANOVA)

4.4. Basic Experimental designs: basic principles, commonly used basic designs- CRD, RBD & LSD

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B. Sc. Semester-VII Zoology (Honors with Research)

Course category: DSE

Course code: B-ZOR473T

Paper–Elective1: Animal Physiology-I (Physiology of Digestion & Excretion)

Total Credits: 4 Hours: 60

Course objectives:

To understand the anatomy and physiology of digestive and excretory system.

Courseoutcomes:

After completing this course, students will know-

1) Histology of salivary gland and other glands of digestive system.
2) Histology of intestine and intestinal glands.
3) Mechanism and physiology of digestion.
4) Functional anatomy of kidney and mechanism of urine formation.
5) Regulation of urine and body fluid concentration and volume.

Unit-I

1.1. Histology of salivary glands, Mechanism of salivary secretion, composition and functions of saliva.

1.2. Histology of stomach, mechanism of secretion of gastric juice, composition and functions of gastric juice.

1.3. Histology of pancreas, mechanism of pancreatic secretion, composition and functions of pancreatic juice.

1.4. Histology of liver, bile secretion, its composition and functions.

Unit-II

2.1. Histology of small and large intestine, intestinal glands, its secretion and control, intestinal bacteria.

2.2. Neural and endocrine regulation of gastrointestinal movements and secretions.

2.3. Gastrointestinal hormones- Synthesis, chemical structure and functions**.**
2.4. Digestion and absorption of proteins, carbohydrates and fats in the gastrointestinal tract.

Unit-III
3.1. Functional anatomy of kidney.
3.2. Mechanism of formation of urine.
3.3. Normal and abnormal constituents of urine.
3.4. Mechanism of concentration and dilution of urine– The Counter current system.

Unit-IV
4.1. Regulation of urine and body fluid concentration and volume, hormonal mechanism of Antidiuratic hormone ,Aldosterone and Renin– Angiotensin system in renal physiology.
4.2. Regulation of water, electrolytes and acid base, renal clearance.
4.3. Physiology of nitrogen excretion
4.4. Renal failure.

B. Sc. Semester-VII Zoology (Honors with Research)

Course category: DSE

LAB Elective1: Animal Physiology-I (Physiology of Digestion & Excretion)

Practicals:

I. Physiology Experiments

1 Effect of pH, temperature, and incubation on human salivary amylase activity.
2 Determination of:-
   a) Clotting time, bleeding time.
   b) Erythrocyte sedimentation rate and
   c) Haemoglobin concentration.
3 Determination of protein, glucose in Urine.

II. Quantitative Analysis

1 Estimation of blood Glucose (Source of blood: Local recognized pathology laboratory)
2 Estimation of blood proteins (Source of blood: Local recognized pathology laboratory)
3 Estimation of blood cholesterol (Source of blood: Local recognized pathology laboratory)
4 Estimation of blood Sodium, potassium, Calcium (Source of blood: Local recognized pathology laboratory)

III. Qualitative Analysis

1 Normal & abnormal constituents of human urine.
2 Blood group detection by antisera.
3 Preparation and study of Urine crystals.

IV. Histological Study of Stomach, Liver, Small intestine, Large intestine, Pancreas, Kidney, with the help of already available permanent slides /ICT tools/ charts/ photographs etc.

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B. Sc. Semester-VII Zoology (Honors with Research)

Course category: DSE

Course code: B-ZOR474T

Paper–Elective2: Fish and Fisheries-I (Fish Biology)

Total Credits: 4 Hours: 60

Course objectives:

1) To study the origin, evolution, classification, and general characters of fishes.
2) To know the accessory respiratory organs in fishes.

Courseoutcomes:

After completion of this course students will gain the knowledge about:

1) Origin and evolution of fishes.
2) Classification, general characters and affinities of Elasmobranchs, Chondrichthyes, Holocephali, Actinopterygii and Crossopterygii.
3) Classification, general characters and affinities of Dipnoi.
4) Accessory respiratory organs and mechanism of air breathing in fishes.

Unit-I

1.1. Origin and Evolution of fishes: Evolutionary classification, ostracoderms and cyclostomes, placoderms, Cartilaginous fishes, Bony fishes
1.2. Jaw suspension and origin of paired fins.
1.3.Classification and general characters of Placoderms: Acanthodii, Coccostei, Pterychthyes, Stegoselachii, Palaeospondyli.
1.4. Affinities of Ostracoderms and Cyclostomes

Unit-II

2.1.Classification and general characters of Elasmobranch /Chondrichthyes: Sharks and Rays, Holocephali
2.2. Affinities and specialized characters of Holocephali.
2.3. Classification and general characters of Actinopterygii/ Ray finned fishes: Palaeonisciformes, Polypteriformes, Acipenseriformes, Amiiformes,Teleostea (Osteoglossomorpha, Elopomorpha, Clupeomorpha, Euteleostei)
2.4. Affinities of Crossopterygians.

Unit-III

3.1. Dipnoi: General characters, classification, fossil Dipnoians and distribution of Dipnoians.
3.2. Specialized characters and affinities of Dipnoians, Blood vascular system of Protopterus.
3.3. Respiratory system: Structure of gillsin fishes, gillhistology
3.4. Blood supply of a gill and mechanism of respiration in teleosts.

Unit-IV

4.1. Accessary respiratory organs: skin, buccopharynx, alimentary canal, opercular cavity and air bladder. Origin of and significance of air breathing organs.
4.2. Mechanism of air breathing, function of accessory respiratory organ.
4.3. Airbladder: Origin and evolution, types of air bladder-physostomous, physoclistous, structure of bladder wall and gas secreting complex.
4.4. Blood supply to air bladder and functions of air bladder

B. Sc. Semester-VII Zoology (Honors with Research)
Course category: DSE
LAB Elective2: Fish and Fisheries-I (Fish Biology)

Practicals:

1. Identification of commercially important fishes up to species.
2. Anatomical observations, demonstration and detailed explanation of general anatomy of fish, urino-genital system and Endocrine glands with the help of ICT tools/ models/ charts/ photographs etc.
3. Study of cranial nervesin *Wallago* and *Labeo* with the help of already available permanents lides/ ICTtools/ models/ charts/ photographs etc.
4. Identification of various developmental stages of carps- spawn, fry and fingerlings of major carps with the help of already available preserved material, permanent slides/ charts/ models / photographs/ ICT tools etc.
5. Study of morphometric and meristic characteristics of fish (Source of fish blood: Local recognized fish markets).

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B. Sc. Semester-VII Zoology (Honors with Research)

Course category: DSE

Course code: B-ZOR475T

Paper–Elective3: Mammalian Reproductive Physiology-I

(Reproductive Process in Male)

Total Credits: 4 Hours: 60

Course objectives:

To introduce students to the physiology of male reproductive system.

Courseoutcomes:

Students on completion of this course, will be able to:

1) Understand the structure, functions of Sertoli cells, Leydig cells , Epididymis and sperm.

2) Students will understand Spermatogenesis and spermiogenesis, Sperm capacitation, decapacitation.

3) Understand the structure and function of vas deferens, seminal vesicle, prostate gland, Cowper's gland and Penis.

4) Male reproductive behavior.

5) Infertility causes and remedy

Unit-I

1.1. Development, descent and structure of the testis.

1.2.Spermatogenesis: Molecular changes, hormonal regulation, and spermiogenesis.

1.3. Sertolicells: Structure, functions, blood testis barrier.

1.4. Leydig cells: Structure, functions and interaction with peritubular and Sertoli cells.

Unit-II

2.1. Epididymis: Structure and function.

2.2. Structure of spermatozoa and anomalies.

2.3. Sperm capacitation: molecular and biochemical changes, decapacitation.

2.4. Vasdeferens: Structur eand function.

Unit-III

3.1. Seminal Vesicle: Structure, function and regulation.

3.2. Prostategland: Structure, function and prostatic cancer.

3.3. Cowpers gland: Structure, function and anomalies.

3.4. Penis: Structure and mechanism of erection.

Unit-IV

4.1. Male reproductive behaviour: Mating system, neural and hormonal control.

4.2. Pheromones:types, structure and function.

4.3. Infertility: causes and remedy.

4.4. Andrologically relevant diseases inadvancedage.

B. Sc. Semester-VII Zoology (Honors with Research)

Course category: DSE

LAB Elective3: Mammalian Reproductive Physiology-I

(Reproductive Process in Male)

Practicals:

1. Demonstration of surgical operation in rat/ mice Orchidectomy or Vasectomy or Epididymoctomy with the help of ICT tools
2. Anatomical observations, demonstration and detailed explanation of the male reproductive system of rat/ mice with the help of ICT tools/ models/ charts/ photographs etc.
3. Sperm count for the assessment of fertility (Source of semen: Government artificial insemination centre).
4. Study of spermatogenesis and identification of its various stages with the help of already available permanent slides /ICT tools/models/ charts/ photographs etc.
5. Estimation of fructose/ sialic acid in reproductive tissue using animal wastes from recognized slaughter houses /poultry farm setc.
6. Experimental studies (histological slides for identification) of the following with the help of already available permanents lides/ ICT tools/ models/ charts/ photographs etc.
   a. Effects of castration and androgen replacement on sex accessory glands
   b. Effects of anti-androgen on testis and sex-accessory glands
   c. Effect of anti-cancer drugs on testis and sex-accessory glands, different duration and different regimen studies
   d. Effect of heavy metals on testis and sex accessory glands
7. Histology: Histological changes in male reproductive organs and sex accessories during active and inactive stage with the help of already available permanent slides/ ICT tools/models/ charts/photographs etc.
8. Study of following endocrine glands with the help of already available permanent slides /ICT tools/ models/ charts /photographs etc.
   a. Pituitary gland: anatomy, cell types and identification of cell types
   b. Thyroid gland: Histology of active and inactive glands, effects of anti thyroid drugs
   c. Adrenal: Normal histology and effects of meta pyrone and cortico steroids administration
9. Field Work:Visit to Artificial insemination centre and submission of report.

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B. Sc. Semester-VII Zoology (Honors with Research)

Course category: DSC/DSE

Course code: B-ZOR476P

LAB: (Based on Paper-I + II + Elective)

Total Credits: 6 Hours: 30

Course objectives:

1) To design the biotechnological laboratory.
2) To perform the experiments on microbial culture, cell culture and molecular separation techniques.
3) To represent the data by diagram and graphs by using computer.

Courseoutcomes:

1) Students can perform their practical work related to techniques in biology independently.
2) They will be liable to analyse the biostatistical data at their own.
3) They will understand and apply various significance tests.

Section A: Biotechnology

1) Preparation of animal cell culture media.
2) Immobilization of cells/ enzymes

3) Antigen–antibody reaction– determination of Blood group
4) Agarosegel electrophoresis of tissue extract.
5) Estimation of proteins by Lowry's and Bradford method.
6) Demonstration of technique of PCR Demonstration of DNA: Feulgen's reaction (Source of tissue: Animal wastes from local recognized slaughterhouses/ poultry forms/ fish markets etc.)
7) Demonstration of DNA: RNA: Methyl Green- Pyronin reaction (Source of tissue: Animal wastes from local recognizeds laughter houses/ poultry forms /fish markets etc.)
8) Histochemical analysis of alkaline phosphatase (Source of tissue: Animal wastes from local recognized slaughter houses/ poultry forms /fish markets etc.)
9) Histochemical analysis of acid phosphatase (Source of tissue: Animal wastes from local recognizeds laughter houses/ poultry forms/ fish markets etc.)
10) Demonstration of separation of amino acids by paper chromatography and TLC
11) Computer aided statistic alanalysis
12) Computer presentation of statistical data, charts and diagrams

Section B: Biotechiques and Biostatistics

Biotechniques-

1) Section cutting of tissue by using freezing microtome.
2) Preparation of media and cultivation of microorganisms.
3) Observation of various microbial colonies on culture plates
4) Demonstration of Gram positive and Gram-negative bacteria.
5) Bacterial motility test by hanging drop method.

Biostatistics-

1) Representation of given data by frequency distribution table
2) Calculation of mean, mode and median from given data
3) Calculation of range, mean deviation, sample variance, standard deviation and standard error from given data.
4) Representation of given data by diagrams
5) Representation of given data by graphs
6) Numerical problems on binomial,Poisson and normal distribution.
7) Numerical problems on z- test, t- test, Chi square test and F- test

Scheme of Marking for Practical Examination:

Distribution of Marks: **Max. Marks: 180**

1. Demonstration of electrophoresis of tissue extract/ Paper chromatography 25
2. Antigen-antibody reaction/ Estmation of proteins by Lowry's method 25
3. Statistical analysis of given data/ Representation of given data by diagrams & graphs 25
4. Demonstration of Gram positive and negative bacteria 25
5. Experiment from elective paper 25
6. Experiment from elective paper 15
7. Certified practical record 30
8. Viva voce 10

B. Sc. Semester-VII Zoology (Honors with Research)

Course category: RM

Course code: B-ZOR477T

Paper: Research Methodology

Total Credits: 4 Hours: 60

Course objectives:

1) To familiarize students with basics of research and research process
2) To provide an introduction to research methods and report writings
3) To give insight into various kinds of research design and sampling

Course outcomes:

At the end of the course the students will be able to:

1) Understand the concept of research and different types of research in the context of biology.
2) Have basic awareness of data analysis and hypothesis testing procedures.
3) Develop laboratory experiment related skills.
4) Have basic knowledge on qualitative research techniques.
5) Develop competence on process of scientific documentation.
6) Analyze the ethical aspects of research.
7) Evaluate the different methods of scientific writing and reporting.

Unit-I

1.1. Research Methodology: meaning and objectives of research, types of research, research process, problems encountered by researchers in India.
1.2. Defining Research Problem: definition, selecting the problem, necessity of defining the problem, techniques involved in defining a problem.
1.3. Research Design: meaning, features of good design, various concepts relating to research design, different research designs.
1.4. Experimental Designs: concepts, basic principles of experimental designs, important experimental designs and their uses.

Unit-II

2.1. Sampling: definition, sampling theory, types of sampling, concept of standard error, sample size and its determination.
2.2. Analysis of Data: types of analysis, role of statistics in research, correlation concept and types, coefficient of correlation, regression concept and types, time series analysis-components, methods of measuring trend.
2.3. Hypothesis Testing: meaning of hypothesis, basic concepts of hypothesis testing, procedure for hypothesis testing.
2.4. Tests of Hypothesis (Tests of Significance): parametric and nonparametric tests, important parametric tests: z-test, t-test, chi-square test and F-test.

Unit-III

3.1. Analysis of Variance (ANOVA): meaning, basic principle of ANOVA, Techniques of analysis of variance, working procedure or steps for ANOVA.
3.2. Probability: definition, basic concepts, theorems of probability, important theoretical distributions and their applications.
3.3. Measures of central location, objectives and types of averages, Measures of variation or variability.
3.4. Analysis of frequencies, graphical representation of ungrouped and grouped data, advantages of graphical representation.

Unit-IV

4.1. Interpretation and Report Writing: precautions for correct interpretation, significance of report writing, different steps in writing report, types of reports, oral presentation, set rules and precautions for writing reports.

4.2. Computers in Research: classification and generations of computers, important applications of computers in research, basics of word processing software-MS Office, internet, mail and file transfer protocol (FTP).

4.3. Intellectual Property Rights (IPR): intellectual property rights and patent law, commercialization, copy right, royalty, trade related aspects of intellectual property rights.

4.4. Ethics in research: ethical issues, ethical committees, CPCSEA guidelines for animals use in research, Plagiarism- definition, different forms, consequences, unintentional plagiarism.

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INSTITUTE OF SCIENCE, NAGPUR

(An Autonomous Institute of Government of Maharashtra)
(To be implemented from 2024-25)
B. Sc. Semester-VIII Zoology (Honors with Research)
Course category: DSC
Course code: B-ZOR481T
Paper–I: Biodiversity and Conservation

Total Credits: 4 Hours: 60

Course objectives:
1) To orient students about rich heritage of Biodiversity of India and make them understand significance of its conservation.
2) To generate qualified students who can directly get jobs in the allied fields of Biodiversity, Conservation and Wildlife Management.
3) To generate a team of postgraduates who can take up jobs related to the environment in educational institutions.
4) To create awareness about Biodiversity and Nature Conservation.

Course outcomes:
Students would appreciate treasure of Biodiversity, its importance and hence would contribute their best for its conservation.

UNIT I
1.1. Biodiversity: Definition, Concept, Types and Values.
1.2. Indian Biodiversity: Zones of Faunal distribution, Major protected areas & their importance.
1.3. Natural History of Fauna of India- Major flora & Fauna Natural History of Western Ghats - Major Fauna Methods of recording Natural History of a place. Resident, Migrant, Vagrant species
1.4. Global Biodiversity: Major Biodiversity areas of the world and Biodiversity Hot Spots

UNIT II
1.1 Human –wildlife interactions: Conservation Vsprotection; Concept of Buffer zones, Wildlife corridors Strategies to reduce human-wildlife interactions.
2.2. Role of Government and NGOs in controlling human-wildlife interactionsSocio-economicissuesrelatedtohuman-wildlife interactions
2.3. Wildlife parks, wildlife reserves, privately owned wildlife reserves & Biosphere reserves Single species / single habitat-based conservation programmes (e.g. Project tiger)
2.4. Ex-situ & in-situ conservation. Conservation Breeding (e.g.Vulture, Pygmy hog, Gharial etc.)

UNIT III

3.1. Role of NGOs in conservation: International NGOs; UNEP, GEF, WCS, Bird Life International Important NGOs in India & their contributions WWF, ATREE, BNHS, WTI, Kalpavriksha etc.

3.2. Molecular Techniques – Genomics (General concepts & applications): Extraction of DNA from samples PCR & RTPCR DNA sequencing DNA fingerprinting Southern Blotting and its applications

3.3. Molecular Techniques – Proteomics (General concepts & applications) Extraction & Evaluation of Proteins, Protein Fingerprinting (e.g.Venomproteins, Plantproteins) Western Blotting and its applications

3.4. Analysis of Animal tracks & signs (General concepts): Tracking Large mammals Studying & analyzing Animal Tracks & signs

UNIT IV

4.1. Management of Protected areas: Principles of wildlife management, Wildlife management techniques

4.2. People's participation in managing protected areas: Integrating Local Community in conservation (e.g. Kaziranga, Eagle's Nest).

4.3. Wildlife Tradeand Laws: Wildlife protection Act of India CITES, TRAFFIC, RED Data Book, Measures to control poaching & wildlife trade

4.4. Regulations & Acts related to protected areas: General concepts of Private forests, Reserve forests, Sanctuaries, National Parks,Wildlife reserves, Coastal Regulation Zone, Protected Areas Network

B. Sc. Semester-VIII Zoology (Honors with Research)
Course category: DSC
Course code: B-ZOR482T
Paper–II: Microtechnique

Total Credits: 4 Hours:60

Course objectives:

1) To study the process of microtechnique for organ histology of animals.

Courseoutcomes:

After completion of this course, students will-

1) Perform microtechnique process independently.
2) Able to work in pathological laboratory
3) Know the idea about histological structure

Unit-I

1.1. Introduction and importance of microtechnique.

1.2. Collection and preparation of material.

1.3. Laboratory procedures for the use of collected material.

1.4. Fixation and fixatives: Formalin, acetone, Carnoy's fluid, Bouin's fluid,

Unit-II

2.1. Washing and dehydration of material, preparation of alcoholic grades
2.2. Clearing and clearing agents: Xylol, benzene, clove and cedar wood oil
2.3. Wax embedding, block making and trimming of block.
2.4. Microtomes-Rocking, Rotary and Freezing microtomes

Unit-III

3.1. Section cutting, Honing and stropping of knife,
3.2. Affixing, processing and spreading sections; labeling slides.
3.3. Difficulties encountered during section cutting- their causes and remedies
3.4. Dehydration of sections for staining

Unit-IV

4.1. Staining: Principles of staining, types of stains, vital staining, H-E staining
4.2. Histochemical techniques for carbohydrates (PAS), proteins (bromophenol blue) and lipids (Sudan black-B).
4.3. Mounting agents: types; DPX, Canada balsam
4.4. Camera lucida drawing

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B. Sc. Semester-VIII Zoology (Honors with Research)
Course category: DSE
Course code: B-ZOR483T
Paper–Elective1: Animal Physiology-II (Physiology of Circulation)

Total Credits: 2 Hours: 30

Course objectives:
1) To learn the anatomy, histology and physiology of heart and cardiac cycle.
2) To know composition, function of blood and lymph, disorders of blood.

Courseoutcomes: By the end of the course, the students should be able to:
1) Understand structure and functioning of heart.
2) Cardiac cycle and cardiac failure.
3) Cellular composition and functions of blood, blood disorders.
4) Lymph – composition, formation and functions, Haemostasis.

Unit-I
1.1. Types of heart (Myogenic and Neurogenic).
1.2. Anatomy, histology and nerve innervations of the heart, heart valves.
1.3. Pacemaker and specialized conducting fibers.
1.4. Blood pressure and factors affecting blood pressure.

Unit-II
2.1. Cardiac cycle, Electrocardiogram (ECG).
2.2. Cardiac output, heart sound.
2.3. Haemodynamics.
2.4. Cardiac Failure.

Unit-III
3.1. Cellular composition and functions of blood.
3.2. Blood groups and Blood transfusion.
3.3. Blood sugars–Causes and control of hypoglycemia and hyperglycemia
3.4. Blood lipids-Causes and control of hypolipidimia and hyperlipidimia

Unit-IV
4.1. Plasmaproteins- Albumins, globulins.
4.2. Haemostasis, Cascade of biochemical reactions in valves in coagulation of blood.
4.3. Transport of O_2 & CO_2 by blood.
4.4. Lymph–composition, formation and functions.

B. Sc. Semester-VIII Zoology (Honors with Research)
Course category: DSE
LAB Elective1: Animal Physiology-II (Physiology of Circulation)

Total Credits: 2 Hours:30

Practicals:

I. Physiology Experiments

1 Study of structure of RBCs invertebrates with the help of already available permanent slides/ ICT tools/ models /charts/ photographs etc.
2 Determination of protein, glucose in Urine from diabetic patient.
3 Total leukocyte count and differential leukocyte count.
4 Total erythrocyte count.

II. Quantitative Analysis

1 Estimation of blood triglycerides (Source of blood: Local recognized pathology laboratory)
2 Estimation of blood alkaline & acid phosphates (Source of blood: Local recognized pathology laboratory).
3 Blood amino-acid separation by TLC Paper chromatography (Source of blood: Local recognized pathology laboratory).

III. Qualitative Analysis

1 Estimation of serum urea (Source of blood: Local recognized pathology laboratory)
2 Preparation and study of haemin crystals.

IV. Histological Study of Thyroid, Pituitary, Blood smear, Heart, T.S. Vein, T.S. Arterywith the help of alreadyavailablepermanentslides/ICTtools/charts/photographsetc.

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B. Sc. Semester-VIII Zoology (Honors with Research)
Course category: DSE
Course code: B-ZOR484T
Paper–Elective2: Fish and Fisheries-II (Applied Fisheries)

Total Credits: 2 Hours: 30

Course objectives:
1) To make students aware about the applications and economic importance of Fishery Science.

Courseoutcomes: After studying this course the students will be able to:
1) Learn the various fisheries of India and breeding of carps.
2) Understand the culture of Indian and exotic fishes.
3) Know the methods of culture of air breathing fishes, crab, ornamental fishes, sea weeds and Spirulina.
4) Learn the techniques of pearl culture, prawn culture, frog culture.

Unit-I
1.1. Fresh water fisheries of India, Riverine and Reservoir fisheries.
1.2. Estuarine and Marine fisheries of India.
1.3. Breeding of Indian Major carps: i) Natural breeding, ii) Induced breeding, iii) Methods of obtaining fish seed from natural resources.
1.4. Neuroendocrine control of carp reproduction.

Unit-II
2.1. Culture of Indian and exotic fishes– Composite culture, Common carp culture
2.2. Monoculture, Monosex culture.
2.3. Integrated Fish farming with –Poultry, Duck, Pig and Paddy.
2.4. Sewage fed fisheries

Unit-III
3.1. Culture of air breathing fishes
3.2. Troutculture
3.3. Ornamental fish culture: i) Oviparous, ii) Live bearers.
3.4. Culture of sea weeds and Spirulina.

Unit-IV
4.1. Pearlculture: fresh water and marine pearl oysters, culture methods.
4.2. Crabculture.
4.3. Prawn culture (Life cycle and breeding)
4.4. Frog culture

B. Sc. Semester-VIII Zoology (Honors with Research)
Course category: DSE
LAB Elective2: Fish and Fisheries-II (Applied Fisheries)

Total Credits: 2 Hours: 30

Practicals:

1. Permanent preparation of various scales using wastes from recognized fish markets.
2. Estimation of dissolve oxygen in water sample.
3. Estimation of CO_2 in water sample.
4. Estimation of chloride in water sample.
5. Estimation of protein in muscles / blood of fish (Source of fish blood: Local recognized fish markets).
6. Determination of free fatty acids (FFAs) in fish oil.

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B. Sc. Semester-VIII Zoology (Honors with Research)
Course category: DSE
Course code: B-ZOR485T
Paper–Elective3: Mammalian Reproductive Physiology-II
(Reproductive Process in Female)

Total Credits: 2 Hours: 30

Course objectives:
To introduce students to the physiology of female reproductive system.

Courseoutcomes: Students on completion of this course will be able to:
1) Study the ovary and female genital tract, the process of folliculogenesis.
2) Understand the oestrous cycle in mammals, menstrual cycle and menopause in female.
3) Study the histology and function of corpus luteum and structure of oviduct, uterus.
4) Understand the structure, functions of cervix and vagina.
4) Study the role of prostaglandins in reproduction, anatomy and growth of mammary glands.

Unit-I
1.1. Differentiation of the ovary and female genital tract.
1.2. The process of folliculogenesis and its hormonal control.
1.3. Recruitment, selection, dominance of follicle and signaling for ovulation.
1.4. Follicle wall: Theca, differentiation, steroid hormone synthesis
(2-gonadotropin, 2-cellconcept).

Unit-II
2.1. Estrous cycle in mammals.
2.2. Menstrual cycle and Menopause.
2.3. Mechanism and hormonal control of ovulation.
2.4. Corpusluteum: histogenesis, function, maintenance and luteolysis.

Unit-III
3.1. Oviduct: structure, regional differentiation, and function.
3.2. Uterus: Types, abnormalities.
3.3. Cervix- structure, functions.
3.4. Vagina- structure, function, detection of various stages of oestrous cycle by vaginalcytology, vaginalplug.

Unit-IV
4.1. Onset of puberty and delayed puberty.
4.2. Prostaglandins and their role in reproduction.
4.3. Anatomy and growth of mammary glands.
4.4. Lactogenesis and galactopoiesis.

B. Sc. Semester-VIII Zoology (Honors with Research)
Course category: DSE
LAB Elective3: Mammalian Reproductive Physiology-II
(Reproductive Process in Female)

Total Credits: 2 Hours: 30

Practicals:

1. Demonstration of surgical operation in rat/ mice Ovariectomy or Tubectomy with the help of ICT tools
2. Anatomical observations, demonstration and detailed explanation of the female reproductive system of rat/ mice with the help of ICT tools/ models/ charts/ photographs etc.
3. Study of Oogenesis and identification of its various stages with the help of already available permanent slides/ ICT tools/ models/ charts/ photographs etc.
4. Experimental studies (histological slides for identification) of the following with the help of already available permanent slides /ICT tools/ models /charts/ photographs etc.
   a. Effect of anti-cancer drugs on ovary
   b. Effect of heavy metals on ovary
5. Histology: Histological changes in female reproductive organs and sex accessories duringactive and inactive stage with the help of already available permanent slides/ ICT tools /models/ charts/ photographs etc.
6. Study of following organs with the help of already available permanent slides/ ICT tools/ models/ charts/ photographs etc.
   a. Uterus: anatomy, cell types and identification of estrous types
   b. Mammary glands: Histology of active and inactive glands

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B. Sc. Semester-VIII Zoology (Honors with Research)
Course category: DSC/DSE
Course code: B-ZOR486P
LAB: (Based on Paper-I + II + Elective)

Total Credits: 6 Hours: 30

Practicals:

Section A: Biodiversity and Conservation

1. Field visits to nearby Zoo, Museum, Forest, Nursery, Aquaria or any other relevant site must be arranged. The report of these visits to be submitted.
2. Adaptations in animals: use pictures or photographs with suitable labels.
3. Application of transacts and quadrants in Simulated pictures/ photographic sheets for data collection. Record & tabulate the data.
4. 4. Using a suitable hand-held camera photograph wild animals, birds and insects to record diagnostic features and Take 5"X 7" prints on photo papers.
5. Collect matured leaves (minimum hundred for a class) from two different plants (e.g. Mango tree & False Ashoka). Measure and record the length (in cm.) along the midrib using a flexible thread. Tabulate the data, make frequency polygon, apply "t" test to the data and comment on the significance of the deference in leaf length between the two plant species.
6. Using photographs/ paintings/ coloured drawings identify and study ecological role of characteristic animal species (major representative species only) of various Biomes.
7. Study of animal architecture (photographs/ diagram/ abandoned specimen); Hive of honeybee, nest of paper wasp, nest of potter wasp, Mount of termite, Nests of Weaver Bird and tailor bird.
8. On a geographic map of India locate & demarcate major sanctuaries/ national parks.

Section B: Microtechnique

1. Collection and fixation of tissue
2. Washing, dehydration and clearing of tissue
3. Wax embedding and block making
4. Trimming of block, section cutting and spreading of sections on slides
5. Double staining by Haematoxylin and Eosin, permanent preparation of slides
6. Vital staining of mitochondria
7. Histochemical demonstration of carbohydrates, proteins and lipids
8. Camera lucida drawing

Scheme of Marking for Practical Examination:

Distribution of Marks	**Max. Marks: 180**
1. Numerical problem on t-test	20
2. Study of vegetation by Quadrat method	20
3. Permanent preparation of H-E staining	20
4. Histochemical demonstration of carbohydrates/ proteins/ lipids	20
5. Experiment from elective paper	15
6. Experiment from elective paper	15
7. Identification and comment on spots (1 to 10)	30
8. Submission of certified practical record and stained slides	30
9. Viva voce	10