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 (History of Indian Science)	**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 (History of Indian Science)	**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: **Basic 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

(An Autonomous Institute of Government of Maharashtra)
(To be implemented from 2024-25)
B. Sc. Semester-I Zoology
Course category: Subject-1
Course code: B-ZO111T

Paper–I: Life and Diversity of Nonchordates-I (Protozoa to Annelida)

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.

Course outcomes:

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

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

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 life cycle.
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 life cycle, 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 life cycle.
3.3 ***Taenia solium***: Structure and life cycle.
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 category: Subject-1
Course code: B-ZO112P
Paper-1 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.

Practicals:

Section A: Life and Diversity of Nonchordates-I (Protozoa to Annelida)

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

i) Protozoa (Slides): *Paramoecium, Euglena, Amoeba, Plasmodium vivax*
ii) Porifera: *Sycon, Leucosolenia, Hyalonema, Euplectella, Spongilla*
iii) Coelenterata: *Obelia, Aurelia, Tubipora, Fungia, Adamsia*
iv) Platyhelminthes: *Planaria, Fasciola, Taenia*
v) Ascheliminthes: *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:

Distribution of Marks–	**Total Marks**	**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. Permanent stained preparation		03
Q.5. Submission of certified practical record		05
Q.6. Submission of slides & visit report		02
Q.7. Viva voce		02

Recommended Books for Life and Diversity of Nonchordates-I (Protozoa to Annelida):

1 **Barnes–Invertebrate Zoology (Halt-Saunders international) Philadelphia, USA**
2 Barradaile L. A. and Potts F. A.– **TheInvertebrate**
3 Nigam**– Biology of Nonchordates**
4 Kotpal, Agrawal and Khetrapal**– Modern Text Book of Zoology- Invertebrates,** Rastogi Publication, Meerut
5 Puranik P. G. and Thakur R. S.**– Invertebrate Zoology**

6 Majupuria T. C.**– Invertebrate Zoology**
7 Dhami and Dhami**– Invertebrate Zoology**
8 Parker and Hashwell, **Text book of Zoology Vol. I (Invertebrates),** A. Z. T. B. S. Publishers & Distributors, New Delhi
9 S. S. Lal- **Practical Zoology Invertebrates 9th edition,** Rastogi Publication, Meerut
10 Barrington E J W– **Invertebrate Structure and Function** ELBS III Edition
11 Kotpal R. L.**– Phylum Protozoa to Echinodermata (series),** Rastogi Publication, Meerut
12 Parker J. and Haswell W.– **Text Book of Zoology**, ELBS Edition
13 Vidyarthi– **Text Book of Zoology**, Agrasia Publishers, Agra
14 Jordan E. L. and Verma P. S.– **Chordate Zoology**, S. Chand and Co., NewDelhi
15 Ayer E.– **Manual of Zoology**
16 M. D. Bhatia – **The Indian Zoological Memories– Leech**
17 Beni Prasad– **The Indian Zoological Memories– Pila**
18 P. K. Gupta– **Vermicomposting for Sustainable Agriculture**, Agrobios India Ltd.
19 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 chromatography (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. *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 will able to-
1) understand and 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 silkworms
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

Recommended Books for Economic Entomology:

1. *General and Applied Entomology* by K.K. Nayar, T. N. Ananthkrishan 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 Hill Co. New York.
3. *Agriculture Entomology* by H .S. Dennis. Timber Press Inc.
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 hands on training of vermicomposting.
2) Get acquainted with hands 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 (Solid waste) 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 top up
6) Vermicompost collection, earth worm separation (Harvesting), air drying of vermicompost, sieving and storage of compost
7) Vermi wash: methods collection and processing
8) Cocoon formation, breeding methods of worms
9) Standardize technique with categorized biodegradable wastes
10) Analysis of vermicompost and vermiwash; soiltesting
11) Applications/ packaging and marketing of by products
12) Visit to vermiculture farm/ setup

Marking Scheme for Practical Examination:

Distribution of Marks-	**Maximum 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

Recommended Books for Vermicomposting:

1) **Lekshmy M S and Santhi R.**Vermitechnology.Saras Publication,pp.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

(An Autonomous Institute of Government of Maharashtra)
(To be implemented from 2024-25)
B. Sc. Semester-II Zoology
Course category: Subject-1
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 and male and female reproductive systems.
1.3 **Insectsas Vectors**: Mosquito, Housefly, Sandfly, Tse-Tse fly.
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 star fish.
3.4 **Echinoderm larvae**: 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 category: Subject-1
Course code: B-ZO122P
Subject-1 LAB

Total Credits: 1 Hours: 15

Course 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

Course 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.

Practicals:
Section–A: 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 starfish, Bipinnaria and Auricularia larva, T. S. *Balanoglossus* through collar and proboscis, Tornaria larva
3. **Study of anatomical features with the help of charts/ models/ videos-**

i) Digestive system of Cockroach
ii) Reproductive system of Cockroach
iii) Nervous system of *Pila*

4. **Mounting-**
   Crustacean larvae and plankton**;** Mouthparts, trachea and salivary gland of Cockroach; Gill lamella, 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

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

1. Barnes**– Invertebrate Zoology (Halt-Saunders international)** 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,**

RastogiPublication, Meerut
5. Puranik P. G. & Thakur R. S.**– Invertebrate Zoology**
6. Majupuria T. C.**– Invertebrate Zoology**
7. Dhami & Dhami**– Invertebrate Zoology**
8. Parker & Hashwell, **Text book of Zoology Vol. I (Invertebrates)** A. Z. T.B. S. Publishers & Distributors, New Delhi
9. Dr. S. S. Lal **Practical Zoology Invertebrates 9th edition,** Rastogi Publication Meerut
10. E J W Barrington– **Invertebrate Structure and Function** ELBS III Edition 8
11. R.L.Kotpal **Phylum Protozoa to Echinodermata (series),** Rastogi and Publication, Meerut
12. Parker J. and Haswell W.– **Text Book of Zoology**, ELBS Edition
13. Vidyarthi– **Text Book of Zoology**, Agrasia Publishers, Agra
14. Jordan E. L. and Verma P. S.– **Chordate Zoology**, S. Chand and Co., NewDelhi
15. Ayer E.– **Manual of Zoology**
16. M. D. Bhatia – **The Indian Zoological Memories – Leech**
17. Beni Prasad– **The Indian Zoological Memories–** ***Pila***
18. P. K. Gupta– **Vermicomposting for Sustainable Agriculture**, Agrobios India Ltd
19. A manual of Practical Zoology Invertebrates– 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

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 Ltd, 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:Apicture album* by Salim Ali and Futehally L. (1968). National Book Trust, India, pp. 51.
8. *The book of Indian birds. 13th edition* 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) 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

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, Allahabad
3. *Fish and Fisheries* by Kamleshwar Pandey and J. P. Shukla. Rastogi Publications, Meerut
4. *A textbook of Fishery Science and Indian Fisheries* by C. B. L. Srivastava. Kitab Mahal, 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-ZO125T
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:

Distribution of Marks-	**Total 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

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. Kitab Mahal, 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 (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

(An Autonomous Institute of Government of Maharashtra)

(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 Neoteny 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

Course 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.

Course 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-ZO233T
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

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 Neoteny 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

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

26. T. B. of Zoology vol II – Parker & Haswell
27. T. B. of Vertebrate Zoology -S. N. Prasad
28. Chordate Zoology –E. L. Jorden and P. S. Verma
29. Vertebrate Zoology – Vishwanath
30. Zoology of Chordates – Nigam H. C.
31. Phylum: Chordata – Newman H.H.
32. Biology of Vertebrates –Walter & Sayles
33. The Vertebrate Body – Romer A. S.
34. Comparative Anatomy of the Vertebrates – Kingslay J. D.
35. The Biology of Amphibia – Noble G. K.
36. Snakes of India – Gharpura K. G.
37. Life of Mammals – Young J.Z.
38. Vertebrates – Kotpal R. L.
39. Introduction to Chordates – Majupuria T.C.
40. Vertebrate Zoology – Dhami & Dhami
41. T. B. Vertebrate Zoology – Agrawal
42. Protochordates – Chatterjee & Pandey
43. Protochordates – Bhatia
44. T. B. of Chordates – Bhamrah and Juneja
45. Chordate Anatomy – Arora M.P.
46. The Chordates – Alexander.
47. T. B. of Animal Embryology – Puranik
48. T. B. of Chordate Embryology – Dalella & Verma
49. T. B. of Embryology – Sandhu
50. 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: VSEC (VSC/SEC)
Course code: B-ZO238P
VSEC 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: 60**
1. Identification and comment on spots (1 to 5)	15
2. Comment on the life cycle of honey bee	10
3. Comment on handling of artificial bee hive and its maintenance	10
4. Submission of visit report	10
5. Submission of certified practical record	10
6. Viva voce	05

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)

(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 embryology 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

Course 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 super coiling, its nature.
3. Students will identify the role of DNA Super coiling, 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.

Course 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

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
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 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 embryology 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)
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

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
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 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: VSEC (VSC/SEC)
Course code: B-ZO248P
VSEC 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.
15. Workbook on Limnology by A. D. Adoni
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 Govt. of Maharashtra)

(w. e. f. 2024-25)

B. Sc. Semester-V Zoology

Course category: DSC

Course code: B-ZO351T

Paper–I: Advanced Genetics

Total Credits: 3 Hours: 45

Course objectives:

1. Students will be able to distinguish between classical, and population genetics.
2. Students will work on genetics issues.
3. Students will be able to prepare Pedigree charts.
4. Students will understand need for Genetic counselling
5. Students will draw parallels between genetics, their personal life, and other fields.
6. Achieve a working knowledge of concepts and recent discoveries in genomics. Explain how technological advances have led to conceptual advances in genomics.
7. To understand the principles of genetics and interrelationship to human disorders and syndromes
8. To know key concepts of developmental genetics and population genetics

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

1. Mendelian Principles and its Extension
2. Prepare Pedigree chart and interpretation
3. Cytoplasmicinheritance, Linkageandcrossingover.
4. Concepts of genetic elements and Genetic mapping.
5. Genetic counselling
6. Genetic basis of human disorders.
7. Population genetics, Genetic counseling and Applied genetics

UNIT-I

1.1 Mendelian Extension: Lethal alleles, Epistasis, Pleiotropy, sex-limited characters inheritance, Pseudogenes, Repetitive DNA

1.2 Human pedigree analysis with symbols used. Philadephia chromosome, Sickcle cell anaemia, Thalessemia

1.3 Extra-chromosomal Inheritance: Polygenic Inheritance, Polygenic inheritance with suitable examples; simple numerical based on it.

1.4 Complex polygenic syndromes: Diabetes mellitus; Mitochondrial syndromes

UNIT-II

2.1 Crossing Over: Linkage, Molecular mechanisms of crossing over.

2.2 Chromosome aberrations :- Deletions, duplications, translocations, inversions

2.3 Variations in chromosome number - Aneuploidy, Polyploidy.

2.4 Transposable Genetic Elements: Pelements in Drosophila, Transposons in humans.

UNIT-III

3.1 Animal Genetics: Animal breeding, outbreeding and inbreeding, conservation of germplasm.
3.2 Diagnosis of genetic defects Amnocentesis. Sperm and egg banks. Karyotyping and FISH.
3.3 Genetic counselling: Components of genetic counselling: Physical examination, Patterns of inheritance, risk assessment and counselling in common Mendelian and multifactor syndromes
3.4 Human Genome: History, organization and goals of the human genome project, and Implications of human genome on research and society.

UNIT-IV

4.1 Molecular pathology of monogenic diseases: Cystic fibrosis, Tay-Sachs Syndrome
4.2 Genetics of Neurogenetic and muscle disorders: Alzheimer's disease and Duchenne Muscular dystrophy
4.3 Genetic basis of eye disorders: Glaucoma and Cataracts
4.4 Genetics of Cancer: Haematological malignancies, Retinoblastoma, and Breast Cancer.

Reference Books:

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.NY.
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.NY.
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.
11. Griffiths A. J.F. Miller J.H. D. T. Suzuki., R. C. Lewontin and W. M. Gelbart. 1996. An, introduction to genetic analysis W. H. Freeman and Company. N.Y.
12. Lewin. B. 1997. Genes. VI. Oxford Universty Press, Oxford, NY, Tokyo.
13. Strickberger M.W., 1996 Genetics, Mac Millan publishing Co. NY.
14. Watson J. D., N. H. Hopkins., J. W. Roberts., J. A. Steitz and A. M. Weiner. 1987. Molecular Biology of Genes. The Benjamin Cummings Publshing Company. Inc. Tokyo.
15. The Human Genome. 2001. Nature. Vol. 409 Series of articles on Human Genome.
16. Drosophila Genome. 2000. Sciene Vol. 267
17. C. elegans Genome. 1998. Scienc VoL 282
18. Arabidopsis Genome. 2Q. Nature Vol. 408
19. Cummings, N. R. 1994. Human Heredity: Principles and Issues. West Publishing Company.
20. Epstein, R. 3. 2003. Human Molecular Biology. Cambridge Univ. Press, Cambridge
21. Jobling N. A., Hurles and Tyler-Smith. 2004. Human Evolutionary Genetics Origin, People & Disease. Garland & Science
22. Khoury, M. 3., 3. Little and W. Burke. 2004. Human Genonie Epidemiology. Oxford Univ. Press, Oxford.
23. Motulsky, V. 1977. Human Genetics. Springer & Verlag, Berlin.-6. Strachan, T. And A. P. Reads, 2004, Human Molecular Gen

B. Sc. Semester-V Zoology
Course category: DSC
Course code: B-ZO352T
Paper–II: Basics of Immunology

Total Credits: 3 Hours: 45

Course objectives:

1. To understand the basic Principles of immunology
2. To explore the structural and functional characteristics of immunoglobulins
3. To develop practical knowledge of immunological techniques
4. To understand the applications of immunological tools

Course outcomes: After successful completion of this course, students will be able to:

1. Explain the concepts of innate and adaptive immunity, antigen-antibody interactions,
2. Describe the various immunodiffusion and immunoelectrophoretic techniques and interpret their outcomes in clinical and research contexts.
3. Demonstrate understanding of diagnostic techniques such as ELISA and RIA, and their real-world applications in detecting diseases.
4. Analyze the role of major histocompatibility complexes, interferons, and NK cells in immune system regulation.
5. Apply knowledge of hybridoma technology and vaccine development in therapeutic and preventive healthcare strategies.

Unit–I

1.1 Immunity: Types-Active and passive immunity. Cell mediated immunity, humoral immunity, immune response, primary and secondary response. Phagocytosis, mechanism of phagocytosis

1.2 Antigens: Features of Ag, Haptens, Carrier molecule, Immunological valence, Antigenic determinants. Adjuvants: Freund's complete and incomplete.

1.3 Antibodies: Nature, Primary structure of immunoglobulins, light chain, heavy chain, variable region, constant region, Hinge region; enzymatic fragmentation of Ig.

1.4 Domain structure of Ig and significance; Classification of Immunoglobulins: Types –IgG (G1, G2, G3 & G4), IgM, IgA, IgD and IgE (Origin, structural functions). Interferon: Types of Interferons. Null cells: Natural Killer cells

Unit–II

2.1 Antigen-Antibody Interactions: Principles and Applications, Cross-Reactivity, Precipitation Reactions (in fluids and gel)

2.2 Agglutination Reactions: Hemagglutination and Agglutination Inhibition

2.3 Immunological techniques: Single immune-diffusion in one Dimension; Radial Immuno-diffusion: Principle, methodology, applications.

2.4 Double diffusion in one and two dimension: Principle, methodology and applications.

Unit–III

3.1 Immuno-electrophoresis: Principle, methodology, applications

3.2 Crossover Immuno-electrophoresis: Principle, methodology, applications

3.3 Rocket Immuno-electrophoresis: Principle, methodology, applications

3.4 Radial Immuno Assay (RIA) and ELISA: Principle, methodology and applications.

Unit–IV

4.1 Tumour Immunity; Immunity to Bacteria; Immunity to viruses; Transplantation Immunity; Immunity to Parasites

4.2 Autoimmunity: Organ-Specific Autoimmune Diseases, Systemic Autoimmune Diseases

4.3 Hybridoma technology: Monoclonal antibodies in therapeutics and diagnosis.
4.4 Vaccines: Various types of vaccines, Strategies of vaccine development.

Reference Books:

1. Elgert, K.D. (2009). Immunology: Understanding the Immune System (2nd ed.). Hoboken, NJ: John Wiley & Sons, Inc.
2. Owen, J.A., Punt, J., Stranford, S.A., & Jones, P.P. (2013). Kuby Immunology (7th ed.). New York: W.H. Freeman and Company.
3. Abbas, A.K., Lichtman, A.H., & Pillai, S. (2022). Cellular and Molecular Immunology (10th ed.). Philadelphia, PA: Elsevier.
4. Shastri, N.V. (2010).Principles of Immunology. Mumbai: Himalaya Publishing House.
5. Shetty, Nandini (2019). Immunology: Introductory Textbook (Revised 2nd ed.). New Delhi: New Age International Publishers.
6. Tripathi, Archana & Dwivedi, A.K. Forensic Serology & Blood Examination. Lucknow: Selective & Scientific Books (SSB).
7. Parslow, T.G., Stites, D.P., Terr, A.I., & Imboden, J.B. (2001).Medical Immunology (10th ed.). New York: Lange Medical Books/McGraw-Hill.
8. Roitt, I., Brostoff, J., & Male, D. (2006).Immunology (7th ed.). Philadelphia: Mosby/Elsevier.
9. Goldsby, R.A., Kindt, T.J., Osborne, B.A., & Kuby, J. (2003).Immunology (5th ed.). New York: W.H. Freeman and Company.
10. Chakravarty, A.K. (2012).Immunology and Immunotechnology. New Delhi: Oxford University Press.
11. Male, D., Brostoff, J., Roth, D.B., & Roitt, I.M. (2012).Roitt's Essential Immunology (12th ed.). Wiley-Blackwell.
12. Coico, R., & Sunshine, G. (2015). Immunology: A Short Course (7th ed.). Hoboken, N J: John Wiley & Sons.

B. Sc. Semester-V Zoology
Course category: DSC
Course code: B-ZO353P
DSC LAB: (Based on Paper-I and Paper-II)

Total Credits: 3 Hours: 30

Practicals:

Section A: Advanced Genetics

1. Pedigree chart construction for given case studies (autosomal dominant/ recessive**,** sex-linked traits).
2. Case history analysis**:** Mock genetic counselling interviews and family history assessment**.**
3. Observation of G-banding pattern using labelled diagrams or slide samples.
4. DNA isolation from peripheral blood lymphocytes or from buccal cells.
5. Demonstration of PCR (thermal cycler function, gel electrophoresis visualization).
6. Chromosomal analysis from given metaphase spreads or images.(onion root tips)
7. Virtual simulation or video demonstration of FISH technique (due to high cost of materials).
8. Problems based on Mendelism and interaction of genes.
9. Case study analysis on infertility, IVF, and prenatal diagnosis.
10. Flow chart/model making on gene structure, cancer genetics pathways.

Section B: Basics of Immunology

1. Blood Typing (ABO and Rh) by forward and reverse method.
2. Differential White Blood Cell (WBC) Count(Prepare blood smears, Stain using Leishman or Giemsa stain, Count and identify different leukocytes under a microscope)
3. Single Radial Immunodiffusion (SRID): Estimate antigen concentration using precipitin ring diameter.
4. Detect antigen-antibody interactions in gel using Immunodiffusion (Ouchterlony Technique)
5. Electrophoretic Techniques (Immunoelectrophoresis)
6. Enzyme-Linked Immunosorbent Assay (ELISA)
7. Model making of antigen-antibody structure, MHC, ELISA plate.
8. To study different types of antibodies using charts/ poster.
9. Case studies on Vaccination
10. Visit to Forensic/ Immunology Laboratory/ Microbiology/ Biotechnology laboratory.

Scheme of Marking for practical Examination:

Distribution of Marks	**Max. Marks: 90**
1. Spotting	20
2. One Minor experiment from section-A	10
3. One Major experiment from section-A	15
4. One Minor experiment from section-B	10
5. One Major experiment from section-B	15
6. Visit Report	05
7. Certified practical record	10
8. Viva voce	05

B. Sc. Semester-V Zoology
Course category: DSC
Course code: B-ZO354T
DSC Paper-III: Principles of Ecology

Total Credits: 2 Hours: 30

Course objectives:

1. To install knowledge of ecological and environmental concepts, issues, and solutions to environmental problems, as well as to raise their awareness.
2. To mould students into good 'ecocitizens' who can meet the world's environmental requirements.

Course outcomes: By the end of this programme, the students will understand:

1. Atmosphere (Hydrosphere, Lithosphere): Major zones and its importance, energy sources, Energy flow in an ecosystem.
2. Ecosystem - Definition and types - pond ecosystem, Food chain, food web and ecological pyramids.
3. Biodiversity and its conservation, causes of reduction, Hot spots in India, Wildlife conservation act (1972), national parks and sanctuaries.
4. Sources, effect and control measures - air pollution, water pollution, noise pollution.
5. Causes and effects of space pollution.

Unit –I

1.1 Atmosphere: Major zones and its importance, composition of air
1.2 Hydrosphere: Global distribution of water, Physico-chemical characteristics of water
1.3 Lithosphere: Types of rocks, formation of soil
1.4 Renewable and non- renewable energy sources

Unit –II

2.1 Ecosystem - Definition and types
2.2 Detailed study of pond ecosystem
2.3 Food chain, food web and ecological pyramids
2.4 Energy flow in an ecosystem, Single channel, Y–shape and Universal model

Unit –III

3.1 Biodiversity and its conservation
3.2 Causes of reduction of biodiversity
3.3 Wildlife conservation act 1972, Zoological Survey of India: formation and role in animal conservation.
3.4 Hot spots of biodiversity in India. Study of national parks and sanctuaries- Tadoba, Melghat and Nagzira

Unit –IV

4.1 Sources, effect and control measures of air pollution, Acid rain, green house effect, ozone depletion and global warming
4.2 Sources, effect and control measures of water pollution
4.3 Sources, effect and control measures of noise pollution
4.4 Causes and effects of air pollution

Recommended Books:

1. Ashthana D.K. – Environmental Problem & Solution

2. Agrawal K. C. – Environmental Biology
3. Agrawal K. C. - Biodiversity
4. Mukharjee – Environmental Biology
5. S. Arora – Fundamentals of Environmental Biology
6. Sharma – Ecology & Environmental Biology
7. Verma P. S. and Agrawal V. K. – Environmental Biology, S. Chand. & Co.
8. Trivedi and Rao – Air Pollution
9. Chapman and Reiss – Ecology-Principles and Applications, Cambridge
10. Chatterjee B – Environmental Laws-Implementation and Problems
11. Sharma P. D. – Environmental Biology, Rastogi Publication, Meerut
12. Trivedi R.K. – Hand Book of Environmental Laws, Rules, Guidelines,Compliances and Standards, Enviromedia
13. Odum E. P. and Barret Thomson – Fundamentals of Ecology
14. Smith R. L. and Harper Collins – Ecology and Field Biology
15. D. N. Saxena – Environmental Biology, Stadium Press (India)
16. Davis – Behavioral Ecology
17. Kumar and Asija – Biodiversity – Principle of Conservation
18. Rao and Rao – Air Pollution
19. S. Satyanarayan, S. B. Zade, S. R. Sitre and P. U. Meshram – A Text Book of Environmental Studies, Allied publisher (India)
20. Smitz – Introduction to Water Pollution
21. N. S. Subrahmnyam and V. S. S. Sambamurthy – Ecology

B. Sc. Semester-V Zoology
Course category: DSC
Course code: B-ZO355P
DSC LAB: (Based on Paper-III)

Total Credits: 1 Hours: 15

Practicals:

1. Estimation of dissolved oxygen of water
2. Estimation of free CO_2 of water
3. Estimation of pH of water sample
4. Estimation of total alkalinity of water sample
5. Estimation of total hardness of water
6. Study of pond ecosystem - Producers, consumers and decomposers
7. Qualitative analysis of plankton
8. Visit to a National park and Sanctuary

Scheme of Marking for practical Examination:

Distribution of Marks	**Max. Marks: 30**
1. Spotting	05
2. One Minor experiment	05
3. One Major experiment	10
4. Certified practical record	08
5. Viva voce	02

B. Sc. Semester-V Zoology
Course category: DSE
Course code: B-ZO356T
DSE Paper-Elective 1: Reproductive Biology

Total Credits: 2 Hours: 30

Course objectives:

1. Reproductive Biology covers principles and techniques in reproduction.
2. It also enlightens the areas including Physiology of human reproductive system and it's hormonal regulation,
3. Applications of Reproductive Biology like Artificial Reproductive Techniques (ARTs) etc**.** that will help to develop further practical skills or research ability of the students.

Course outcomes: Students on completion of this course will be able to:

1. Students will learn about the basic concept and mechanism of reproductive physiology as well as practical implications of the reproductive biology such as IVF, contraception, and how to medically manage

Unit-I

1.1 Reproductive System: Sex Differentiation (Gonadogenesis, Genital Duct and External Genitalia), Abnormalities of Human Sex Development.
1.2 Hypothalamo – Hypophyseal – Gonadal axis: Location, Regulation, Function and Factors affecting it.
1.3 Gonadal hormones: Types (steroids, glycoprotein hormones and prostaglandins) and mechanism of hormonal action.
1.4 Reproductive Endocrine Disorders in Male and Female: Hypogonadism, ED (Erectile Dysfunction), Gynecomastia, POS (Polycystic Ovarian Syndrome), Hirsuitism, Perimenopause.

Unit-II

2.1 Histology of male reproductive system in rat and human: Testis: Structure, Cellular Function, Spermatogenesis.
2.2 Structure and Function of Epididymis and Sex Accessory Glands.
2.3 Androgen metabolism and Biochemistry of Semen.
2.4 Cryptorchidism and Castration.

Unit-III

3.1 Histology of female reproductive system in rat and human: Ovary: Structure, folliculogenesis, ovulation, corpus luteum formation and regression.
3.2 Reproductive cycles in rat and human and their regulation.
3.3 Gestation, pregnancy diagnosis, foeto – maternal relationship; Mechanism of parturition and its hormonal regulation.
3.4 Lactation and its regulation.

Unit-IV

4.1 Infertility in male and female: causes, diagnosis and management.
4.2 Assisted Reproductive Technology: sex selection, sperm banks, frozen embryos, in vitro fertilization, ET, EFT, IUT, ZIFT, GIFT, ICSI, PROST.
4.3 Modern contraceptive measures.
4.4 Demographic terminology used in family planning- birth limiting, birth spacing, contraceptive continuation rates, contraceptive prevalence, CYP, HTSP, Informed choice, unmate need, total fertility rate, method mix.

References:

1. Austin, C.R. and Short, R.V. reproduction in Mammals. Cambridge University Press.
2. Degroot, L.J. and Jameson, J.L. (eds). Endocrinology. W.B. Saunders and Company.
3. Knobil, E. et al. (eds). The Physiology of Reproduction. Raven Press Ltd.
4. Hatcher, R.A. et al. The Essentials of Contraceptive Technology. Population Information Programme.
5. Developmental Biology by Gilbert
6. Human Physiology by Vander
7. Human Physiology by Dr. A.K. Jain

B. Sc. Semester-V Zoology
Course category: DSE
Course code: B-ZO358P
DSE LAB- Elective 1: Reproductive Biology

Total Credits: 2 Hours: 30

Practicals:

1. Observation of histological sections from photomicrographs/ charts/ permanent slides of rat/human: testis, epididymis and accessory glands of male reproductive systems; Sections of ovary, fallopian tube, uterus (proliferative and secretary stages), cervix and vagina.
2. Study of modern contraceptive devices.
3. Examination of vaginal smear of rats/ Human.
4. Sperm count and sperm motility in rat/human.
5. Pregnancy diagnosis by using kit.
6. Estimation of fructose in semen.
7. Surgical techniques: Principles of surgery in endocrinology. Ovarectomy, hysterectorny, castration and vasectomy in rats through ICT tools.
8. A case Study of animal house: set up and maintenance of animal house, breeding techniques, care of normal and experimental animals.

Scheme of Marking for practical Examination:

Distribution of Marks	**Max. Marks: 60**
1. Spotting	20
2. One experiment Minor	10
3. One experiment Major	15
4. Certified practical record	10
5. Viva voce	05

B. Sc. Semester-V Zoology
Course category: MINOR
Course code: B-ZO359T
MINOR Paper-I: Principles of Ecology

Total Credits: 2 Hours: 30

Course objectives:

1) To install knowledge of ecological and environmental concepts, issues, and solutions to environmental problems, as well as to raise their awareness.
2) To mould students into good 'ecocitizens' who can meet the world's environmental requirements.

Course outcomes: By the end of this programme, the students will understand :

1) Atmosphere (Hydrosphere, Lithosphere): Major zones and its importance, energy sources, Energy flow in an ecosystem.
2) Ecosystem - Definition and types - pond ecosystem, Food chain, food web and ecological pyramids.
3) Biodiversity and its conservation, causes of reduction, Hot spots in India, Wildlife conservation act (1972), national parks and sanctuaries.
4) Sources, effect and control measures - air pollution, water pollution, noise pollution.
5) Causes and effects of space pollution.

Unit –I

1.1 Atmosphere: Major zones and its importance, composition of air
1.2 Hydrosphere: Global distribution of water, Physico-chemical characteristics of water
1.3 Lithosphere: Types of rocks, formation of soil
1.4 Renewable and non- renewable energy sources

Unit –II

2.1 Ecosystem - Definition and types
2.2 Detailed study of pond ecosystem
2.3 Food chain, food web and ecological pyramids
2.4 Energy flow in an ecosystem, Single channel, Y–shape and Universal model

Unit –III

3.1 Biodiversity and its conservation
3.2 Causes of reduction of biodiversity
3.3 Wildlife conservation act 1972, Zoological Survey of India: formation and role in animal conservation.
3.4 Hot spots of biodiversity in India. Study of national parks and sanctuaries Tadoba, Melghat and Nagzira

Unit –IV

4.1 Sources, effect and control measures of air pollution, Acid rain, green house effect, ozone depletion and global warming
4.2 Sources, effect and control measures of water pollution
4.3 Sources, effect and control measures of noise pollution
4.4 Causes and effects of air pollution

Recommended Books:

22. Ashthana D.K. – Environmental Problem & Solution

23. Agrawal K. C. – Environmental Biology
24. Agrawal K. C. - Biodiversity
25. Mukharjee – Environmental Biology
26. S. Arora – Fundamentals of Environmental Biology
27. Sharma – Ecology & Environmental Biology
28. Verma P. S. and Agrawal V. K. – Environmental Biology, S. Chand. & Co.
29. Trivedi and Rao – Air Pollution
30. Chapman and Reiss – Ecology-Principles and Applications, Cambridge
31. Chatterjee B – Environmental Laws-Implementation and Problems
32. Sharma P. D. – Environmental Biology, Rastogi Publication, Meerut
33. Trivedi R. K. – Hand Book of Environmental Laws, Rules, Guidelines,Compliances and Standards, Enviromedia
34. Odum E. P. and Barret Thomson – Fundamentals of Ecology
35. Smith R.L. and Harper Collins – Ecology and Field Biology
36. D. N. Saxena – Environmental Biology, Stadium Press (India)
37. Davis – Behavioral Ecology
38. Kumar and Asija – Biodiversity – Principle of Conservation
39. Rao and Rao – Air Pollution
40. S. Satyanarayan, S. B. Zade, S.R. Sitre and P. U. Meshram – A Text Book of Environmental Studies, Allied publisher (India)
41. Smitz – Introduction to Water Pollution
42. N. . Subrahmnyam and V. S. S. Sambamurthy – Ecology

B. Sc. Semester-V Zoology
Course category: MINOR
Course code: B-ZO3510P
MINOR LAB: (Based on Paper-I)

Total Credits: 2 Hours: 30

Practicals:

1. Estimation of dissolved oxygen of water
2. Estimation of free CO_2 of water
3. Estimation of pH of water sample
4. Estimation of total alkalinity of water sample
5. Estimation of total hardness of water
6. Study of pond ecosystem - Producers, consumers and decomposers
7. Qualitative analysis of plankton
8. Visit to a National park and Sanctuary

Scheme of Marking for practical Examination:

Distribution of Marks	**Max. Marks: 30**
1. Spotting	05
2. One Minor experiment	05
3. One Major experiment	08
4. Certified practical record	10
5. Viva voce	02

B. Sc. Semester-V Zoology
Course category: VSEC (VSC/SEC)
Course code: B-ZO3511P
VSEC (VSC/SEC): Haematological Techniques

Total Credits: 2 Hours: 30

Course objectives:

1) To create skilled students/ manpower in the diagnosis and prognosis of diseases
2) To provide hands on practice of haematological tests
3) To train the students in blood analysis that will help them for getting job opportunity

Course outcomes: After completion of this course,

1) Students will be able to observe various steps in the phenomenon of fibrin formation
2) They will be able to prepare a good blood smear that helps in identification of various types of blood cells
3) Students will learn various types of blood groups
4) They will understand how the haem part of haemoglobin forms crystals
5) They will be able to handle haematological tests in clinical laboratories

Practicals:

1. To study collection of blood sample by pricking and capillary method.
2. Preparation of a peripheral blood film / smear to identify different types of blood cells.
3. Determination of bleeding time of own blood.
4. Determination of the clotting time of human blood.
5. Determination of the Blood Groups and Rh factor.
6. Estimation of haemoglobin percentage in human blood.
7. Preparation of the haemin crystals using human blood.
8. Counting of total Red blood cells (RBC) using haemocytometer.
9. Counting of total White blood cells (WBC) using haemocytometer.
10. Determination of Differential leucocyte count (DLC).
11. Demonstration of Barr body in blood of human female
12. Study of the osmatic fragility of red blood cells of human blood cells using isotonic, hypotonic and hypertonic solutions of sodium chloride.
13. Visit to a Haematological Laboratory.

Scheme of Marking for Practical Examination:

Distribution of Marks– Total Marks: 60

1. Identification and comment on spots (1 to 5)	05
2. Determination of bleeding time/ clotting time of human blood/ preparation of blood smear	05
3. Determination of blood groups/ estimation of haemoglobin percentage/ demonstration of Barr body	15
4. Preparation of haemin crystals/ counting of RBCs or WBCs/ determination of DLC	15
5. Submission of visit report	05
6. Submission of certified practical report	10
7. Viva voce	05

Recommended Books:

1. Heshu S. R. (2016). Principles of Hematology Laboratory Manual. Komar University of Science and Technology.
2. Kapoor Neerja (2011). Practical Zoology (Vertebrates), Silver Line Publications, Allahabad
3. Kamat Girish (2011). Practical Manual of Hematology, SDM College of Medical Sciences, Dharwad, Karnataka, India
4. Godkar P. B. Text book of Medical Laboratory Technology
5. Mukherjee K. L. Medical Laboratory Technology volume-I
6. Barbara J. B, Imelda B. and Michael A. L. (2017). Dacie and Lewis Practical Haematology
7. De Gruchy's Clinical Haematology in Medical Practice
8. John B. Henry. Clinical Diagnostics and Management by Laboratory methods (20^{th} edition)
9. Shadma Siddiqui and C. B. S. Dangi (2020). Practical Manual for Clinical and Applied Haematology, Notion Press Media, Chennai
10. Gayatri Prakash (2012). Lab Manual on Blood Analysis and Medical Diagnostics. S. Chand & Co. New Delhi
11. Lal S. S. (2019). Practical Zoology Vertebrate (12^{th} edition). Rastogi Publications
12. Verma P. S. and Agarwal V. K. A Manual of Practical Zoology: Chordates. S. Chand & Co, New Delhi
13. Swarup H, Pathak S. C. and Arora S. (1981). Laboratory Techniques in Modern Biology. Kalyani Publishers, New Delhi
14. Balasubramanian K. S. Laboratory Manual of Biochemistry and Physiology. S. Nagin & Co, Delhi
15. Poddar T. K, Mukhopadhyay S. and Das S. K. (2003). An Advanced Laboratory Manual of Zoology. MacMillan India Ltd.
16. Tembhare D. B. (2010). Techniques in Life Sciences. Himalaya Publishing House, Delhi
17. Gupta P. and Chaturvedi M. (2000). Modern Experimental Zoology. Raj Publishing House, Jaipur

INSTITUTE OF SCIENCE, NAGPUR

(An Autonomous Institute of Govt. of Maharashtra)

(w. e. f. 2024-25)

B. Sc. Semester-VI Zoology

Course category: DSC

Course code: B-ZO361T

Paper–I: Genetic Engineering

Total Credits: 3 Hours: 45

Course objectives:

1. Introduce students to the fundamental principles, tools, and methodologies of genetic engineering and recombinant DNA technology.
2. Equip students with knowledge of key molecular biology techniques, including DNA/RNA isolation, PCR, blotting methods, and gene sequencing.
3. Demonstrate the applications of genetic engineering in various fields such as agriculture, medicine, and forensic science.
4. Foster an understanding of the ethical considerations and societal impacts associated with genetic modifications and gene therapy.

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

1. Students understand fundamental tools and concepts used in genetic manipulation.
2. Students learn how foreign DNA is introduced and expressed in host cells.
3. Students understand real-world applications of genetic engineering in healthcare and biotechnology.
4. Assess the practical applications of genetic engineering in real-world scenarios, such as the development of genetically modified organisms, gene therapy approaches, and the creation of DNA vaccines.

UNIT-I

1.1 Introduction to Genetic Engineering: Definition, and scope,

1.2 Enzymes used in Recombinant DNA Technology: Restriction endonucleases, DNA ligase, DNA polymerase

1.3 Vectors in genetic engineering: Plasmids, bacteriophages, cosmids

1.4 Concept of recombinant DNA (rDNA) and cloning

UNIT-II

2.1 Isolation and purification of DNA(genomic and plasmid) RNA

2.2 Various methods of Separation: Southern and Northern blotting.

2.3 PCR: polymerase chain reaction

2.4 Gene sequencing: Maxam Gilbert method and Sanger method.

UNIT-III

3.1 Steps in gene cloning: Isolation, insertion, transformation, selection.

3.2 Transformation techniques:Heat-shock method, Electroporation, Microinjection (conceptual)

3.3 Selection and screening of recombinants (blue-white screening, antibiotic resistance)

3.4 Expression of cloned genes in prokaryotic and eukaryotic systems

UNIT-IV

4.1 Cloning of animals through somatic cell nuclear transfer.

4.2 Applications of recombinant DNA technology in agriculture, medicineanf forensic science.

4.3 Gene therapy: Concepts, types (somatic vs germline), and examples
4.4 DNA vaccines and CRISPR technology (basic introduction)

Reference Books :

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.NY.
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.NY.
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.
11. Griffiths A. J.F. Miller J.H. D. T. Suzuki., R. C. Lewontin and W. M. Gelbart. 1996. An, introduction to genetic analysis W. H. Freeman and Company. N.Y.
12. Lewin. B. 1997. Genes. VI. Oxford Universty Press, Oxford, NY, Tokyo.
13. Strickberger M.W., 1996 Genetics, Mac Millan publishing Co. NY.
14. Watson J. D., N. H. Hopkins., J. W. Roberts., J. A. Steitz and A. M. Weiner. 1987. Molecular Biology of Genes. The Benjamin Cummings Publshing Company. Inc. Tokyo.
15. The Human Genome. 2001. Nature. Vol. 409 Series of articles on Human Genome.
16. Drosophila Genome. 2000. Sciene Vol. 267
17. C. elegans Genome. 1998. Scienc VoL 282
18. Arabidopsis Genome. 2Q. Nature Vol. 408
19. Cummings, N. R. 1994. Human Heredity: Principles and Issues. West Publishing Company.
20. Epstein, R. 3. 2003. Human Molecular Biology. Cambridge Univ. Press, Cambridge
21. Jobling N. A., Hurles and Tyler-Smith. 2004. Human Evolutionary Genetics Origin, People & Disease. Garland & Science
22. Khoury, M. 3., 3. Little and W. Burke. 2004. Human Genonie Epidemiology. Oxford Univ. Press, Oxford.
23. Motulsky, V. 1977. Human Genetics. Springer & Verlag, Berlin.-6. Strachan, T. And A. P. Reads, 2004, Human Molecular Gen

B. Sc. Semester-VI Zoology
Course category: DSC
Course code: B-ZO362T
Paper–II: Advanced Immunology

Total Credits: 3 Hours: 45

Course objectives:

1. To provide an understanding of the structural and functional components of the immune system.
2. To explain the mechanisms of innate and adaptive immune responses.
3. To explore the molecular and cellular basis of T and B cell activation.
4. To develop awareness of clinical immunology topics such as autoimmune disorders, immune deficiencies, transplantation immunology, and cancer immunotherapy

Course outcomes: By the end of the course, students will be able to:

1. Describe the organization of the immune system, including lymphoid organs, immune cells, and blood group systems, and differentiate between types of immunity (active vs. passive).
2. Explain the mechanisms of innate immunity, including phagocytosis, inflammation, cytokines, complement activation, and types of hypersensitivity.
3. Demonstrate understanding of adaptive immune responses, including antigen presentation, T and B cell function, antibody classes, and the concept of immunological memory.
4. Analyze clinical conditions related to immune dysfunction such as autoimmunity, immuno deficiencies, transplant rejection, and modern immunotherapy techniques.

Unit–I

1.1 Overview of lymphoid system, cells of the immune system, primary and secondary lymphoid organs, tertiary lymphoid tissues
1.2 Passive Immunity: Artificial Immunity, Natural immunity
1.3 Active Immunity: Artificial Immunity, Natural immunity.
1.4 Blood groups: Biochemistry of ABO, Rhesus system, Lewis, Luthern systems, Bombay and Golden significance. Secretors and non-secretors.

Unit–II

2.1 Mechanisms of innate immunity: phagocytosis and inflammation
2.2 Cytokines: cytokine signalling and cytokine related diseases.
2.3 Complement system: Basic concept of complement cascade , classical , alternative and MBL pathways. MAC pathway.
2.4 Hypersensitivity reactions: Types I Anaphylaxis, Type II, Type III and Type–IV

Unit-III

3.1 Major histocompatibility complex: Structure and function of MHC molecules.
3.2 Antigen recognition: Role of MHC, antigen-presenting cells (APCs)
3.3 Immune response mechanism (Cellular response): T-lymphocytes, subsets (CD4+, CD8+), development, and Activation
3.4 Immune response mechanism (Humoral response): B-lymphocytes, Activation, Antibody production, and classes (IgM, IgG, etc.), Clonal Selection Theory

Unit–IV

4.1 Autoimmunity: Autoimmunity diseases and their treatments (Systemic disease -Rheumatoid arthritis, organ-specific Disease-Graves' disease)

4.2 Immunodeficiency disorders (e.g., HIV/AIDS, SCID)
4.3 Tumour immunology: Types and roles of Tumour Antigens and Immune responses to Tumour Antigens
4.4 Transplantation immunology: Immunosuppression, cross matching, Mechanism of Graft Rejection, Tissue and organ transplantation.

Reference Books:

1. Elgert, K.D. (2009). Immunology: Understanding the Immune System (2nd ed.). Hoboken, NJ: John Wiley & Sons, Inc.
2. Owen, J.A., Punt, J., Stranford, S.A., & Jones, P.P. (2013). Kuby Immunology (7th ed.). New York: W.H. Freeman and Company.
3. Abbas, A.K., Lichtman, A.H., & Pillai, S. (2022). Cellular and Molecular Immunology (10th ed.). Philadelphia, PA: Elsevier.
4. Shastri, N.V. (2010).Principles of Immunology. Mumbai: Himalaya Publishing House.
5. Shetty, Nandini (2019). Immunology: Introductory Textbook (Revised 2nd ed.). New Delhi: New Age International Publishers.
6. Tripathi, Archana & Dwivedi, A.K. Forensic Serology & Blood Examination. Lucknow: Selective & Scientific Books (SSB).
7. Parslow, T.G., Stites, D.P., Terr, A.I., & Imboden, J.B. (2001).Medical Immunology (10th ed.). New York: Lange Medical Books/McGraw-Hill.
8. Roitt, I., Brostoff, J., & Male, D. (2006).Immunology (7th ed.). Philadelphia: Mosby/Elsevier.
9. Goldsby, R.A., Kindt, T.J., Osborne, B.A., & Kuby, J. (2003).Immunology (5th ed.). New York: W.H. Freeman and Company.
10. Chakravarty, A.K. (2012).Immunology and Immunotechnology. New Delhi: Oxford University Press.
11. Male, D., Brostoff, J., Roth, D.B., & Roitt, I.M. (2012).Roitt's Essential Immunology (12th ed.). Wiley-Blackwell.
12. Coico, R., & Sunshine, G. (2015).Immunology: A Short Course (7th ed.). Hoboken, NJ: John Wiley & Sons.

B. Sc. Semester-VI Zoology
Course category: DSC
Course code: B-ZO363P
DSC LAB: (Based on Paper-I and Paper-II)

Total Credits: 3 Hours: 30

Practicals:

Section A: Genetic Engineering

1. Extract of DNA from bactreria/ mammalian tissue/ plant materials.
2. Restriction Digestion of DNA : To Perform digestion of extracted DNA using restriction enzymes. (Kit-Based or Demonstration)
3. Agarose Gel Electrophoresis: Separate and visualize DNA fragments.
4. PCR Amplification of a Target Gene (Kit-Based or Demonstration)
5. Bioinformatics Tools for Gene/ Plasmid Analysis (In-silico Practical: Use online tools like NEBcutter, BLAST, or SnapGene Viewer.

Section B: Advanced Immunology

1. Determine the blood group of individuals using Coombs and Dodd 1961 test
2. Determine the blood group of individuals using Absorption elution assay.
3. Sterilization techniques: Autoclaving (Moistened-heat), Oven sterilization (dry-heat),
4. Preparation of media: For Bacteria and Fungi.
5. Isolation and cultivation of pure cultures: Serial dilution, Pour plate method, Spread plate method and streak plate method.
6. Antibody Titration via Serial Dilution: Perform serial dilutions to measure antibody concentration.
7. Case Study Analysis: Use real or hypothetical case studies on autoimmune diseases, immunodeficiency and submit report.
8. Case Study Analysis: Use real or hypothetical case studies on Transplantation or tumours and submit report.
9. Visit to Forensic /Immunology Laboratory/Microbiology/ Biotechnology laboratory.

Scheme of Marking for practical Examination:

Distribution of Marks	**Max. Marks: 90**
1. Spotting	20
2. One Minor experiment from section-A	10
3. One Major experiment from section-A	15
2. One Minor experiment from section-B	10
3. One Major experiment from section-B	15
4. Visit report	05
4. Certified practical record	10
5. Viva voce	05

B. Sc. Semester-VI Zoology
Course category: DSC
Course code: B-ZO364T
Paper–III: Cell Biology

Total Credits: 2 Hours: 30

Objectives:

1. To provide a foundational understanding of celltypes and characteristics.
2. To gain a better understanding of cell organelles andtheir role in metabolic processes.
3. To comprehend cell division and genetic makeup, aswell as their relevance.

Outcomes: By the end of this course, the students will understand:

1. Ultra structure of prokaryotic and eukaryotic cell,
2. Structure and function of cell organelles.
3. Oxidative phosphorylation, Glycolysis and Kreb's cycle and Electron Transport Chain andterminal oxidation.
4. Giant chromosomes: Lamp-brush and polytene chromosome
5. Cell cycle and mitosis, meiosis (different phases and significance)
6. Cellular ageing and cell death, elementary idea of cancer and its causative agents

Unit –I

1.1 Ultrastructure of prokaryotic and eukaryotic cell

1.2 Plasma membrane: Structure- Fluid Mosaic Model and functions.

1.3 Endoplasmic reticulum: Types, ultrastructure and functions

1.4 Golgi complex: Ultrastructure and functions

Unit –II

2.1 Ultrastructure of mitochondria

2.2 Oxidative phosphorylation – Glycolysis and Kreb's cycle

2.3 Electron Transport Chain and terminal oxidation

2.4 Lysosome: Structure, polymorphism and functions

Unit –III

3.1 Nucleus: Ultrastructure of nuclear membrane -Nuclear pore complex, functions of nuclear membrane.

3.2 Structure and functions of nucleolus

3.3 Chromosome: Structure and types, structure of nucleosome

3.4 Giant chromosomes: Lamp-brush and polytene chromosome

Unit --IV

4.1 Ribosome: Structure, types, Lake's model and functions

4.2 Somatic cell division: Cell cycle phases and check points. Mitosis

4.3 Meiosis (different phases and significance), synaptonemal complex.

4.4 Cellular ageing and cell death.

Recommended Books for Cell Biology:

1. C.B. Powar, Cell Biology – Himalaya Publication, New Delhi
2. Dr. S.P. Singh, Dr. B.S. Tomar – Cell Biology 9 th revised edition, Rastogi Publication, Meerut
3. Gupta P.K. – Cell and Molecular Biology, Rastogi Publication, Meerut 9
4. Veer Bala Rastogi – Introduction to Cell Biology, Rastogi Publication, Meerut

5. Gerald Karp – Cell and Molecular Biology-Concepts and Experiments, JohnWiley, 2007
6. De-Robertis – Cell Biology
7. Verma and Agrawal – Concepts of Cell Biology
8. Dowben – Cell Biology
9. Witt – Biology of Cell
10. Ambrose and Eastyr – Cell Biology

B. Sc. Semester-VI Zoology
Course category: DSC
Course code: B-ZO365P
DSC LAB: (Based on Paper-III)

Total Credits: 1 Hours: 15

Practicals:

1. Study of pictures of ultra structure of prokaryotic cell and eukaryotic cell.
2. Study of osmosis in human RBCs (hypotonic, hypertonic and isotonic medium).
3. Demonstration of mitotic cell division in onion root tips by squash method by slides/charts
4. Demonstration of meiosis in *Tradescantia* bud / Grasshopper testis using slides/charts
5. Demonstration of salivary gland chromosome in Chironomous larva by using charts/ videos.
6. Demonstration of mitochondria in buccal epithelium/ lip mucosa by Janus Green-B method.
7. Measurement of micro objects by using ocular and stage micrometer
8. Demonstration of Barr body in blood smear.

Scheme of Marking for practical Examination:

Distribution of Marks	**Max. Marks: 30**
1. Spotting	05
2. One Minor experiment	05
3. One Major experiment	10
4. Certified practical record	08
5. Viva voce	02

B. Sc. Semester-VI Zoology
Course category: DSE
Course code: B-ZO366T
DSE Paper-Elective 1: Basic Developmental Biology

Total Credits: 2 Hours: 30

Course objectives:

1. The course will help the students to learn and develop an understanding of a cell as a basic unit of life.
2. The course will enable them to understand the functions of cellular organelles and how a cell carries out and regulates cellular functions.
3. The course will provide the students a complete comprehension about the essential vertebrate developmental biology.
4. The course will help the students to understand the conundrum of the different levels of biological complexity by tracing them back to events at the level of genes and genomes.

Course outcomes: Students on completion of this course will be able to:

1. Explain the structure and functions of cell organelles involved in diverse cellular processes. Know the evolution of different concepts in developmental biology.
2. Understand the process of gamete formation from stem cell population to mature ova and sperm.
3. Know the differences between Spermatogenesis and Oogenesis.
4. Comprehend the sequence of steps leading to the fusion of gametes and learn the contribution of sperm and ova to zygote formation
5. Understand how polyspermy is avoided in animal kingdom.
6. Learn the mechanisms underpinning cellular diversity and specificity in animals.
7. Learn the methods and tools related to developmental biology help to understand different processes of embryogenesis.

Unit-I: Early development

1.1 Types of eggs- Classification on the basis of amount and distribution of yolk. Chemical composition of yolk.
1.2 Fertilization-Mechanism and significance.
1.3 Cleavage- Types of cleavages
1.4 Blastulation- Definition and types.

Unit-II: **Frog and Chick embryology**

2.1 Fate map of frog
2.2 Morphogenetic movements in the early development of Frog (Invagination, Epiboly and Emboly).
2.3 Development of Chick up to the formation of primitive streak.
2.4 Development of extra embryonic membranes in Chick and their significance.

Unit-III: Mammalian development

3.1 Gametogenesis- (Spermatogenesis and Oogenesis).
3.2 Structure of a Sperm and Ovum.
3.3 Implantation- Definition and types.
3.4 Placentation- Definition, types and functions of placenta.

Unit-IV

4.1 Apoptosis –Mechanism and significance.
4.2 Stem Cells- Sources, types and their use in human welfare.

4.3 In Vitro fertilization- Technique, advantages and disadvantages, Test tube Baby.
4.4 Semen bank, Artificial inseminations and Contraceptives.

References:

1. Developmental Biology - Gilbert, S. F. (2006) VIII Edition, Sinauer Associates, Inc., Publishers,
2. Sunderland, Massachusetts, USA.
3. An introduction to Embryology - Balinsky, B.I. (2008) International Thomson Computer)2 Press.
4. Patten's Foundations of Embryology - Carlson, Bruce M (1996) McGraw Hill, Inc.)3
5. Biology - Campbell, N. A. and Reece J. B. (2011) IX Edition, Pearson, Benjamin, Cummings.
6. Evolutionary Biology - Douglas, J. Futuyma (1997) Sinauer Associates.
7. Gilbert, S. F. (2006). Developmental Biology, VIII Edition, Sinauer Associates, Inc., Publishers,
8. Sunderland, Massachusetts, USA.
9. Balinsky, B.I. (2008). An introduction to Embryology, International Thomson Computer Press.
10. Carlson, Bruce M (1996). Patten's Foundations of Embryology, McGraw Hill, Inc.

B. Sc. Semester-VI Zoology
Course category: DSE
Course code: B-ZO368P
DSE LAB- Elective 1: Basic Developmental Biology

Total Credits: 2 Hours: 30

Practicals:

1. Study of permanent slides of Frog embryo: T.S. of Tadpole through internal and external gills, V.S. of
2. Blastula, Gastrula and Neurula,
3. Study of permanent slides of Chick embryo: Whole mount of 18 hrs, 24 hrs, 30 hrs, 36 hrs and 72 hrs.
4. Examination of gametes of Frog – Sperm and Ova through permanent slides or microphotographs
5. Whole mount of chick embryo by window method
6. Study of different types of Placenta by charts/ model/ Audio visual methods

Scheme of Marking for practical Examination:

Distribution of Marks	**Max. Marks: 60**
1. Spotting	20
2. One experiment Minor	10
3. One experiment Major	15
4. Certified practical record	10
5. Viva voce	05

B. Sc. Semester-VI Zoology
Course category: VSEC (VSC/SEC)
Course code: B-ZO369P
VSEC (VSC/SEC): Basic Health Care

Total Credits: 2 Hours: 30

Course objectives:

1) To study basic health care methods
2) To ensure the value of health
3) To make health as an asset of the student community
4) To impart knowledge, attitude and skills in students, so that they can solve their health problems

Course outcomes: After completion of this course,

1) Students can handle the various basic health care methods independently
2) They will be get sure about the importance of health
3) They will be able to extend their knowledge about value of health among people
4) They can promote the development and use of health services

Practicals:

1. To record the radial pulse rate.
2. To record the heart rate using stethoscope.
3. To record the body temperature by using clinical thermometer.
4. To record the blood pressure using sphygmomanometer.
5. Detection of the given sample of carbohydrate by qualitative tests.
6. Detection of the given sample of protein by qualitative tests.
7. Detection of the given sample of fat / lipid by qualitative tests.
8. Detection of the given sample of cholesterol by qualitative tests.
9. To detect normal constituents in given sample of urine by qualitative tests.
10. To detect abnormal constituents in given sample of urine by qualitative tests.
11. Study of parasitic Protozoans and Helminthes.
12. Study of insect vectors of human diseases.
13. Visit to a Primary health care centre.

Scheme of Marking for Practical Examination:

Distribution of Marks–	**Total Marks: 60**
1. Identification and comment on spots	10
2. Recording of pulse rate/ heart rate/ body temperature/ blood pressure	06
3. Detection of the given sample of carbohydrate/ protein/ lipid/ cholesterol by qualitative tests	12
4. Detection of normal/ abnormal constituents in given urine sample	12
5. Submission of visit report	05
6. Submission of certified practical report	10
7. Viva voce	05

Recommended Books:

1. Heshu S. R. (2016). Principles of Hematology Laboratory Manual. Komar University of Science and Technology.

2. Kapoor Neerja (2011). Practical Zoology (Vertebrates), Silver Line Publications, Allahabad
3. Kamat Girish (2011). Practical Manual of Hematology, SDM College of Medical Sciences, Dharwad, Karnataka, India
4. Godkar P. B. Text book of Medical Laboratory Technology
5. Mukherjee K. L. Medical Laboratory Technology volume-I
6. Barbara J. B, Imelda B. and Michael A. L. (2017). Dacie and Lewis Practical Haematology
7. De Gruchy's Clinical Haematology in Medical Practice
8. John B. Henry. Clinical Diagnostics and Management by Laboratory methods (20^{th} edition)
9. Shadma Siddiqui and C. B. S. Dangi (2020). Practical Manual for Clinical and Applied Haematology, Notion Press Media, Chennai
10. Gayatri Prakash (2012). Lab Manual on Blood Analysis and Medical Diagnostics. S. Chand & Co. New Delhi
11. Lal S. S. (2019). Practical Zoology Vertebrate (12^{th} edition). Rastogi Publications
12. Verma P. S. and Agarwal V. K. A Manual of Practical Zoology: Chordates. S. Chand & Co, New Delhi
13. Swarup H, Pathak S. C. and Arora S. (1981). Laboratory Techniques in Modern Biology. Kalyani Publishers, New Delhi
14. Balasubramanian K. S. Laboratory Manual of Biochemistry and Physiology. S. Nagin & Co, Delhi
15. Poddar T. K, Mukhopadhyay S. and Das S. K. (2003). An Advanced Laboratory Manual of Zoology. MacMillan India Ltd.
16. Tembhare D. B. (2010). Techniques in Life Sciences. Himalaya Publishing House, Delhi
17. Gupta P. and Chaturvedi M. (2000). Modern Experimental Zoology. Raj Publishing House, Jaipur

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

---

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.

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.

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.

Course outcomes:

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 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–Elective 1: 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.
Course outcomes:
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.
7. C. L. Prosser (1973): "Comparative Animal Physiology" W. B. Saunders.
8. C. Ladd Prosser Ed. (1991): "Neural & Integrative Animal Physiology""Comparative Animal Physiology", 4th Ed. Wileg – Liss Publ.
10. Withers, P.C. (1983): "Comparative Animal Physiology" International Ed. Saunders College Publishing.
11. K. Schmidt – Niel (1983): "Animal Physiology: Adaptation & Environmental" 3rd Ed. Cambridge Univ. Press.
12. R. W. Hill (1978): "Comparative Physiology of Animals – An Environmental Approach" Harper & Row Publ.
13. P. W. Hochachka& G. M. Somero (1973): "Strategies of Biochemical Adaptation".
14. J. G. Philips (1975): "Environmental Physiology" Blackwell Scientific Publ.
15. J. R. Bernstein (1972): "Biochemical Responses to Environmental Stress" Academic Press
16. Philip Carew Withers (1992): Comparative animal physiology SaundersCollege Pub.,

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.

Course outcomes:

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 gills in fishes, gill histology
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).

REFERENCES:

1. Agarwal, V.P. 1999. Recent trends in aquaculture. Publisher Society of Biosciences, Agricultural Research, New Delhi. pp. 342.
2. Ahne, W.1980. Fish diseases. Spranger - Verlay, Berlin Heidelberg, New York.
3. Aitken, A., Mackie, M., Merritt S. H. and Windsor, M. L. 1982. Fish handling and processing.
4. Andrew, P. 1999. Fish business management: strategy, marketing - Development, fishing News
5. Austin, B. and Austin, D.A., 1987. Bacterial fish pathogens: Diseases in farmed and wild fish.
6. Balachandran K. K. 2001. Post harvest technology of fish and fish products. Daya Publishing.
7. Brandt. A. V. 1984. Fish catching methods of the world. Fishing News Books Ltd., London.
8. Connell, J. J., 1980. Advances in fish sciences and technology. Farnhan Survey England.
9. Cunningham, S., Dunn, M.R. and Whitmarsh, D., 1985. Fisheries Economics: An Introduction.
10. Cushing, D. H. 1968. Fisheries Biology: A study of population dynamics. Univ. Wisconsin Press,
11. Dahama, O. P. 1993. Extension and rural welfare. Ramprasad and Sons, Agra.
12. Das, P. and Jhingran, A. G. 1976. Fish Genetics in India, Today and Tomorrow Publishers, New
13. Day, F. William 1958. Fishes of India, Vol.1-2, Dawson & Sons Ltd., London.
14. Dhote, A. K. 1989. Fisheries management and extension : Inland fisheries, instructional-cum-practical manual (VI), National Council of Educational Research
15. Fort, R. S., 1961. Fishery Management, Faber & Faber, London.
16. George, M. Hall, 1992. Fish processing technology. VCH Publications, Inc., New York.
17. Goneshvar, C. and Sudhakar, C. 1997. Aquaculture in India, Publisher Sir Sai Publishing,
18. Govindan, I. K., 1985. Fish processing technology, Oxford and IBH Publishing Company.Pvt.
19. Gulland, J.A., 1983. Fish Stock Assessment. A manual of Basic Methods, John Wiley & Sons,
20. Hall, G. M., 1992. Fish processing technology. VCH publishers, Inc., New York.
21. Harry M. K. 1992. The Biology of Fishes, Daya Pub. House, Delhi. P.396.
22. Jhingran, V.G. & Pullin, R.S.V. 1985. A hatchery manual for the common, Chinese and Indian fisheries.
23. Jhingran, V.G. 1982. Fish and fisheries of India . Hindustan Pub. Corporation, Delhi. P.666.
24. John, E. Bardech, John, H. Ryther and William, O. Mclancy, 1972. Aquaculture - The farming
25. John, S. 1996. Commercial fishing method - An introduction to vessels and gear. Fishing News
26. Jones, S. 1969. The prawn fishery resources of India. FAO Fish Rep. 57(2).

27. Kabata, Z., 1985. Parasites and diseases of fish cultured in the tropics. IDRC, Taylor & Francis,
28. Lagler, K. F., Bardach, J. E. and Miller, R. R. 1962. Ichthyology. John Wiley, New York. 545 p.
29. Leatherland, J.F., Woo, P.T.K. and Bruno, D.W., 1998. Fish Diseases and Disorders, Vol. I-III.
30. Linwood, S. 1999. Introduction to Fish Physiology, Narendra Pub.Co, New Delhi
31. Matty, A.J., 1985. Fish Endocrinology. Timber Press, Portland.
32. Nikolsky. 1963. The Ecology of fishes, G.V.T.F.H. Publications Inc. Ltd., Academic press,
33. Pillai, T.V.R., 1990. Aquaculture principles and practices, Fishing News Books.
34. Pitcher, T.J. and Hart, P.J.B. 1982. Fisheries Ecology. The Avi Publishing Co. Westport,
35. Potts, G.W. and Wotton, R.J., 1984. Fish Reproduction: Strategies and Tactics, Academic Press,
36. Prasad, M.K.D. &Pitchaiah, P.S. 1999. Inland water resources - India Vol. I Discovery Publishing
37. Rao, P.S.1983. Fisheries economics and management in India. Pioneer Publishers
38. Rao, S.N., 1986. Economics of Fisheries. Daya Publishing House, Delhi.
39. Richard, Lloyd, 1989. Pollution and freshwater fish - Fishing News Books, London.
40. Robert, R. Stickney, 1994. Principles of Aquaculture. John Wiley & Sons, INC. New York.
41. Roberts, R.J., 1991. Fish Pathology. Bailliere Jindall, London.
42. Shaug, Y.C. 1981. Aquaculture economics: Basic concepts and methods of analysis, Groom
43. Shenoy, L.1988. Course manual in Fishing Technology. CIFE, Mumbai (1:88) pp. 91.
44. Shepherd, C. J. and Bromage, N.R. 1992. Intensive Fish Farming, Pu. Oxford Blackwell Scientific
45. Talwar, P. K. 1990. Inland fishes of India and adjacent countries, vol-I, II, New Delhi, Oxford
46. Templeton, R. G. K. 1995. Freshwater Fisheries Management. Fishing News Books.

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.

Course outcomes:

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:

1. A textbook of in vitro fertilization and assisted reproduction edited by P.R. Brinsden and P.A. Rainsbur Jaypee brothers1992.
2. Advances in Reproductive Physiology, Vol. 1 to 6: Mclaren, (1968). Logos PressLtd., London.
3. Advances in Reproductive Toxicology eds. S. C. Joshi and A. S. Ansari Pointer publishers.
4. Andrology. 2nd Edition Male Reproductive health and dysfunction (Eds. E. Nieschlag & H.M. Behre) 2000.
5. Biochemistry of Mammalian Reproduction: Zanveld, L.J.D. & R.T. Chatterton (1982). John Wiley & sons, New York. The Ovary. Vol.I,II&III: Zuckerman, S, (1962). Academic Press, London.
6. Comparative cellular and molecular biology of testis in vertebrates (Trends in endocrine, paracrine and autocrine regulation of structure of functions) (2001) S.S.Guraya, Oxford and IBH Publishing Co. Pvt.Ltd. New Delhi, Calcutta.
7. Comparative Endocrinology and Reproduction. Eds. K.P. Joy, A. Krishna and C. Haldar, Narosa Publishing House (1998).

8. Contraceptive Technology Past, Present and Future: Das. R.P. (1989). N.I.H.F.W. New Delhi.
9. Encylopedia of Reproduction Vol.I,II,III,IV eds. Ernst Knobiland J.D.Neill (1998).
10. Endocrinology and metabolism. 4th edition 2001. Philip Felig & Lowrence A. Frohmon McGraw HillInc. Medical Publishing Division.
11. Endocrinology.Vol.1to3:L.J.Degrootetal. (1989). W.B. Saundors Co. Philadelphia.
12. General Endocrinolgoy: Turner, C.D. & J.T. Bagnara (1990) W.B. Saunders Co., & ToppanCo., Philadelphia, London & Tokyo.
13. Patterns of Reproduction: Asdell S.A.(1964). Constable and Co. London.
14. Physiology of Lactation: Smith, Vearch, Constable &Co., London.
15. Postgraduate Reproductive endocrinology.4thEdition. 1997. R. Rajan Jaypee brothers. Medical Publishers (P)Ltd.
16. Practice of fertility control, Choudhary S.K. Churchill and Livingstone.
17. Progressin Reproductive Biology, Vol. 4. The pineal and reproduction: Reiter, R.J. Series Ed. P.O. Hubinant, Karger, Basel. Paris, London (latestedition).
18. Reproduction in Mammals Series: 1 to 6: Austin, C.R. and R. V. Short (1984 &1994), Cambridge University Press, Cambridge.
19. Reproductive Endocrinology: Ref. No.1,Vol.3 Hormones in Reproduction.
20. Seasonal Patterns of Stress, immune function and disease R.J. Nelson, G.E. Demas, S.L.Klein,L.J. Kriegsfeld.2002. CambridgeUniv.Press.
21. The Prostaglandins Vol.I&II: Ramwell, P.W.(1974). Prenum Press, New York and London.
22. The TestisVol.1 to 4: Jhonson, A.D. and W. R., Gomes.
23. WHO laboratory manual for the examination of human semen and sperm–cervical mucus interaction. 4thEdition Cambridge Univ. Press. 2000.

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.

Course outcomes:

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.

Practicals:

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/ TLC	25
2. Antigen-antibody reaction/ Estimation of proteins by Lowry's method	25
3. Statistical analysis of given data/ Representation of given data by diagrams or graphs	25
4. Demonstration of Gram positive and Gram 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.
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.

REFERENCES:

1. Ahuja, Ram (2014). *Research methods*. Jaipur: Rawat Publications. 454p.
2. Burns, Robert B. (2000). *Introduction to research methods*. London: Sage Publications. ix,613p.
3. Dixit, Manoj (2011). *Research methodology*. New Royal Book, Lucknow.vi,418p.
4. Jackson, Sherri L. (2009). *Research methods and statistics*. New Delhi: Cengage Learning India. 324p.
5. Kothari, C.R. (2011). *Research methodology: methods and techniques*. (3rd ed.). New Delhi: New Age International. xx,449p.
6. Sharma, Manoj (2004). *Research methodology*. New Delhi: Anmol Publications. vii;400p.
7. P. Suresh Narayana et al. (2018). Research Methodology in Zoology. Scientific Publishers, Jodhpur.
8. Sarkar, S. V. (2000). Intellectual property rights and Copy rights. EssEss Publications.
9. Banergee, P. K. (2013). Introduction to Biostatistics- A textbook of Biometry. S. Chand & Company Ltd. New Delhi.
10. Rao. K. S. (2010). Biostatistics for Health and Life Sciences.Himalayta Publishing House, New Delhi.
11. Jasra P. K. and Gurdeep Raj (2000). Biostatistics.KRISHNAPrakashan Media 9P) Ltd. Meerut, U. P.
12. Dutta N. K. (2002). Fundamentals of Biostatistics- Practical Approach.Kanishka Publishers & Distributors, 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 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

---

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.

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.

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.

Course outcomes:

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 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 with Research)

Course category: DSE

Course code: B-ZOR473T

Paper–Elective 1: 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.

Course outcomes:

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 Elective 1: 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.
7. C. L. Prosser (1973): "Comparative Animal Physiology" W. B. Saunders.
8. C. Ladd Prosser Ed. (1991): "Neural & Integrative Animal Physiology""Comparative Animal Physiology", 4th Ed. Wileg – Liss Publ.
10. Withers, P.C. (1983): "Comparative Animal Physiology" International Ed. Saunders College Publishing.
11. K. Schmidt – Niel (1983): "Animal Physiology: Adaptation & Environmental" 3rd Ed. Cambridge Univ. Press.
12. R. W. Hill (1978): "Comparative Physiology of Animals – An Environmental Approach" Harper & Row Publ.
13. P. W. Hochachka& G. M. Somero (1973): "Strategies of Biochemical Adaptation".
14. J. G. Philips (1975): "Environmental Physiology" Blackwell Scientific Publ.
15. J. R. Bernstein (1972): "Biochemical Responses to Environmental Stress" Academic Press
16. Philip Carew Withers (1992): Comparative animal physiology SaundersCollege Pub.,

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

Course category: DSE

Course code: B-ZOR474T

Paper–Elective 2: 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.

Course outcomes:

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 gills in fishes, gill histology
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 Elective 2: 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).

REFERENCES:

1. Agarwal, V.P. 1999. Recent trends in aquaculture. Publisher Society of Biosciences, Agricultural Research, New Delhi. pp. 342.
2. Ahne, W.1980. Fish diseases. Spranger - Verlay, Berlin Heidelberg, New York.
3. Aitken, A., Mackie, M., Merritt S. H. and Windsor, M. L. 1982. Fish handling and processing.
4. Andrew, P. 1999. Fish business management: strategy, marketing - Development, fishing News
5. Austin, B. and Austin, D.A., 1987. Bacterial fish pathogens: Diseases in farmed and wild fish.
6. Balachandran K. K. 2001. Post harvest technology of fish and fish products. Daya Publishing.
7. Brandt. A. V. 1984. Fish catching methods of the world. Fishing News Books Ltd., London.
8. Connell, J. J., 1980. Advances in fish sciences and technology. Farnhan Survey England.
9. Cunningham, S., Dunn, M.R. and Whitmarsh, D., 1985. Fisheries Economics: An Introduction.
10. Cushing, D. H. 1968. Fisheries Biology: A study of population dynamics. Univ. Wisconsin Press,
11. Dahama, O. P. 1993. Extension and rural welfare. Ramprasad and Sons, Agra.
12. Das, P. and Jhingran, A. G. 1976. Fish Genetics in India, Today and Tomorrow Publishers, New
13. Day, F. William 1958. Fishes of India, Vol.1-2, Dawson & Sons Ltd., London.
14. Dhote, A. K. 1989. Fisheries management and extension : Inland fisheries, instructional-cum-practical manual (VI), National Council of Educational Research
15. Fort, R. S., 1961. Fishery Management, Faber & Faber, London.
16. George, M. Hall, 1992. Fish processing technology. VCH Publications, Inc., New York.
17. Goneshvar, C. and Sudhakar, C. 1997. Aquaculture in India, Publisher Sir Sai Publishing,
18. Govindan, I. K., 1985. Fish processing technology, Oxford and IBH Publishing Company.Pvt.
19. Gulland, J.A., 1983. Fish Stock Assessment. A manual of Basic Methods, John Wiley & Sons,
20. Hall, G. M., 1992. Fish processing technology. VCH publishers, Inc., New York.
21. Harry M. K. 1992. The Biology of Fishes, Daya Pub. House, Delhi. P.396.

22. Jhingran, V.G. & Pullin, R.S.V. 1985. A hatchery manual for the common, Chinese and Indian fisheries.
23. Jhingran, V.G. 1982. Fish and fisheries of India . Hindustan Pub. Corporation, Delhi. P.666.
24. John, E. Bardech, John, H. Ryther and William, O. Mclancy, 1972. Aquaculture - The farming
25. John, S. 1996. Commercial fishing method - An introduction to vessels and gear. Fishing News
26. Jones, S. 1969. The prawn fishery resources of India. FAO Fish Rep. 57(2).
27. Kabata, Z., 1985. Parasites and diseases of fish cultured in the tropics. IDRC, Taylor & Francis,
28. Lagler, K. F., Bardach, J. E. and Miller, R. R. 1962. Ichthyology. John Wiley, New York. 545 p.
29. Leatherland, J.F., Woo, P.T.K. and Bruno, D.W., 1998. Fish Diseases and Disorders, Vol. I-III.
30. Linwood, S. 1999. Introduction to Fish Physiology, Narendra Pub.Co, New Delhi
31. Matty, A.J., 1985. Fish Endocrinology. Timber Press, Portland.
32. Nikolsky. 1963. The Ecology of fishes, G.V.T.F.H. Publications Inc. Ltd., Academic press,
33. Pillai, T.V.R., 1990. Aquaculture principles and practices, Fishing News Books.
34. Pitcher, T.J. and Hart, P.J.B. 1982. Fisheries Ecology. The Avi Publishing Co. Westport,
35. Potts, G.W. and Wotton, R.J., 1984. Fish Reproduction: Strategies and Tactics, Academic Press,
36. Prasad, M.K.D. &Pitchaiah, P.S. 1999. Inland water resources - India Vol. I Discovery Publishing
37. Rao, P.S.1983. Fisheries economics and management in India. Pioneer Publishers
38. Rao, S.N., 1986. Economics of Fisheries. Daya Publishing House, Delhi.
39. Richard, Lloyd, 1989. Pollution and freshwater fish - Fishing News Books, London.
40. Robert, R. Stickney, 1994. Principles of Aquaculture. John Wiley & Sons, INC. New York.
41. Roberts, R.J., 1991. Fish Pathology. Bailliere Jindall, London.
42. Shaug, Y.C. 1981. Aquaculture economics: Basic concepts and methods of analysis, Groom
43. Shenoy, L.1988. Course manual in Fishing Technology. CIFE, Mumbai (1:88) pp. 91.
44. Shepherd, C. J. and Bromage, N.R. 1992. Intensive Fish Farming, Pu. Oxford Blackwell Scientific
45. Talwar, P. K. 1990. Inland fishes of India and adjacent countries, vol-I, II, New Delhi, Oxford
46. Templeton, R. G. K. 1995. Freshwater Fisheries Management. Fishing News Books.

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

Course category: DSE

Course code: B-ZOR475T

Paper–Elective 3: 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.

Course outcomes:

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 Elective 3: 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:

1. A textbook of in vitro fertilization and assisted reproduction edited by P.R. Brinsden and P.A. Rainsbur Jaypee brothers1992.
2. Advances in Reproductive Physiology, Vol. 1 to 6: Mclaren, (1968). Logos PressLtd., London.
3. Advances in Reproductive Toxicology eds. S. C. Joshi and A. S. Ansari Pointer publishers.
4. Andrology. 2nd Edition Male Reproductive health and dysfunction (Eds. E. Nieschlag & H.M. Behre) 2000.
5. Biochemistry of Mammalian Reproduction: Zanveld, L.J.D. & R.T. Chatterton (1982). John Wiley & sons, New York. The Ovary. Vol.I,II&III: Zuckerman, S, (1962). Academic Press, London.
6. Comparative cellular and molecular biology of testis in vertebrates (Trends in endocrine, paracrine and autocrine regulation of structure of functions) (2001) S.S.Guraya, Oxford and IBH Publishing Co. Pvt.Ltd. New Delhi, Calcutta.
7. Comparative Endocrinology and Reproduction. Eds. K.P. Joy, A. Krishna and C.

Haldar, Narosa Publishing House (1998).

8. Contraceptive Technology Past, Present and Future: Das. R.P. (1989). N.I.H.F.W. New Delhi.
9. Encylopedia of Reproduction Vol.I,II,III,IV eds. Ernst Knobiland J.D.Neill (1998).
10. Endocrinology and metabolism. 4th edition 2001. Philip Felig & Lowrence A. Frohmon McGraw HillInc. Medical Publishing Division.
11. Endocrinology.Vol.1to3:L.J.Degrootetal. (1989). W.B. Saundors Co. Philadelphia.
12. General Endocrinolgoy: Turner, C.D. & J.T. Bagnara (1990) W.B. Saunders Co., & ToppanCo., Philadelphia, London & Tokyo.
13. Patterns of Reproduction: Asdell S.A.(1964). Constable and Co. London.
14. Physiology of Lactation: Smith, Vearch, Constable &Co., London.
15. Postgraduate Reproductive endocrinology.4thEdition. 1997. R. Rajan Jaypee brothers. Medical Publishers (P)Ltd.
16. Practice of fertility control, Choudhary S.K. Churchill and Livingstone.
17. Progressin Reproductive Biology, Vol. 4. The pineal and reproduction: Reiter, R.J. Series Ed. P.O. Hubinant, Karger, Basel. Paris, London (latestedition).
18. Reproduction in Mammals Series: 1 to 6: Austin, C.R. and R. V. Short (1984 &1994), Cambridge University Press, Cambridge.
19. Reproductive Endocrinology: Ref. No.1,Vol.3 Hormones in Reproduction.
20. Seasonal Patterns of Stress, immune function and disease R.J. Nelson, G.E. Demas, S.L.Klein,L.J. Kriegsfeld.2002. CambridgeUniv.Press.
21. The Prostaglandins Vol.I&II: Ramwell, P.W.(1974). Prenum Press, New York and London.
22. The TestisVol.1 to 4: Jhonson, A.D. and W. R., Gomes.
23. WHO laboratory manual for the examination of human semen and sperm–cervical mucus interaction. 4thEdition Cambridge Univ. Press. 2000.

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: 2 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.

Course outcomes:

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.

Practicals:

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: 60**

1. Demonstration of electrophoresis of tissue extract/ Paper chromatography/ TLC	09
2. Antigen-antibody reaction/ Estimation of proteins by Lowry's method	07
3. Statistical analysis of given data/ Representation of given data by diagrams or graphs	09
4. Demonstration of Gram positive and Gram negative bacteria	07
5. Experiment from elective paper	09
6. Experiment from elective paper	07
7. Certified practical record	10
8. Viva voce	02

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

Course category: RM

Course code: B-ZOR477P

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.
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.

REFERENCES:

1. Ahuja, Ram (2014). *Research methods*. Jaipur: Rawat Publications. 454p.
2. Burns, Robert B. (2000). *Introduction to research methods*. London: Sage Publications. ix,613p.
3. Dixit, Manoj (2011). *Research methodology*. New Royal Book, Lucknow.vi,418p.
4. Jackson, Sherri L. (2009). *Research methods and statistics*. New Delhi: Cengage Learning India. 324p.
5. Kothari, C.R. (2011). *Research methodology: methods and techniques*. (3rd ed.). New Delhi: New Age International. xx,449p.
6. Sharma, Manoj (2004). *Research methodology*. New Delhi: Anmol Publications. vii;400p.
7. P. Suresh Narayana et al. (2018). Research Methodology in Zoology. Scientific Publishers, Jodhpur.
8. Sarkar, S. V. (2000). Intellectual property rights and Copy rights. EssEss Publications.
9. Banergee, P. K. (2013). Introduction to Biostatistics- A textbook of Biometry. S. Chand & Company Ltd. New Delhi.
10. Rao. K. S. (2010). Biostatistics for Health and Life Sciences.Himalayta Publishing House, New Delhi.
11. Jasra P. K. and Gurdeep Raj (2000). Biostatistics.KRISHNAPrakashan Media 9P) Ltd. Meerut, U. P.
12. Dutta N. K. (2002). Fundamentals of Biostatistics- Practical Approach.Kanishka Publishers & Distributors, New Delhi.

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 Vs protection; Concept of Buffer zones, Wildlife corridors Strategies to reduce human-wildlife interactions.
2.2. Role of Government and NGOs in controlling human-wildlife interactions Socio-economic issues related to human-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

References for Biodiversity and Conservation:

1. Agrawal, K. C. (2009). Biodiversity: Concept, Conservation and Management. ISBN: 81-89153-05-6.
2. Ahluwalia, V. K.; Malhotra, S. (2008). Environmental Science. ISBN-13: 978-1-42007-069-9.
3. Anderson, A. David (2010). Environmental economics and Natural resource Management. ISBN-13: 978-0-415-77904-3.
4. Balvanera, P.; Daily, G. C.; Ehrlich, P. R.;. Ricketts, T. H.; Bailey, S. A.; Kark, S.; Kremen, C.; Pereira, H. (2001). Conserving Biodiversity and Ecosystem Services. *Science*.
5. Botkin, D. B.; Keller, E. A. (2010). Envionmental Science. ISBN-13: 978-0470520338.
6. Central Zoo Authority (CZA) report (2011). Important zoo in India. www.cza.nic.in
7. Chaturvedi, Mahendra (2010). Biodiversity and Conservation. ISBN: 978-93-80388-03-8.
8. ENVIS. Environmental Information system. www.envis.nic.in
9. Gadgll, M.; Berkes, F.; Folke, C (1993). Indigenou knowledge for biodiversity conservation. *Ambio*Vol 22 No. 2-3.
10. IUCN Red List (2007). International Union for Conservation of Nature and Natural Resources.
11. Joshi, B. D.; Tripathi, C. P. M. and Joshi, P. C. (2008). Biodiversity and Environment Management. ISBN-13: 9788131304402.
12. Khoshoo, T.N. (1993). Himalayan biodiversity conservation - An overview pp. 5 - 35.
13. Mishra, S.P.; Pandey S. N. (2011). Essential Environmental Studies. ISBN: 978-93-8115-619-3.
14. MoEF Annual Report (2007-08). Ministry of Environment and Forest.
15. MoEF report of protected area network (2009). Ministry of Environment and Forest.
16. National Biodiversity Action Plan (2008). Government of India. Ministry of Environment and Forests.
17. NBA Annual Report (2009-10). National Biodiversity Authority. Govt. of India.
18. Negi, S. S. (1996). Biosphere Reserves in India. ISBN: 81-7387-043-8.
19. Negi, S. S. (2002). Handbook of National Parks, Wildlife Sanctuaries and Biosphere Reserves in India (3rd Edition). ISBN: 81-7387-128-0.
20. Oldfield, M.L. (1984). The value of conserving genetic resources. USDl, National Park Service, Washington D.C.
21. Pandey, B. N.; Singh, Shiveh P.; Singh, Rashmi (2010). Sustainable Management and Conservation of Biodiversity. ISBN: 978-93-80428-01-7.
22. Pullin, Andrew S. (2002). Conservation Biology. ISBN: 0521642841.
23. Sharma, P. D. (2012). Ecology and Environment. ISBN-13: 978-81-7133-965-5.
24. Tiger status Report (2011). National Tiger Conservation Authority, MoEF. Govt. of India.
25. UNESCO report (2005). World Network of Biosphere Reserves.
26. Wildlife (Protection) Act (1972). www.moef.nic.in/legis/wildlife/wildlife1_html

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.
Course outcomes: 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 Microtechnique:

1. Baker JR. Principles of Biological Microtechnique: A Study of Fixation and Dyeing. London, England: Methuen & Co. Ltd; 1958
2. Sanderson JB. Biological Microtechnique. Royal Microscopical Society Microscopy Handbooks. Vol. 28. Preston, UK: Bios Scientific Publishers Limited, A.M.A. Graphics Ltd.; 1994. 224 p
3. Preece A. Manual for Histologic Technicians. 3rd ed. Boston, MA: Little, Brown and Company; 1972. 428 p
4. Clayden EC. Practical Section Cutting and Staining. 2nd ed. London, England: J. & A. Churchill Ltd.; 1951
5. Mayers CP. Histological fixation by microwave heating. Journal of Clinical Pathology. 1970;23(3):273-275
6. Tripathi M, Bansal R, Gupta M, Bharat V. Comparison of routine fixation of tissues with rapid tissue fixation. Journal of Clinical and Diagnostic Research. 2013;7(12):2768-2773
7. Kiernan JA. Histological & Histochemical Methods: Theory & Practice. 2nd ed. Oxford, England: Pergamon Press; 1992

8. Gray P. Handbook of Basic Microtechnique. 3rd ed. New York: McGraw-Hill Book Company Inc; 1964. 302 p
9. Humason GL. Animal Tissue Techniques. 4th ed. San Francisco, CA: W.H. Freeman and Company; 1979. 661 p
10. Willey RL. Micro techniques: A Laboratory Guide. New York: The Macmillan Company; 1971. 99 p
11. Davenport HA. Histological and Histochemical Techniques. Philadelphia: W.B. Saunders Company; 1969. 401 p
12. Drury RAB, Wallington EA, Cameron SR. Carleton's Histological Technique. 4th ed. New York: Oxford University Press; 1976. 432 p
13. Bancroft JD, Stevens A. Theory and Practice of Histological Techniques. 2nd ed. New York: Churchill Livingstone; 1982. 662 p
14. Richardson DS, Lichtman JW. Clarifying tissue clearing. Cell. 2015;162:246-257
15. Troyer H. Principles and Techniques of Histochemistry. Boston MA: Little, Brown and Company (Inc.); 1980. 431 p
16. Patki L. R, Bhalchandra B. L. and Jeevaji I. H. An Introduction to Microtechnique. S. Chand & Co. Ltd, New Delhi, India: 1992. 167pp.

B. Sc. Semester-VIII Zoology (Honors)

Course category: DSE

Course code: B-ZOH483T

Paper–Elective1: Animal Physiology-II (Physiology of Circulation)

Total Credits: 4 Hours: 60

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.

Course outcomes: 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)

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. Artery with the help of already available permanent slides/ ICTtools/ 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 H all Inc.
7. C. L. Prosser (1973): "Comparative Animal Physiology" W. B. Saunders.
8. Withers, P.C. (1983): "Comparative Animal Physiology" International Ed. Saunders College Publishing.
9. K. Schmidt – Niel (1983): "Animal Physiology: Adaptation & Environmental" 3rd Ed. Cambridge Univ. Press.
10. R. W. Hill (1978): "Comparative Physiology of Animals – An Environmental Approach" Harper & Row Publ.
11. P. W. Hochachka & G. M. Somero (1973): "Strategies of Biochemical Adaptation".
12. J. G. Philips (1975): "Environmental Physiology" Blackwell Scientific Publ.
13. J. R. Bernstein (1972): "Biochemical Responses to Environmental Stress" Academic Press

B. Sc. Semester-VIII Zoology (Honors)
Course category: DSE
Course code: B-ZOH484T
Paper–Elective 2: Fish and Fisheries-II (Applied Fisheries)

Total Credits: 4 Hours: 60

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

Course outcomes: 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 Elective 2: Fish and Fisheries-II (Applied Fisheries)

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.

REFERENCES:

1. Agarwal, V.P. 1999. Recent trends in aquaculture. Publisher Society of Biosciences, Agricultural Research, New Delhi. pp. 342.
2. Ahne, W.1980. Fish diseases. Spranger - Verlay, Berlin Heidelberg, New York.
3. Aitken, A., Mackie, M., Merritt S. H. and Windsor, M. L. 1982. Fish handling and processing.
4. Andrew, P. 1999. Fish business management: strategy, marketing - Development, fishing News
5. Austin, B. and Austin, D.A., 1987. Bacterial fish pathogens: Diseases in farmed and wild fish.
6. Balachandran K. K. 2001. Post harvest technology of fish and fish products. Daya Publishing.
7. Brandt. A. V. 1984. Fish catching methods of the world. Fishing News Books Ltd., London.
8. Connell, J. J., 1980. Advances in fish sciences and technology. Farnhan Survey England.
9. Cunningham, S., Dunn, M.R. and Whitmarsh, D., 1985. Fisheries Economics: An Introduction.
10. Cushing, D. H. 1968. Fisheries Biology: A study of population dynamics. Univ. Wisconsin Press,
11. Dahama, O. P. 1993. Extension and rural welfare. Ramprasad and Sons, Agra.
12. Das, P. and Jhingran, A. G. 1976. Fish Genetics in India, Today and Tomorrow Publishers, New
13. Day, F. William 1958. Fishes of India, Vol.1-2, Dawson & Sons Ltd., London.
14. Dhote, A. K. 1989. Fisheries management and extension : Inland fisheries, instructional-cum-practical manual (VI), National Council of Educational Research
15. Fort, R. S., 1961. Fishery Management, Faber & Faber, London.
16. George, M. Hall, 1992. Fish processing technology. VCH Publications, Inc., New York.
17. Goneshvar, C. and Sudhakar, C. 1997. Aquaculture in India, Publisher Sir Sai Publishing,
18. Govindan, I. K., 1985. Fish processing technology, Oxford and IBH Publishing Company.Pvt.
19. Gulland, J.A., 1983. Fish Stock Assessment. A manual of Basic Methods, John Wiley & Sons,
20. Hall, G. M., 1992. Fish processing technology. VCH publishers, Inc., New York.
21. Harry M. K. 1992. The Biology of Fishes, Daya Pub. House, Delhi. P.396.
22. Jhingran, V.G. & Pullin, R.S.V. 1985. A hatchery manual for the common, Chinese and Indian fisheries.

23. Jhingran, V.G. 1982. Fish and fisheries of India . Hindustan Pub. Corporation, Delhi. P.666.
24. John, E. Bardech, John, H. Ryther and William, O. Mclancy, 1972. Aquaculture - The farming
25. John, S. 1996. Commercial fishing method - An introduction to vessels and gear. Fishing News
26. Jones, S. 1969. The prawn fishery resources of India. FAO Fish Rep. 57(2).
27. Kabata, Z., 1985. Parasites and diseases of fish cultured in the tropics. IDRC, Taylor & Francis,
28. Lagler, K. F., Bardach, J. E. and Miller, R. R. 1962. Ichthyology. John Wiley, New York. 545 p.
29. Leatherl and, J.F., Woo, P.T.K. and Bruno, D.W., 1998. Fish Diseases and Disorders, Vol. I-III.
30. Linwood, S. 1999. Introduction to Fish Physiology, Narendra Pub. Co, New Delhi
31. Matty, A.J., 1985. Fish Endocrinology. Timber Press, Portland.
32. Nikolsky. 1963. The Ecology of fishes, G.V.T.F.H. Publications Inc. Ltd., Academic press,
33. Pillai, T.V.R., 1990. Aquaculture principles and practices, Fishing News Books.
34. Pitcher, T.J. and Hart, P.J.B. 1982. Fisheries Ecology. The Avi Publishing Co. Westport,
35. Potts, G.W. and Wotton, R.J., 1984. Fish Reproduction: Strategies and Tactics, Academic Press,
36. Prasad, M.K.D. & Pitchaiah, P.S. 1999. Inland water resources - India Vol. I Discovery Publishing
37. Rao, P.S.1983. Fisheries economics and management in India. Pioneer Publishers
38. Rao, S.N., 1986. Economics of Fisheries. Daya Publishing House, Delhi.
39. Richard, Lloyd, 1989. Pollution and freshwater fish - Fishing News Books, London.
40. Robert, R. Stickney, 1994. Principles of Aquaculture. John Wiley & Sons, INC. New York.
41. Roberts, R.J., 1991. Fish Pathology. Bailliere Jindall, London.
42. Shaug, Y.C. 1981. Aquaculture economics: Basic concepts and methods of analysis, Groom
43. Shenoy, L.1988. Course manual in Fishing Technology. CIFE, Mumbai (1:88) pp. 91.
44. Shepherd, C. J. and Bromage, N.R. 1992. Intensive Fish Farming, Pu. Oxford Blackwell Scientific
45. Talwar, P. K. 1990. Inland fishes of India and adjacent countries, vol-I, II, New Delhi, Oxford
46. Templeton, R. G. K. 1995. Freshwater Fisheries Management. Fishing News Books.

B. Sc. Semester-VIII Zoology (Honors)
Course category: DSE
Course code: B-ZOH485T
Paper–Elective 3: Mammalian Reproductive Physiology-II
(Reproductive Process in Female)

Total Credits: 4 Hours: 60

Course objectives:
To introduce students to the physiology of female reproductive system.
Course outcomes: 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. Corpus luteum: 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 vaginal cytology, vaginal plug.

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)

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

REFERENCES:

1. A textbook of in vitro fertilization and assisted reproduction edited by P.R. Brinsden and P.A. Rainsbur Jaypee brothers1992.
2. Advances in Reproductive Physiology, Vol. 1 to 6: Mclaren, (1968). Logos Press Ltd., London.
3. Advances in Reproductive Toxicology eds. S. C. Joshi and A. S. Ansari Pointer publishers.
4. Andrology. 2nd Edition Male Reproductive health and dysfunction (Eds. E. Nieschlag & H.M. Behre) 2000.
5. Biochemistry of Mammalian Reproduction: Zanveld, L.J.D. & R.T. Chatterton (1982). John Wiley & sons, New York. The Ovary. Vol.I,II &III: Zuckerman, S, (1962). Academic Press, London.
6. Biology of Gestation: Assalye ,N.S.(1968). Academic Press, London.
7. Biology of ovarian follicles in mammals (1985). S.S. Guraya Springer-Verlag.
8. Comparative cellular and molecular biology of testis in vertebrates (Trends in endocrine, paracrine and autocrine regulation of structure of functions) (2001) S.S. Guraya, Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi, Calcutta.
9. Comparative Endocrinology and Reproduction. Eds. K.P. Joy, A. Krishna and C. Haldar, Narosa Publishing House (1998).
10. Contraceptive Technology Past, Present and Future: Das. R.P. (1989). N.I.H.F.W. NewDelhi.
11. Control of ovulation: Crighton, D.B., Haynes, N.B. Foxcroft, G.R. & G.E. Lamming (1978).Butterworths , London.
12. Encylopedia of Reproduction Vol.I, II,III,IV eds. Ernst Knobiland J.D. Neill (1998).
13. Endocrinology and metabolism. 4th edition 2001. Philip Felig & Lowrence A. Frohmon McGrawHill Inc. Medical Publishing Division.

14. Endocrinology.Vol.1to3: L.J. Degrootetal.(1989). W.B. Saundors Co. Philadelphia.
15. General Endocrinolgoy: Turner, C.D. & J.T. Bagnara (1990) W.B. Saunders Co., &Toppan Co., Philadelphia, London & Tokyo.
16. Hormonal Control of Lactation: Cowie, A.T. Forryth, I.A. and I. Hart (1980). Springer-Verlag, Berlin & NewYork.
17. Mammalian Oviduct: Hafez, E.S., and R.J. Blandu. The University of Chicago Press,Chicago, London.
18. Marshall's Physiology of Reproduction. 4th Edition Vol. 3 Pregnancy and Lactation PartI, II,III edited by G.E. Lamming, Champan and Hall.
19. Ovarian Cycle of Mammals: Perry, J.S. Oliver and Boyd, Edinburgh.
20. Patterns of Reproduction: Asdell, S.A.(1964). Constable and Co. London.
21. Physiology of Lactation: Smith, Vearch, Constable & Co., London.
22. Postgraduate Reproductive endocrinology. 4thEdition. 1997. R.Rajan Jaypee brothers. Medical Publishers (P)Ltd.
23. Practice of fertility control, Choudhary S.K.Churchill and Livingstone.
24. Progress in Reproductive Biology, Vol. 4. The pineal and reproduction: Reiter, R.J. Series Ed. P.O. Hubinant, Karger, Basel. Paris, London(latest edition).
25. Reproduction in Mammals Series: 1 to 6: Austin, C.R. and R. V. Short (1984 &1994), Cambridge University Press, Cambridge.
26. Reproductive Endocrinology: Ref. No.1,Vol. 3 Hormones in Reproduction.
27. Seasonal Patterns of Stress, immune function and disease R.J. Nelson, G.E. Demas, S.L. Klein, L.J. Kriegsfeld. 2002. Cambridge Univ. Press.
28. Shaw's text book of Gynaecology eds. V.G. Padubidri and S.N. Daftary. 2000.
29. The Biology of Blastocyst: Blandau, R.J. (1971). The University of Chicago Press, Chicago & London.
30. The Prostaglandins Vol. I&II: Ramwell, P.W. (1974). Prenum Press, New York and London.
31. The Testis Vol.1 to 4: J honson, A.D. and W. R., Gomes.
32. Vertebrate Foetal Membrances: Mossman, H.W. (1989). Rutgress Press Ltd.
33. WHO aboratory manual for the examination of human semen and sperm– cervical mucus interaction. 4thEdition Cambridge Univ. Press. 2000.

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/ z-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	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-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 Vs protection; Concept of Buffer zones, Wildlife corridors Strategies to reduce human-wildlife interactions.
2.2. Role of Government and NGOs in controlling human-wildlife interactions Socio-economic issues related to human-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

References for Biodiversity and Conservation:

1. Agrawal, K. C. (2009). Biodiversity: Concept, Conservation and Management. ISBN: 81-89153-05-6.
2. Ahluwalia, V. K.; Malhotra, S. (2008). Environmental Science. ISBN-13: 978-1-42007-069-9.
3. Anderson, A. David (2010). Environmental economics and Natural resource Management. ISBN-13: 978-0-415-77904-3.
4. Balvanera, P.; Daily, G. C.; Ehrlich, P. R.;. Ricketts, T. H.; Bailey, S. A.; Kark, S.; Kremen, C.; Pereira, H. (2001). Conserving Biodiversity and Ecosystem Services. *Science*.
5. Botkin, D. B.; Keller, E. A. (2010). Envionmental Science. ISBN-13: 978-0470520338.
6. Central Zoo Authority (CZA) report (2011). Important zoo in India. www.cza.nic.in
7. Chaturvedi, Mahendra (2010). Biodiversity and Conservation. ISBN: 978-93-80388-03-8.
8. ENVIS. Environmental Information system. www.envis.nic.in
9. Gadgll, M.; Berkes, F.; Folke, C (1993). Indigenou knowledge for biodiversity conservation. *Ambio*Vol 22 No. 2-3.
10. IUCN Red List (2007). International Union for Conservation of Nature and Natural Resources.
11. Joshi, B. D.; Tripathi, C. P. M. and Joshi, P. C. (2008). Biodiversity and Environment Management. ISBN-13: 9788131304402.
12. Khoshoo, T.N. (1993). Himalayan biodiversity conservation - An overview pp. 5 - 35.
13. Mishra, S.P.; Pandey S. N. (2011). Essential Environmental Studies. ISBN: 978-93-8115-619-3.
14. MoEF Annual Report (2007-08). Ministry of Environment and Forest.
15. MoEF report of protected area network (2009). Ministry of Environment and Forest.
16. National Biodiversity Action Plan (2008). Government of India. Ministry of Environment and Forests.
17. NBA Annual Report (2009-10). National Biodiversity Authority. Govt. of India.
18. Negi, S. S. (1996). Biosphere Reserves in India. ISBN: 81-7387-043-8.
19. Negi, S. S. (2002). Handbook of National Parks, Wildlife Sanctuaries and Biosphere Reserves in India (3rd Edition). ISBN: 81-7387-128-0.
20. Oldfield, M.L. (1984). The value of conserving genetic resources. USDl, National Park Service, Washington D.C.
21. Pandey, B. N.; Singh, Shiveh P.; Singh, Rashmi (2010). Sustainable Management and Conservation of Biodiversity. ISBN: 978-93-80428-01-7.
22. Pullin, Andrew S. (2002). Conservation Biology. ISBN: 0521642841.
23. Sharma, P. D. (2012). Ecology and Environment. ISBN-13: 978-81-7133-965-5.
24. Tiger status Report (2011). National Tiger Conservation Authority, MoEF. Govt. of India.
25. UNESCO report (2005). World Network of Biosphere Reserves.
26. Wildlife (Protection) Act (1972). www.moef.nic.in/legis/wildlife/wildlife1_html

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.
Course outcomes: 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 Microtechnique:

1. Baker JR. Principles of Biological Microtechnique: A Study of Fixation and Dyeing. London, England: Methuen & Co. Ltd; 1958
2. Sanderson JB. Biological Microtechnique. Royal Microscopical Society Microscopy Handbooks. Vol. 28. Preston, UK: Bios Scientific Publishers Limited, A.M.A. Graphics Ltd.; 1994. 224 p
3. Preece A. Manual for Histologic Technicians. 3rd ed. Boston, MA: Little, Brown and Company; 1972. 428 p
4. Clayden EC. Practical Section Cutting and Staining. 2nd ed. London, England: J. & A. Churchill Ltd.; 1951
5. Mayers CP. Histological fixation by microwave heating. Journal of Clinical Pathology. 1970;23(3):273-275
6. Tripathi M, Bansal R, Gupta M, Bharat V. Comparison of routine fixation of tissues with rapid tissue fixation. Journal of Clinical and Diagnostic Research. 2013;7(12):2768-2773

7. Kiernan JA. Histological & Histochemical Methods: Theory & Practice. 2nd ed. Oxford, England: Pergamon Press; 1992
8. Gray P. Handbook of Basic Microtechnique. 3rd ed. New York: McGraw-Hill Book Company Inc; 1964. 302 p
9. Humason GL. Animal Tissue Techniques. 4th ed. San Francisco, CA: W.H. Freeman and Company; 1979. 661 p
10. Willey RL. Micro techniques: A Laboratory Guide. New York: The Macmillan Company; 1971. 99 p
11. Davenport HA. Histological and Histochemical Techniques. Philadelphia: W.B. Saunders Company; 1969. 401 p
12. Drury RAB, Wallington EA, Cameron SR. Carleton's Histological Technique. 4th ed. New York: Oxford University Press; 1976. 432 p
13. Bancroft JD, Stevens A. Theory and Practice of Histological Techniques. 2nd ed. New York: Churchill Livingstone; 1982. 662 p
14. Richardson DS, Lichtman JW. Clarifying tissue clearing. Cell. 2015;162:246-257
15. Troyer H. Principles and Techniques of Histochemistry. Boston MA: Little, Brown and Company (Inc.); 1980. 431 p
16. Patki L. R, Bhalchandra B. L. and Jeevaji I. H. An Introduction to Microtechnique. S. Chand & Co. Ltd, New Delhi, India: 1992. 167pp.

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: 4 Hours: 60

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.

Course outcomes: 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)

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. Artery with the help of already available permanent slides/ ICTtools/ 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 H all Inc.
7. C. L. Prosser (1973): "Comparative Animal Physiology" W. B. Saunders.
8. Withers, P.C. (1983): "Comparative Animal Physiology" International Ed. Saunders College Publishing.
9. K. Schmidt – Niel (1983): "Animal Physiology: Adaptation & Environmental" 3rd Ed. Cambridge Univ. Press.
10. R. W. Hill (1978): "Comparative Physiology of Animals – An Environmental Approach" Harper & Row Publ.
11. P. W. Hochachka & G. M. Somero (1973): "Strategies of Biochemical Adaptation".
12. J. G. Philips (1975): "Environmental Physiology" Blackwell Scientific Publ.
13. J. R. Bernstein (1972): "Biochemical Responses to Environmental Stress" Academic Press

B. Sc. Semester-VIII Zoology (Honors with Research)
Course category: DSE
Course code: B-ZOR484T
Paper–Elective 2: Fish and Fisheries-II (Applied Fisheries)

Total Credits: 4 Hours: 60

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

Course outcomes: 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 Elective 2: Fish and Fisheries-II (Applied Fisheries)

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.

REFERENCES:

1. Agarwal, V.P. 1999. Recent trends in aquaculture. Publisher Society of Biosciences, Agricultural Research, New Delhi. pp. 342.
2. Ahne, W.1980. Fish diseases. Spranger - Verlay, Berlin Heidelberg, New York.
3. Aitken, A., Mackie, M., Merritt S. H. and Windsor, M. L. 1982. Fish handling and processing.
4. Andrew, P. 1999. Fish business management: strategy, marketing - Development, fishing News
5. Austin, B. and Austin, D.A., 1987. Bacterial fish pathogens: Diseases in farmed and wild fish.
6. Balachandran K. K. 2001. Post harvest technology of fish and fish products. Daya Publishing.
7. Brandt. A. V. 1984. Fish catching methods of the world. Fishing News Books Ltd., London.
8. Connell, J. J., 1980. Advances in fish sciences and technology. Farnhan Survey England.
9. Cunningham, S., Dunn, M.R. and Whitmarsh, D., 1985. Fisheries Economics: An Introduction.
10. Cushing, D. H. 1968. Fisheries Biology: A study of population dynamics. Univ. Wisconsin Press,
11. Dahama, O. P. 1993. Extension and rural welfare. Ramprasad and Sons, Agra.
12. Das, P. and Jhingran, A. G. 1976. Fish Genetics in India, Today and Tomorrow Publishers, New
13. Day, F. William 1958. Fishes of India, Vol.1-2, Dawson & Sons Ltd., London.
14. Dhote, A. K. 1989. Fisheries management and extension : Inland fisheries, instructional-cum-practical manual (VI), National Council of Educational Research
15. Fort, R. S., 1961. Fishery Management, Faber & Faber, London.
16. George, M. Hall, 1992. Fish processing technology. VCH Publications, Inc., New York.
17. Goneshvar, C. and Sudhakar, C. 1997. Aquaculture in India, Publisher Sir Sai Publishing,
18. Govindan, I. K., 1985. Fish processing technology, Oxford and IBH Publishing Company.Pvt.
19. Gulland, J.A., 1983. Fish Stock Assessment. A manual of Basic Methods, John Wiley & Sons,
20. Hall, G. M., 1992. Fish processing technology. VCH publishers, Inc., New York.
21. Harry M. K. 1992. The Biology of Fishes, Daya Pub. House, Delhi. P.396.

22. Jhingran, V.G. & Pullin, R.S.V. 1985. A hatchery manual for the common, Chinese and Indian fisheries.
23. Jhingran, V.G. 1982. Fish and fisheries of India . Hindustan Pub. Corporation, Delhi. P.666.
24. John, E. Bardech, John, H. Ryther and William, O. Mclancy, 1972. Aquaculture - The farming
25. John, S. 1996. Commercial fishing method - An introduction to vessels and gear. Fishing News
26. Jones, S. 1969. The prawn fishery resources of India. FAO Fish Rep. 57(2).
27. Kabata, Z., 1985. Parasites and diseases of fish cultured in the tropics. IDRC, Taylor & Francis,
28. Lagler, K. F., Bardach, J. E. and Miller, R. R. 1962. Ichthyology. John Wiley, New York. 545 p.
29. Leatherl and, J.F., Woo, P.T.K. and Bruno, D.W., 1998. Fish Diseases and Disorders, Vol. I-III.
30. Linwood, S. 1999. Introduction to Fish Physiology, Narendra Pub. Co, New Delhi
31. Matty, A.J., 1985. Fish Endocrinology. Timber Press, Portland.
32. Nikolsky. 1963. The Ecology of fishes, G.V.T.F.H. Publications Inc. Ltd., Academic press,
33. Pillai, T.V.R., 1990. Aquaculture principles and practices, Fishing News Books.
34. Pitcher, T.J. and Hart, P.J.B. 1982. Fisheries Ecology. The Avi Publishing Co. Westport,
35. Potts, G.W. and Wotton, R.J., 1984. Fish Reproduction: Strategies and Tactics, Academic Press,
36. Prasad, M.K.D. & Pitchaiah, P.S. 1999. Inland water resources - India Vol. I Discovery Publishing
37. Rao, P.S.1983. Fisheries economics and management in India. Pioneer Publishers
38. Rao, S.N., 1986. Economics of Fisheries. Daya Publishing House, Delhi.
39. Richard, Lloyd, 1989. Pollution and freshwater fish - Fishing News Books, London.
40. Robert, R. Stickney, 1994. Principles of Aquaculture. John Wiley & Sons, INC. New York.
41. Roberts, R.J., 1991. Fish Pathology. Bailliere Jindall, London.
42. Shaug, Y.C. 1981. Aquaculture economics: Basic concepts and methods of analysis, Groom
43. Shenoy, L.1988. Course manual in Fishing Technology. CIFE, Mumbai (1:88) pp. 91.
44. Shepherd, C. J. and Bromage, N.R. 1992. Intensive Fish Farming, Pu. Oxford Blackwell Scientific
45. Talwar, P. K. 1990. Inland fishes of India and adjacent countries, vol-I, II, New Delhi, Oxford
46. Templeton, R. G. K. 1995. Freshwater Fisheries Management. Fishing News Books.

B. Sc. Semester-VIII Zoology (Honors with Research)
Course category: DSE
Course code: B-ZOR485T
Paper–Elective 3: Mammalian Reproductive Physiology-II
(Reproductive Process in Female)

Total Credits: 4 Hours: 60

Course objectives:
To introduce students to the physiology of female reproductive system.
Course outcomes: 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. Corpus luteum: 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 vaginal cytology, vaginal plug.

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 Elective 3: Mammalian Reproductive Physiology-II
(Reproductive Process in Female)

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

REFERENCES:

1. A textbook of in vitro fertilization and assisted reproduction edited by P.R. Brinsden and P.A. Rainsbur Jaypee brothers1992.
2. Advances in Reproductive Physiology, Vol. 1 to 6: Mclaren, (1968). Logos Press Ltd., London.
3. Advances in Reproductive Toxicology eds. S. C. Joshi and A. S. Ansari Pointer publishers.
4. Andrology. 2nd Edition Male Reproductive health and dysfunction (Eds. E. Nieschlag & H.M. Behre) 2000.
5. Biochemistry of Mammalian Reproduction: Zanveld, L.J.D. & R.T. Chatterton (1982). John Wiley & sons, New York. The Ovary. Vol.I,II &III: Zuckerman, S, (1962). Academic Press, London.
6. Biology of Gestation: Assalye ,N.S.(1968). Academic Press, London.
7. Biology of ovarian follicles in mammals (1985). S.S. Guraya Springer-Verlag.
8. Comparative cellular and molecular biology of testis in vertebrates (Trends in endocrine, paracrine and autocrine regulation of structure of functions) (2001) S.S. Guraya, Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi, Calcutta.
9. Comparative Endocrinology and Reproduction. Eds. K.P. Joy, A. Krishna and C. Haldar, Narosa Publishing House (1998).
10. Contraceptive Technology Past, Present and Future: Das. R.P. (1989). N.I.H.F.W. NewDelhi.
11. Control of ovulation: Crighton, D.B., Haynes, N.B. Foxcroft, G.R. & G.E. Lamming (1978).Butterworths , London.
12. Encylopedia of Reproduction Vol.I, II,III,IV eds. Ernst Knobiland J.D. Neill (1998).
13. Endocrinology and metabolism. 4th edition 2001. Philip Felig & Lowrence A. Frohmon

McGrawHill Inc. Medical Publishing Division.
14. Endocrinology.Vol.1to3: L.J. Degrootetal.(1989). W.B. Saundors Co. Philadelphia.
15. General Endocrinolgoy: Turner, C.D. & J.T. Bagnara (1990) W.B. Saunders Co., &Toppan Co., Philadelphia, London & Tokyo.
16. Hormonal Control of Lactation: Cowie, A.T. Forryth, I.A. and I. Hart (1980). Springer-Verlag, Berlin & NewYork.
17. Mammalian Oviduct: Hafez, E.S., and R.J. Blandu. The University of Chicago Press,Chicago, London.
18. Marshall's Physiology of Reproduction. 4th Edition Vol. 3 Pregnancy and Lactation PartI, II,III edited by G.E. Lamming, Champan and Hall.
19. Ovarian Cycle of Mammals: Perry, J.S. Oliver and Boyd, Edinburgh.
20. Patterns of Reproduction: Asdell, S.A.(1964). Constable and Co. London.
21. Physiology of Lactation: Smith, Vearch, Constable & Co., London.
22. Postgraduate Reproductive endocrinology. 4thEdition. 1997. R.Rajan Jaypee brothers. Medical Publishers (P)Ltd.
23. Practice of fertility control, Choudhary S.K.Churchill and Livingstone.
24. Progress in Reproductive Biology, Vol. 4. The pineal and reproduction: Reiter, R.J. Series Ed. P.O. Hubinant, Karger, Basel. Paris, London(latest edition).
25. Reproduction in Mammals Series: 1 to 6: Austin, C.R. and R. V. Short (1984 &1994), Cambridge University Press, Cambridge.
26. Reproductive Endocrinology: Ref. No.1,Vol. 3 Hormones in Reproduction.
27. Seasonal Patterns of Stress, immune function and disease R.J. Nelson, G.E. Demas, S.L. Klein, L.J. Kriegsfeld. 2002. Cambridge Univ. Press.
28. Shaw's text book of Gynaecology eds. V.G. Padubidri and S.N. Daftary. 2000.
29. The Biology of Blastocyst: Blandau, R.J. (1971). The University of Chicago Press, Chicago & London.
30. The Prostaglandins Vol. I&II: Ramwell, P.W. (1974). Prenum Press, New York and London.
31. The Testis Vol.1 to 4: J honson, A.D. and W. R., Gomes.
32. Vertebrate Foetal Membrances: Mossman, H.W. (1989). Rutgress Press Ltd.
33. WHO aboratory manual for the examination of human semen and sperm– cervical mucus interaction. 4thEdition Cambridge Univ. Press. 2000.

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: 2 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/ z-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: 60**
1. Numerical problem on t-test	07
2. Study of vegetation by Quadrat method	08
3. Permanent preparation of H-E staining	07
4. Histochemical demonstration of carbohydrates/ proteins/ lipids	08
5. Experiment from elective paper	07
6. Experiment from elective paper	08
7. Identification and comment on spots (1 to 5)	05
8. Submission of certified practical record	08
9. Viva voce	02