INSTITUTE OF SCIENCE, NAGPUR

(An Autonomous Institute of Govt. of Maharashtra)

Department of Zoology

Teaching and Examination scheme

Bachelor of Science (Honors/Research)

Four-Year (Eight Semester Degree Course)

B.Sc. Sem- I (Zoology -Major, Minor from Basket)

Sr No	Course Category	Name of the course (Title of the Paper)	Course code	Teaching Scheme (hrs)			Total Credit	Evaluation Scheme			
				Theory	Tutorial	Practical					
				Th	Tu	P		Duration of Examination (Hrs)	End Semester Evaluation (ESE)	Continuous Internal Evaluation (CIE)	Minimum Passing Marks
1	DSC	Paper 1: **Life and Diversity of Nonchordates-I (Protozoa to Annelida)**	**BZODSCT1**	2	--	--	2	2	40	10	20
		Paper 2: **Principles of Ecology**	**BZODSCT2**	2	--	--	2	2	40	10	20
		DSC Lab (Based on Paper1 + Paper 2)	**BZODSCP1**	--	--	4	2	4 – 6	40	10	25
2	GE/OE	**Bioinstrumentation**	**BZOGE1**	2	--	--	2	2	40	10	20
		Economic Entomology	**BZOGE2**	2	--	--	2	2	40	10	20
3	VSEC (VSC/SEC)	**Vermicomposting**	**BZOVSEC1**	--	--	4	2	4 - 6	40	10	25
			BZOVEC2	--	--	4	2	4 - 6	40	10	25
4	AEC	English Compulsory		2	--	--	2	2	40	10	20
5	VEC	Environmental Studies		2	--	--	2	2	40	10	20
6	IKS	Indian Knowledge System (Yoga for Health)	**BZOIKS1**	2	--	--	2	2	40	10	20
7	CC	NSS /NCC / Sports / Cultural		--	--	4	2	--	25	25	25
Total				14	--	16	22	--	425	125	--

B.Sc. Sem-II (Zoology -Major, Minor from Basket)

Sr No	Course Category	Name of the course (Title of the Paper)	Course code	Teaching Scheme (hrs)			Total Credit	Evaluation Scheme			
				Theory	Tutorial	Practical					
				Th	Tu	P		Duration of Examination (Hrs)	End Semester Evaluation (ESE)	Continuous Internal Evaluation (CIE)	Minimum Passing Marks
1	DSC	Paper 1: **Life and Diversity of Nonchordates-II (Arthropoda to Hemichordata)**	**BZODSCT3**	2	--	--	2	2	40	10	20
		Paper 2:**Cell Biology**	**BZODSCT4**	2	--	--	2	2	40	10	20
		DSC Lab (Based on Paper 1 + Paper 2)	**BZODSCP2**	--	--	4	2	4 – 6	40	10	25
2	GE/OE	**Avian Biology**	**BZOGE3**	2	--	--	2	2	40	10	20
		Inland Fish culture	**BZOGE4**	2	--	--	2	2	40	10	20
3	VSEC (VSC/SEC)		**BZOVSEC3**	--	--	4	2	4 - 6	40	10	25
		Aquarium-Fish-Keeping	**BZOVSEC4**	--	--	4	2	4 - 6	40	10	25
4	AEC	English Compulsory		2	--	--	2	2	40	10	20
5	VEC	Constitution of India		2	--	--	2	2	40	10	20
6	IKS	Indian Knowledge System (Yoga for better Lifestyle)	**BZOIKS2**	2	--	--	2	2	40	10	20
7	CC	NSS /NCC / Sports / Cultural		--	--	4	2	--	25	25	25
Total				14	--	16	22	--	425	125	--

B.Sc. Sem-III (Zoology -Major, Minor from Basket)

Sr No	Course Category	Name of the course (Title of the Paper)	Course code	Teaching Scheme (hrs)			Total Credit	Evaluation Scheme			
				Theory	Tutorial	Practical		Duration of Examination (Hrs)	End Semester Evaluation (ESE)	Continuous Internal Evaluation (CIE)	Minimum Passing Marks
				Th	Tu	P					
1	DSC	Paper 1: **Life and Diversity of Chordates-I (Protochordata to Amphibia)**	**BZODSCT5**	2	--	--	2	2	40	10	20
		Paper 2: **Basics of Genetics**	**BZODSCT6**	2	--	--	2	2	40	10	20
		DSC Lab (Based on Paper 1 + Paper 2)	**BZODSCP3**	--	--	4	2	4 – 6	40	10	25
2	Minor	Paper 1: **Life and Diversity of Chordates-I (Protochordata to Amphibia)**	**BZOMINT1**	2	--	--	2	2	40	10	20
		Paper 2: **Basics of Genetics**	**BZOMINT2**	2	--	--	2	2	40	10	20
		Minor Lab (Based on Paper 1 + Paper 2)	**BZOMINP1**	--	--	4	2	4 - 6	40	10	25
3	GE/OE	**Animal behaviour**	**BZOGE5**	2	--	--	2	2	40	10	20
4	VSEC (VSC/SEC)	**Honey bee Keeping**	**BZOVSEC5**	--	--	4	2	4 - 6	40	10	25
5	AEC	Second Language		2	--	--	2	2	40	10	20
6	FP	Field Project	**BZOFP**	--	--	4	2	4 - 6	25	25	25
7	CC	NSS/NCC / Sports / Cultural		--	--	4	2	--	25	25	25
Total				12	--	20	22	--	410	140	--

B.Sc. Sem-IV (Zoology -Major, Minor from Basket)

Sr No	Course Category	Name of the course (Title of the Paper)	Course code	Teaching Scheme (hrs)			Total Credit	Evaluation Scheme			
				Theory	Tutorial	Practical		Duration of Examination (Hrs)	End Semester Evaluation (ESE)	Continuous Internal Evaluation (CIE)	Minimum Passing Marks
				Th	Tu	P					
1	DSC	Paper 1: **Life and Diversity of Chordates-II (Reptilia to Mammalia)**	**BZODSCT7**	2	--	--	2	2	40	10	20
		Paper 2: **Molecular Biology**	**BZODSCT8**	2	--	--	2	2	40	10	20
		DSC Lab (Based on Paper 1 + Paper 2)	**BZODSCP4**	--	--	4	2	4 – 6	40	10	25
2	Minor	Paper 1: **Life and Diversity of Chordates-II (Reptilia to Mammalia)**	**BZOMINT3**	2	--	--	2	2	40	10	20
		Paper 2: **Molecular Biology**	**BZOMINT4**	2	--	--	2	2	40	10	20
		Minor Lab (Based on Paper1 + Paper2)	**BZOMINP2**	--	--	4	2	4 - 6	40	10	25
3	GE/OE	**Ecosystems**	**BZOGE6**	2	--	--	2	2	40	10	20
4	VSEC (VSC/SEC)	**Water Quality Analysis**	**BZOVSEC6**	--	--	4	2	4 - 6	40	10	25
5	AEC	Second Language		2	--	--	2	2	40	10	20
6	CEP	Community Service		--	--	4	2	--	25	25	25
7	CC	NSS/NCC / Sports / Cultural		--	--	4	2	--	25	25	25
Total				12	--	20	22	--	410	140	--

B.Sc. Sem-V (Zoology -Major, Minor from Basket)

Sr No	Course Category	Name of the course (Title of the Paper)	Course code	Teaching Scheme (hrs)			Total Credit	Evaluation Scheme			
				Theory	Tutorial	Practical		Duration of Examination (Hrs)	End Semester Evaluation (ESE)	Continuous Internal Evaluation (CIE)	Minimum Passing Marks
				Th	Tu	P					
1	DSC	Paper 1: **Advanced Genetics**	**BZODSCT9**	3	--	--	3	3	60	15	30
		Paper 2: **Basics of Immunology**	**BZODSCT10**	3	--	--	3	3	60	15	30
		DSC Lab (Based on Paper 1 + Paper 2)	**BZODSCP5**	--	--	6	3	6	60	15	38
2	DSE	Elective 1: **Reproductive biology** Elective 2**: Parasitology**	**BZODSET1 BZODSET2**	2	--	--	2	2	40	10	20
		DSE Lab (Based on Elective 1) **DSE Lab** (Based on Elective 2)	**BZODSEP1 BZODSEP2**	--	--	4	2	4-6	40	10	25
3	Minor	Paper 1: **Cellular organization**	**BZOMINT5**	2	--	--	2	2	40	10	20
		Paper 2: **Basics of Genetics**	**BZOMINT6**	2	--	--	2	2	40	10	20
		Minor Lab (Based on Paper1 + Paper2)	**BZOMINP3**	--	--	4	2	4 – 6	40	10	25
4	VSEC (VSC/SEC)	**Haematological Techniques**	**BZOVSEC7**	--	--	4	2	4 - 6	40	10	25
5	CEP	Community Service		--	--	2	1	--		25	13
				12	--	20	22		420	130	--

B.Sc. Sem-VI (Zoology -Major, Minor from Basket)

Sr No	Course Category	Name of the course (Title of the Paper)	Course code	Teaching Scheme (hrs)			Total Credit	Evaluation Scheme			
				Theory	Tutorial	Practical		Duration of Examination (Hrs)	End Semester Evaluation (ESE)	Continuous Internal Evaluation (CIE)	Minimum Passing Marks
				Th	Tu	P					
1	DSC	Paper 1: **Genetic Engineering**	**BZODSCT11**	3	--	--	3	3	60	15	30
		Paper 2: **Advanced Immunology**	**BZODSCT12**	3	--	--	3	3	60	15	30
		DSC Lab (Based on Paper1 + Paper2)	**BZODSCP6**	--	--	6	3	6	60	15	38
2	DSE	Elective 1: **Developmental biology** Elective 2**: Biomolecules**	**BZODSET3** **BZODSET4**	2	--	--	2	2	40	10	20
		DSE Lab (Based on Elective1) **DSE Lab** (Based on Elective2)	**BZODSEP3** **BZODSEP4**	--	--	4	2	4-6	40	10	25
3	Minor	Paper 1: **Basic Physiology**	**BZOMINT7**	2	--	--	2	2	40	10	20
		Minor Lab (Based on Paper 1)	**BZOMINP4**	--	--	2	1	2	20	5	13
4	VSEC (VSC/SEC)	**Basic Health Care**	**BZOVSEC8**	--	--	4	2	4 - 6	40	10	25
5	OJT	Internship / Apprenticeship (Related to DSC)	**BZOOJT**	--	--	8	4	4 – 6	80	20	50
				10	--	24	22		440	110	--

B.Sc. Sem-VII (Honors) (Zoology -Major, Minor from Basket)

Sr No	Course Category	Name of the course (Title of the Paper)	Course code	Teaching Scheme (hrs)			Total Credit	Evaluation Scheme			
				Theory	Tutorial	Practical		Duration of Examination (Hrs)	End Semester Evaluation (ESE)	Continuous Internal Evaluation (CIE)	Minimum Passing Marks
				Th	Tu	P					
1	DSC	Paper 1: **Biotechnology**	**BZOHDSCT13**	4	--	--	4	3	80	20	40
		Paper 2: **Biotechniques and Biostatistics**	**BZOHDSCT14**	4	--	--	4	3	80	20	40
		DSC Lab (Based on Paper1+2+Elective)	**BZOHDSCP7**	--	--	12	6	6	100	50	75
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)**	**BZOHDSET5** **BZOHDSET6** **BZOHDSET7**	4	--	--	4	3	80	20	40
		DSE Lab (Based on Elective1) **DSE Lab** (Based on Elective2) **DSE Lab** (Based on Elective3)									
3	RM	Research Methodology	**BZOHRM**	4	--	--	4	3	80	20	40
				16	--	12	22		420	130	--

B.Sc. Sem-VIII (Honors) (Zoology -Major, Minor from Basket)

Sr No	Course Category	Name of the course (Title of the Paper)	Course code	Teaching Scheme (hrs)			Total Credit	Evaluation Scheme			
				Theory	Tutorial	Practical		Duration of Examination (Hrs)	End Semester Evaluation (ESE)	Continuous Internal Evaluation (CIE)	Minimum Passing Marks
				Th	Tu	P					
1	DSC	Paper 1: **Biodiversity & Conservation**	**BZOHDSCT15**	4	--	--	4	3	80	20	40
		Paper 2:**Microtechnique**	**BZOHDSCT16**	4	--	--	4	3	80	20	40
		DSC Lab (BasedonPaper1+2+Elective)	**BZOHDSCP8**	--	--	12	6	6	100	50	75
2	DSE	Elective1:**Animal Physiology-II (Physiology of Circulation)** Elective2**:Fish & Fisheries-II (Applied Fisheries)** Elective3:**Mammalian Reproductive Physiology-II (Reproductive process in Female)**	**BZOHDSET8** **BZOHDSET9** **BZOHDSET10**	4	--	--	4	3	80	20	40
		DSE Lab (Based on Elective1) **DSE Lab** (Based on Elective2) **DSE Lab** (Based on Elective3)									
3	OJT	Internship / Apprenticeship (Related to DSC)	**BZOHOJT**	--	--	8	4	4 – 6	80	20	50
				12	--	20	22		420	130	--

B.Sc. Sem-VII (Honors with Research) (Zoology -Major, Minor from Basket)

Sr No	Course Category	Name of the course (Title of the Paper)	Course code	Teaching Scheme (hrs)			Total Credit	Evaluation Scheme			
				Theory	Tutorial	Practical		Duration of Examination (Hrs)	End Semester Evaluation (ESE)	Continuous Internal Evaluation (CIE)	Minimum Passing Marks
				Th	Tu	P					
1	DSC	Paper 1: **Biotechnology**	**BZORDSCT13**	4	--	--	4	3	80	20	40
		Paper 2: **Bitechniques and Biostatistics**	**BZORDSCT14**	4	--	--	4	3	80	20	40
		DSC Lab (Based on Paper 1+2+Elective)	**BZORDSCP7**	--	--	4	2	4-6	40	10	25
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)**	**BZORDSET5** **BZORDSET6** **BZORDSET7**	4	--	--	4	3	80	20	40
		DSE Lab (Based on Elective 1) **DSE Lab** (Based on Elective 2) **DSE Lab** (Based on Elective 3)									
3	RM	Research Methodology	BZORRM	4	--	--	4	3	80	20	40
4	RP	Research Project / Dissertation (Core)	BZORRP1	--	--	8	4	--	50	50	50
				16	--	12	22		410	140	--

B.Sc. Sem-VIII (Honors with Research) (Zoology -Major, Minor from Basket)

Sr No	Course Category	Name of the course (Title of the Paper)	Course code	Teaching Scheme (hrs)			Total Credit	Evaluation Scheme			
				Theory	Tutorial	Practical		Duration of Examination (Hrs)	End Semester Evaluation (ESE)	Continuous Internal Evaluation (CIE)	Minimum Passing Marks
				Th	Tu	P					
1	DSC	Paper 1: **Biodiversity & Conservation**	**BZORDSCT15**	4	--	--	4	3	80	20	40
		Paper 2:**Microtechnique**	**BZORDSCT16**	4	--	--	4	3	80	20	40
		DSC Lab (Based on Paper1+2+Elective)	**BZORDSCP8**	--	--	4	2	4-6	40	10	25
2	DSE	Elective1:**Animal Physiology-II (Physiology of Circulation)** Elective2**:Fish & Fisheries-II (Applied Fisheries)** Elective3:**Mammalian Reproductive Physiology-II (Reproductive process in Female)**	**BZORDSET8** **BZORDSET9** **BZORDSET10**	4	--	--	4	3	80	20	40
		DSE Lab (Based on Elective 1) **DSE Lab** (Based on Elective 2) **DSE Lab** (Based on Elective 3)									
3	RP	Research Project / Dissertation-1 (Core)	BZORRP2	--	--	8	4	--	50	50	50
		Research Project / Dissertation-2 (Core)	BZORRP3			8	4	--	50	50	50
				12	--	20	22		380	170	--

Table showing total marks in theory and Practical semester wise:

Semester	Theory	Practical	Total Marks
1	350	200	550
II	350	200	550
III	300	250	550
IV	300	250	550
V	300	250	550
VI	250	300	550
VII (Honors)	350	200	550
VIII (Honors)	250	300	550
VII (Research)	350	200	550
VIII (Research)	250	300	550
For Honors	**2450**	**2500**	**4400**
For Research	**2450**	**2500**	**4400**

Total Credits:

1. Three Year UG Degree Program: 132
2. Four Year UG Degree Program: 172

Abbreviations: Generic/Open Electives: OE, Vocational Skills & Skill Enhancement Courses: VSEC, Vocational Skill Courses: VSC, Skill Enhancement Courses: SEC, Ability Enhancement Courses: AEC, Indian Knowledge Systems: IKS, Value Education Courses: VEC, On Job Training (Internship/Apprenticeship): OJT, Field Project: FP, Community Engagement & Service: CEP, Co-curricular Courses: CC, Research Methodology: RM, Research Project: RP

B. Sc. Semester-I Zoology
Course category: DSC
Course code: BZODSCT1
Paper–I:Life and Diversity of Nonchordates-I (ProtozoatoAnnelida)

Total Credits: 2 Hours:30

Course objectives:

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

Courseoutcomes:

Bythe end of this programme, the students willget knowledgeand theywill understandthe:

1) GeneralcharactersandclassificationofProtozoa,Porifera,Helminthes, Annelida.
2) Structureand reproductionof*Paramoecium,Plasmodium,Sycon,Obelia,Ascaris*,Leech.
3) Lifecycleof *Plasmodium,Obelia, Ascaris, Taeniasolium*.
4) ParasiticProtozoansof Man-Modeofinfectionand itscontrol,Parasitic adaptationsinhelminthes.
5) Canalsysteminsponges,Vermicultureanditsimportance.

Unit–I **(7.5 Hrs)**

1.1 **Protozoa**:Generalcharactersandclassificationuptoclasses.
1.2***Paramoecium***:Structureandreproduction.
1.3 ***Plasmodium***:Structureandlifecycle.
1.4 **Parasitic Protozoans of Man:** *Entamoeba, Trypanosoma,Giardia* and *Leishmania*-Modeofinfectionandits control.

Unit–II **(7.5 Hrs)**

2.1 **Porifera**:Generalcharactersandclassificationuptoclasses
2.2 ***Sycon***:Structure,reproductionanddevelopment,Canalsysteminsponges.
2.3 **Coelenterata**:Generalcharactersandclassificationuptoclasses.
2.4 ***Obelia*:**Structureandlifecycle,Polymorphismin hydrozoa.

Unit–III **(7.5 Hrs)**

3.1 **Helminthes**:Generalcharactersandclassificationuptoclasses.
3.2 ***Ascaris***:Externalmorphology,reproductivesystemandlifecycle.
3.3 ***Taeniasolium***:Structureandlifecycle.
3.4 **Elementaryideaofparasiticadaptationsinhelminthes.**

Unit–IV **(7.5 Hrs)**

4.1 **Annelida**:Generalcharactersandclassificationuptoclasses
4.2 **Leech**:Morphology,digestiveandurinogenitalsystem
4.3 Copulation,fertilizationandcocoonformationinleech.
4.4 Vermicultureanditsimportance

B. Sc. Semester-I Zoology
Course category: DSC
Course code: BZODSCT2
Paper –II: Principles of Ecology

Total Credits: 2 Hours:30

Course objectives:

1) Toinstallknowledgeofecologicalandenvironmentalconcepts,issues,andsolutionstoenvironmental problems,as wellastoraise their awareness.
2) Tomouldstudentsintogood‘ecocitizens’whocanmeettheworld'senvironmentalrequirements.

Course outcomes:

Bythe endof this programme,the students willunderstand :

1) Atmosphere(Hydrosphere,Lithosphere):Majorzonesanditsimportance,energysources,Energyflowin anecosystem.
2) Ecosystem-Definitionandtypes-pond ecosystem,Foodchain,foodwebandecologicalpyramids.
3) Biodiversity and its conservation, causes of reduction, Hot spots in India, Wildlifeconservationact (1972), nationalparksand sanctuaries.
4) Sources,effectandcontrolmeasures- airpollution,waterpollution,noisepollution.
5) Causes and effects of space pollution.

Unit–I **(7.5 Hrs)**

1.1 Atmosphere:Majorzonesanditsimportance,compositionofair
1.2 Hydrosphere:Globaldistributionofwater,Physico-chemicalcharacteristicsofwater
1.3 Lithosphere:Typesofrocks,formationofsoil
1.4 Renewableandnon-renewableenergysources

Unit–II **(7.5 Hrs)**

2.1 Ecosystem-Definitionandtypes
2.2 Detailedstudyofpondecosystem
2.3 Foodchain,foodwebandecologicalpyramids
2.4 Energyflowinanecosystem,Singlechannel,Y–shapeandUniversalmodel

Unit–III **(7.5 Hrs)**

3.1 Biodiversityanditsconservation
3.2 Causesofreductionofbiodiversity
3.3 Wildlifeconservationact1972,Zoological SurveyofIndia:formationandrolein animal conservation.
3.4 HotspotsofbiodiversityinIndia.Studyofnationalparksandsanctuaries-Tadoba,Melghat andNagzira

Unit–IV **(7.5 Hrs)**

4.1 Sources,effectandcontrolmeasuresofairpollution,Acidrain,greenhouseeffect,ozonedepletionandglobalwarming
4.2 Sources,effectandcontrolmeasuresofwaterpollution
4.3 Sources,effectandcontrolmeasuresofnoisepollution
4.4 Causes and effects of air pollution

B. Sc. Semester-I Zoology
Course category: DSC
Course code: BZODSCP1
PRACTICAL (Based on Paper-I and II)

Total Credits: 2 Hours:30

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
4) To study the physico-chemical parameters of water

Outcomes:

Bythe end of this programme, the students will beable to:

1) Studyandclassifyinvertebrateswiththehelpofmuseum specimens,permanent slides, diagrams.
2) Preparetemporaryandpermanentslides.
3) EstimateDO,freeCO_2,pH,totalhardness ofwatersample.
4) Studyofpondecosystem –analyzeplanktonqualitatively.
5) ObserveanimalsinnaturalhabitatofNationalParkandSanctuary

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

1. Study ofmuseum specimensbyspecimen/charts/model (classificationofanimalsup toorders).

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

2. Studyofpermanentslides:byspecimen/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 andfemale*Ascaris,*Scolexof*Taenia,*Matureandgravidproglottidsof*Taeniasolium,*T. S.ofLeechthroughcroppockets,Trochophorelarva

3. Studyofanatomicalfeatureswiththehelpofspecimen/charts/models/videos.

Digestive,nervousandreproductivesystemofEarthworm.

4. Mounting:

Zooplankton,SpiculesandGemmulesofsponge.

SectionB:Principles of Ecology

1. Estimationofdissolvedoxygenofwater
2. Estimationof freeCO_2ofwater
3. EstimationofpHofwatersample
4. Estimationoftotalhardnessofwater
5. Studyofpondecosystem -Producers,consumersanddecomposers
6. Qualitativeanalysisofplankton
7. VisittoaNationalparkandSanctuary

Scheme of Marking for Practical Examination:

Distributionof Marks–	**TotalMarks**	**40**
Q.1. Identificationand CommentonSpots (6Museumspecimens+1Env.bio.spot+3slides)		10
Q.2. Studyofanatomical features-		10
Q.3. Environmentalbiologyexperiment		05
Q.4. Permanentstainedpreparation		05
Q.5. Submissionofcertifiedpracticalrecord		06
Q.6. Submission ofslides&visitreport		02
Q.7. Viva voce		02

ListofRecommendedBooks for **Life and Diversity of Nonchordates-I (ProtozoatoAnnelida):**

1 **Barnes–Invertebrate Zoology(Halt-Saundersinternational)Philadelphia,USA**
2 BarradaileL. A.andPottsF.A.–**TheInvertebrate**
3 Nigam**–BiologyofNonchordates**
4 Kotpal, AgrawalandKhetrapal**–ModernTextBookofZoology- Invertebrates,**
5 RastogiPublication, Meerut
6 PuranikP.G.andThakurR.S. **–InvertebrateZoology**
7 MajupuriaT.C. **–InvertebrateZoology**
8 DhamiandDhami**–InvertebrateZoology**
9 Parker and Hashwell, **Textbook of Zoology Vol. I (Invertebrates),** A. Z. T. B. S.Publishers&Distributors,New Delhi
10 S.S. Lal -**Practical Zoology Invertebrates 9th edition,** Rastogi PublicationMeerut
11 Barrington EJW –**InvertebrateStructureandFunction**ELBSIIIEdition
12 Kotpal R. L.**–PhylumProtozoatoEchinodermata(series),**RastogiandPublication,Meerut
13 ParkerJ.andHaswellW.–**Text BookofZoology**,ELBSEdition
14 Vidyarthi–**Text BookofZoology**,AgrasiaPublishers, Agra
15 JordanE.L.andVermaP.S.–**ChordateZoology**,S. ChandandCo.,NewDelhi
16 AyerE.–**ManualofZoology**
17 M.D.Bhatia –**TheIndian ZoologicalMemories –Leech**
18 BeniPrasad–**TheIndian ZoologicalMemories–Pila**
19 P.K.Gupta–**VermicompostingforSustainableAgriculture**,AgrobiosIndiaLtd.
20 P.S.Verma**--** AmanualofPracticalZoologyInvertebrates

ListofRecommendedBooks for **Principles of Ecology**:

1) AshthanaD.K.**–EnvironmentalProblem&Solution**
2) AgrawalK.C.**–EnvironmentalBiology**
3) AgrawalK.C.**-Biodiversity**
4) Mukharjee**–EnvironmentalBiology**
5) S.Arora**–FundamentalsofEnvironmentalBiology**
6) Sharma**–Ecology&EnvironmentalBiology**
7) VermaP.S.andAgrawalV.K.**–EnvironmentalBiology,S. Chand. & Co.**
8) Trivediand Rao**–AirPollution**
9) ChapmanandReiss–**Ecology-PrinciplesandApplications**,Cambridge
10) ChatterjeeB–**EnvironmentalLaws-ImplementationandProblems**
11) SharmaP.D.–**EnvironmentalBiology**,RastogiPublication, Meerut
12) TrivediR.K.–HandBookofEnvironmentalLaws, Rules,Guidelines,Compliances andStandards,Enviromedia
13) OdumE.P.andBarretThomson – **FundamentalsofEcology**
14) SmithR.L. and HarperCollins –**EcologyandFieldBiology**
15) D.N.Saxena**–EnvironmentalBiology**, StadiumPress(India)
16) Davis–**BehavioralEcology**
17) Kumarand Asija–**Biodiversity–PrincipleofConservation**
18) RaoandRao–**AirPollution**
19) S. Satyanarayan, S. B. Zade, S.R. Sitre and P.U. Meshram – **A Text Book ofEnvironmentalStudies**,Alliedpublisher(India)
20) Smitz–**IntroductiontoWaterPollution**
21) N.S.SubrahmnyamandV.S.S.Sambamurthy**–Ecology**

B. Sc. Semester-I Zoology
Course category: GE
Course code: BZOGE1
Paper: Bioinstrumentation

Total Credits: 2 Hours:30

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

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

Unit-I **(7.5 Hrs)**
1.1 Principles and applications of pH Meter and Autoclave
1.2 Principles and applications of Hot air oven and Incubator
1.3 Principles and applications of Laminar air flow chamber / Biosafety cabinets
1.4 Principles and applications of BOD Incubator, Lyophilizer.

Unit-II **(7.5 Hrs)**
2.1 Chromatography: Paper and Thin layer chromatography
2.2 Column and Ion – exchange chromatography
2.3 Gas and High Performance Liquid Cchromatography (HPLC)
2.4 Centrifuge - Types of centrifuge and its application.

Unit-III **(7.5 Hrs)**
3.1 Electrophoresis: Principle working and applications- Paper electrophoresis
3.2 Principle working and applications- SDS-PAGE electrophoresis
3.3 Principle working and applications- Agar gel electrophoresis.
3.4 Principle working and applications- Immuno electrophoresis

Unit-IV **(7.5 Hrs)**
4.1 Principle and working of Colorimetry and Flame photometry
4.2 Spectrometry: Principle and working of UV and Visible spectrophotometer
4.3 Spectroscopy: Principle, construction and uses of IR Spectroscopy and Raman Spectroscopy
4.4 Principle, construction and uses of X ray spectroscopy and NMR spectroscopy

ListofRecommendedBooks forBioinstrumentation:

1. *Biochemistry*. 6th Edition by Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). Freeman,
2. New York.
3. *Biophysics: An Introduction* by Cotterill, R. M. J. (2002). John Wiley & Sons, England.
4. *Principles of protein X-ray crystallography* by Drenth, J. (2007). 3rd Ed. Springer, Germany.
5. *Biochemistry*. 3rd edition by Garrett, R. H. and Grisham, C. M. (2004). Brooks/Cole, Publishing Company, California.
6. *Understanding NMR Spectroscopy* by Keeler, J. (2002). John Wiley & Sons, England.
7. *Methods in Modern Biophysics.* Second Edition by Nölting, B. (2006). Springer, Germany.
8. *Biophysics* by Pattabhi, V. and Gautham, N. (2002). Kluwer Academic Publishers, NewYork and Narosa Publishing House, Delhi.
9. 9. *Principles and Techniques of Biochemistry and Molecular Biology* by Wilson Keith and Walker John (2005), 6th Ed. Cambridge University Press, New York.
10. *Proteins NMR Spectroscopy: Principles and Practice* by Cavanagh John *et.al.* (1995), Academic Press
11. *Molecular Biophysics: Structures in Motion* by Daune M. and W. J. Duffin (1999), Oxford University Press.
12. *Methods in Modern Biophysics by* Nalting B. and B. Nalting (2003) Springer Verlag
13. *Physical Biochemistry: Applications to Biochemistry and Molecular Biology* by Freilder, D. Freeman, San. Francisco, 1976
14. *Biochemical Techniques: Theory and Practice* by Robyt, John F.; White, Bernard J. Waveland Press, Inc., U.S.A. Published: 1990.
15. *General Biophysics, Vol I&II* by Volkones H.V.
16. *Biophysical Chemistry, Edition III* by Upadhyay, Himalaya Publication
17. *Biophysics* by S. Mahesh (2003), New Age International Private Ltd.
18. *Techniques and Methods in Biology* by Ghatak, K.L (2003), PHI Learning Private Ltd. New Delhi
19. *Biochemistry, 4th Edition* by Zubay, G.L. (1993), WmC. Brown Publishers.

B. Sc. Semester-I Zoology
Course category: GE
Course code: BZOGE2
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: Aftercompletionofthecourse,studentswillable to-
1) understand andexplainthe Mulberry and Tasarsericulture
2) understandandexplain 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

ListofRecommendedBooks forEconomic Entomology:

1. *General and Applied Entomology* by K.K. Nayar, T. N. Ananthkrishan and B.V. Davis.TataMcGraw-HillCo. Ltd.,pp.589.
2. *Destruction and Useful Insect, Their Habits and Control*by C. L. Metcalf,W. P. Flint and R. I.Metcalf. McGraw HillCo.New York.
3. *AgricultureEntomology* by H.S.Dennis.TimberPressInc.
4. *TextBookofAgricultureEntomology* by AlfordV. David.BlackwellScience.
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
Course code: BZOVSEC1
PRACTICAL: 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 completionofthiscourse, studentwill–
1) Getacquaintedwithhandontrainingofvermicomposting.
2) Getacquaintedwithhandontrainingofvermiwash.
3) Abletounderstandandlearnaboutthevermicompostmarketing.
4) Abletodointernshipinanycommercialvermicompostor vermiwashunit.

Practicals:
1) CollectionofBiodegradablewastes(Solidwaste)andtheirsegregationandp rocessing
2) BedPreparationforPit/Windrowmethod
3) PitRegulation,itsmaintenanceandprecautions
4) Earthwormcollectionandapplicationonbed
5) Inspectionofbed,watering and topup
6) Vermicompost collection,earthwormseparation(Harvesting),airdryingofvermicompost, sievingandstorageofcompost
7) Vermiwash:methodscollectionandprocessing
8) Cocoonformation,breedingmethodsofworms
9) Standardizetechniquewithcategorizedbiodegradablewastes
10) Analysisofvermicompostandvermiwash;soiltesting
11) Applications/packagingandmarketingofbyproducts
12) Visit tovermiculturefarm/setup

Marking Scheme for Practical Examination:
Maximum Marks: 40

Q. 1. Practical based	10
Q. 2. Practical based	10
Q. 3. Practical based	05
Q. 3. Visit Report	05
Q. 4. Practical record	08
Q. 5. Viva	02

ListofRecommendedBooks forVermicomposting:
1) LekshmyMSandSanthiR. Vermitechnology.Saras Publication,pp.416.**Singh K (2014).** Textbook of vermicompost: vermiwash and biopesticides. AstralInternational,pp.97.
2) DaviesP.(2014). Vermicompostingandvermiculture,pp.49.
3) Das M. (2013). Tools for vermitechnology. IK International Publishing House Pvt. Ltd., 1st ed.,pp.196.

B. Sc. Semester-I Zoology
Course category: VSEC
Course code: BZOVSEC2
PRACTICAL: Apiculture

Total Credits: 2 Hours:30

Course objectives:
1) To study the biology of honey bee
2) To study the various species of honey bee
3) To study the culture method of honey bee

Course outcomes:
1) Students can run their own business honey production
2) They will be able to perform extraction of honey
3) They will be able to handle and use bee keeping instrument
4) They will understand the social organization of honey bees

Practicals:
1) Introduction to apiculture and its importance.
2) To Study morphology and anatomy of honey bee.
3) To Study classification and life cycle of honey bee.
4) Study of social organization in honey bees.
5) Study of artificial bee rearing
6) Study of bee hives
7) Study of methods of extraction of honey
8) Study of different species of honey bees.
9) Collection and preservation of honey pasture.
10) Study of bee keeping equipment.

Marking Scheme for Practical Examination:

Maximum Marks:	**40**
Q. 1. Practical based	10
Q. 2. Practical based	10
Q. 3. Practical based	05
Q. 3. Practical based	05
Q. 4. Practical record	08
Q. 5. Viva	02

ListofRecommendedBooks forApiculture:

1) *Economic Zoology* by G. S. Shukla and V. B. Upadhyay (1993). Rastogi Publications, Meerut.
2) *Economic Zoology* by K. K. C. Vishwapremi (2011). Silver Line Publications, Allahabad
3) *Applied Zoology* by R. V. Didolkar (1996). Kasturi Publishers, Nagpur
4) *Modern book of Zoology Invertebrates* by R. L. Kotpal (2011). Rastogi Publications, Meerut.
5) *Invertebrate Zoology* by T. C. Majupuria (1976). S. Nagin & Company, Delhi
6) *Invertebrate Zoology* by E. L. Jordan and P. S. Verma (1991). S. Chand & Company, New Delhi.
7) *Modern Entomology* by D. B. Tembhare (2009). Himalaya Publishing House, Delhi.
8) *Elements of Entomology* by Rajendra Singh (2010). Rastogi Publications, Meerut.

B. Sc. Semester-I Zoology
Course category: IKS
Course code: BZOIKS1
Paper: Indian Knowledge System (Yoga for Health)

Total Credits: 2 Hours: 30

Objectives:

1) To prepare students for worldly challenges, make them mentally, physically, and emotionally balanced.
2) To instill moral, ethical and social values in students.
3) To mould the students into responsible and good citizens.
4) All round development of the students.
5) To educate and encourage students for attaining perfection in pranayama.

Outcomes:

By the end of this course, the students will understand and inculcate:

1) Importance of being physically, mentally and emotionally balanced person.
2) Social, moral, ethical values and responsibilities of a good citizen.
3) Perfection in performing asanas.
4) Complete knowledge of pranayama. Knowledge of physical and physiological deformities and their remedies.

Unit –I **(7.5 Hrs)**

1.1 Definition, and Meaning of Yoga.
1.2 Aims and Objectives of Yoga.
1.3 Importance of Yoga for health and wellness.
1.4 Need of Yoga in Day-to-day Life. Application of yoga as therapy in the modern world.

Unit –II **(7.5 Hrs)**

2.1 The Yoga Sutra: General Consideration. (Samadhi pada, Sadhana pada, Vibhuti pada and Kaivalya pada)
2.2 Concept of Yogic Practices. (Karma yoga, Bhakti yoga, Jnana yoga and Raja yoga)
2.3 Foundation of Yoga.
2.4 Yoga in Early Age.

Unit –III **(7.5 Hrs)**

3.1. Techniques and Benefits of Asanas.
3.2. Effect of Yogasana: Skeletal System- Vrukshasana, Pashchimottanasana.
3.3. Effect of Yogasana: Circulatory system- Machhendrasana,Trikonasana, Digestivesystem- Vajrasana.
3.4. Effec t of Yogasana: Nervous system- Adhomukhsvanasana, Shirsasana, Respiratorysystem- Gomukhasana, Excretory System-Tadasana, Utkatasana.

Unit –IV **(7.5 Hrs)**

4.1 Principles of Breathing.
4.2 Awareness–Relaxation, Sequence.
4.3 Effect of Pranayama on various systems of the body- Shavasana, Makarasana.
4.4 Influences of relaxation, meditative posture on various systems of the body, Meditation. (Sukhasana, Vajrasana and Padmasana)

References:

1. Brown, F.Y.(2000). How to use yoga. Delhi: Sports Publication.
2. Gharote, M. L. and Ganguly, H. (1988). Teaching methods for yogic practices. Lonawala:Kaixydahmoe.
3. Rajjan, S. M. (1985). Yoga strengthening of relaxation for sports man. New Delhi: Allied

Publishers.
4. Shankar, G. (1998). Holistic approach of yoga. New Delhi: Aditya Publishers.
5. Shekar, K. C. (2003). Yoga for health. Delhi: Khel Sahitya Kendra.
6. Swami Satyananda Saraswathi. (1984), Kundalini and Tantra, Bihar: Yoga Publications
Trust.
7. Swami Sivananda, (1971), The Science of Pranayama. Chennai: A Divine Life Society
Publication. Thirumalai.
8. Kumar. S and Indira. S (2011). Yoga in Your Life, Chennai: The Parkar Publication.
9. Tiwari O.P. (1998), Asanas- Why and How.Lonavala: Kaivalyadham

B. Sc.Semester-II Zoology
Course category: DSC
Course code: BZODSCT3
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**:Generalcharactersandclassificationuptoclasses.
1.2 **Cockroach**:Mouthparts,digestivesystemandmaleandfemalereproductive systems.
1.3 **InsectsasVectors**:Mosquito,Housefly,Sandfly,Tse-Tsefly.
1.4 **Studyofcrustaceanlarvae** :Nauplius,Zoea andMegalopa.

Unit–II **(7.5 Hrs)**

2.1 **Mollusca:**Generalcharactersandclassificationuptoclasses.
2.2 ***Pila*:**Morphologyanddigestivesystem.
2.3 **Pila**:Respiratoryandreproductivesystem.
2.4 **Molluscanlarvae:**GlochidiumandVeliger.

Unit–III **(7.5 Hrs)**

3.1 **Echinodermata**:Generalcharactersandclassificationuptoclasses
3.2 ***Asterias***:Externalfeaturesanddigestivesystem
3.3 Watervascularsysteminstarfish.
3.4 **Echinodermlarvae**:BipinnariaandAuricularia

Unit–IV **(7.5 Hrs)**

4.1**Hemichordata**:Generalcharactersandphylogeny
4.2 ***Balanoglossus***:Externalfeaturesanddigestivesystem
4.3 Reproductionin*Balanoglossus*,Tornarialarva
4.4 Affinitiesof*Balanoglossus*

B. Sc.Semester-II Zoology
Course category: DSC
Course code: BZODSCT4
Paper –II: Cell Biology

Total Credits: 2 Hours:30

Objectives:
1) To provide a foundational understanding of cell types and characteristics.
2) To gain a better understanding of cell organelles and their role in metabolic processes.
3) To comprehend cell division and genetic makeup, as well as their relevance.

Outcomes:
By the end of this programme, the students will get knowledge and they will understand the:
1) Ultra structure of prokaryotic and eukaryotic cell,
2) Structure and function of cell organelles.
3) Oxidative phosphorylation, Glycolysis and Kreb's cycle & Electron Transport Chain and terminal 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 **(7.5 Hrs)**
1.1 Ultrastructureofprokaryoticandeukaryoticcell
1.2 Plasmamembrane:Structure-FluidMosaicModelandfunctions.
1.3 Endoplasmicreticulum:Types,ultrastructureandfunctions
1.4 Golgicomplex:Ultrastructureandfunctions

Unit–II **(7.5 Hrs)**
2.1 Ultrastructureofmitochondria
2.2 OxidativephosphorylationGlycolysisandKreb'scycle
2.3 ElectronTransportChainandterminaloxidation
2.4 Lysosome:Structure,polymorphismandfunctions

Unit–III **(7.5 Hrs)**
3.1 Nucleus:Ultrastructureofnuclearmembrane-Nuclearporecomplex,functionsof nuclear membrane.
3.2 Structureandfunctionsofnucleolus
3.3 Chromosome:Structureandtypes,structureofnucleosome
3.4 Giantchromosomes:Lamp-brushandpolytenechromosome

Unit --IV **(7.5 Hrs)**
4.1 Ribosome:Structure,types,Lake'smodelandfunctions
4.2 Somaticcelldivision:Cellcycle phases and check points. Mitosis
4.3 Meiosis(differentphasesandsignificance),synaptonemalcomplex.
4.4 Cellularageing and cell death.

B. Sc.Semester-II Zoology
Course category: DSC
Course code: BZODSCP2
PRACTICAL (Based on Paper-I and II)

Total Credits: 2 Hours:30

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
4) To study ultra structure of cells
5) To gain the knowledge of cell division

Outcomes:
Bythe end of this programme, the students will beable to:
1) Studyand classifylife and diversityofinvertebrates
2) Preparetemporaryandpermanentslides.
3) Studytheultrastructureofprokaryoticcell & eukaryoticcell.
4) Observeosmosis in humanRBCs, Barrbodyin blood smear.
5) Prepareandobservethemitoticcelldivisioninonionroot tips, meiosisinTradescantiabud/Grasshoppertestis bysquash method.
6) Studythe salivarygland chromosome inChironomous larva.
7) Prepareand observethemitochondria inbuccal epithelium/lip mucosa.
8) Useocularmicrometer tomeasuremicro-objects.

Section–A:Life and Diversity of Nonchordates-II (ArthropodatoHemichordata)
1. Studyofmuseumspecimenswiththehelpofspecimen/charts/models (Classificationof animals uptoorders):
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. Studyofpermanentslideswiththehelpof specimen/charts:
Nauplius,ZoeaandMegalopalarvaofArthopoda,VeligerandGlochidiumlarvaof Mollusca,T.S.ofarmofstarfish,BipinnariaandAuricularialarva,T.S. *Balanoglossus* throughcollarandproboscis,Tornarialarva
3. Studyofanatomicalfeatureswiththehelpofcharts/models/videos-
i) DigestivesystemofCockroach
ii) ReproductivesystemofCockroach
iii) Nervoussystemof*Pila*
4. Mounting-
Crustaceanlarvaeandplankton**;**Mouthparts,tracheaandsalivaryglandofCockroach;Gil llamella, osphradiumand radullaof*Pila.*

SectionB:CellBiology

1. Studyofpicturesofultra structureofprokaryoticcell&eukaryoticcell.
2. StudyofosmosisinhumanRBCs(hypotonic,hypertonicandisotonicmedium).
3. Demonstrationofmitoticcelldivisioninonionroottipsbysquashmethod by slides/charts
4. Demonstrationofmeiosisin*Tradescantia*bud / Grasshopper testis usingslides/charts
5. Demonstrationof salivary glandchromosomeinChironomouslarvabyusingcharts/videos.
6. Demonstrationofmitochondriainbuccalepithelium/lipmucosabyJanusGreen-B method.
7. Measurementofmicroobjects by using ocular and stage micrometer
8. Demonstrationof Barrbodyinbloodsmear.

Scheme of Marking for Practical Examination:

Distributionof Marks–	**TotalMarks40**
Q.1. Identificationand CommentonSpots (6Museumspecimens+4slides)	10
Q.2. Studyofanatomical features-	10
Q.3. Cellbiologyexperiment	05
Q.4. Permanentstainedpreparation	05
Q.5. Submissionofcertifiedpracticalrecord	06
Q.6. Submissionofslides	02
Q.7. Viva voce	02

ListofRecommendedBooks for Life and Diversity of Nonchordates-II (ArthropodatoHemichordata):

1. Barnes–**Invertebrate Zoology(Halt-Saundersinternational)**Philadelphia,USA
2. BarradaileL.A.&PottsF.A.–**TheInvertebrate**
3. Nigam–**BiologyofNonchordates**
4. Kotpal, Agrawal&Khetrapal–**ModernTextBookofZoology- Invertebrates,**
5. RastogiPublication, Meerut
6. PuranikP.G.&ThakurR.S. **–InvertebrateZoology**
7. MajupuriaT.C. **–InvertebrateZoology**
8. Dhami&Dhami**–InvertebrateZoology**
9. Parker &Hashwell, **Textbook of Zoology Vol. I (Invertebrates)** A.Z.T.B.S.Publishers&Distributors,New Delhi
10. Dr. S.S. Lal **Practical Zoology Invertebrates 9th edition,** Rastogi PublicationMeerut
11. EJWBarrington–**InvertebrateStructureandFunction**ELBSIIIEdition8
12. R.L.Kotpal**– PhylumProtozoatoEchinodermata(series),**RastogiandPublication,Meer ut
13. ParkerJ.andHaswellW.–**Text BookofZoology**,ELBSEdition
14. Vidyarthi–**Text BookofZoology**,AgrasiaPublishers, Agra
15. JordanE.L.andVermaP.S.–**ChordateZoology**,S. ChandandCo.,NewDelhi
16. AyerE.–**ManualofZoology**
17. M.D.Bhatia –**TheIndian ZoologicalMemories –Leech**
18. BeniPrasad–**TheIndian ZoologicalMemories–Pila**
19. P.K.Gupta–**VermicompostingforSustainableAgriculture**,AgrobiosIndiaLtd
20. AmanualofPracticalZoologyInvertebrates– P.S.Verma

ListofRecommendedBooks for Cell Biology:

1. C.B.Powar,**CellBiology**–HimalayaPublication, NewDelhi
2. Dr. S.P. Singh, Dr. B.S. Tomar – **Cell Biology** 9 th revised edition, RastogiPublication,Meerut
3. GuptaP.K.– **CellandMolecularBiology**,RastogiPublication,Meerut9
4. Veer BalaRastogi– **Introduction toCellBiology**,RastogiPublication,Meerut
5. Gerald Karp – **Cell and Molecular Biology-Concepts and Experiments**, JohnWiley,2007
6. De-Robertis–**CellBiology**
7. Vermaand Agrawal**– ConceptsofCellBiology**
8. Dowben**–CellBiology**
9. Witt**–Biology ofCell**
10. AmbroseandEastyr–**CellBiology**

B. Sc.Semester-II Zoology
Course category: GE
Course code: BZOGE3
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

ListofRecommendedBooks for Avian Biology:

1. *Modern text book of Zoology: Vertebrates, 3rd edition* (2010) by Kotpal R. L, Rastogi Publications, Meerut, India.
2. *Introduction to Chordates, 4th edition* (1973) by Majupuria T. C, S. Nagin & Company, Delhi.
3. *Encyclopaedia of Birds, 1st edition* (2001) by Shukla A. N. and Tyagi Rajiv, Anmol Publications Pvt. Td, New Delhi.
4. *Text book of Animal Behaviour, 1st edition* (1996) by Gundevia H. S. and Singh H. C, S. Chand & Company td, New Delhi.
5. *Animal Behaviour, 1st edition* (1992) by Arora M. P, Himalaya Publishing House, Delhi.
6. *Economic Zoology & Animal Behaviour, 1st edition* (2011) by Vishwapremi K. K. C, Silver Line Publications, Allahabad.
7. *CommonIndianBirds:Apicturealbum* bySalimAliandFutehallyL.(1968).NationalBookTrust,India,pp.51.
8. *ThebookofIndianbirds.13thedition* bySalimAli(2003).Oxfordpublication,pp.326.
9. *Birds of India - A PictorialFieldGuide* byGrewal B,Sen S, Singh S,Devasar Nand BhatiaG.(2016).OmBooksInternational,pp.792.

B. Sc.Semester-II Zoology
Course category: GE
Course code: BZOGE4
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: Aftercompletionofthecourse,studentswillable to-
1) understand the culture activities of fish
2) know the cultivable different fish species
3) know the construction of ponds
4) students can convert the achieved knowledge in to action

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

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

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

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

ListofRecommendedBooks for Inland Fish Culture:

1. *A text book of Fish Biology and Fisheries* by S. S. Khanna and H. R. Singh, Narendra Publishing House, Delhi
2. *An Introduction to Fishes, 6th edition* by S. S. Khanna, Silver Line Publications, Allahabads
3. *Fish and Fisheries* by 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
Course code: BZOVSEC3
PRACTICAL: 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 zooplankton
10) Identification of macrophytes (aquatic weeds)

ListofRecommendedBooks 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 Jurgen Schwoerbel. 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 Jurgen Schwoerbel. 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

B. Sc.Semester-II Zoology
Course category: VSEC
Course code: BZOVSEC4
PRACTICAL: 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:

Maximum Marks:	40
Q. 1. Practical based	10
Q. 2. Practical based	10
Q. 3. Practical based	05
Q. 3. Practical based	05
Q. 4. Practical record	08
Q. 5. Viva	02

List of Recommended Books for Aquarium-Fish Keeping:

1. *Handbook for Aquarium Fish Hobbyists* by K. V. Devraj. Sri K. V. Trust, Chikballapur (Karnataka)
2. *Aquarium-Fish Keeping* by C. B. L. Srivastava. 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: BZOIKS2
Paper: Indian Knowledge System (Yoga for Better Lifestyle)

Total Credits: 2 Hours: 30

Objectives:

1) To prepare students for global challenges, make them mentally, physically, and emotionally balanced.
2) To instill moral, ethical and social values in students.
3) To mould the students into responsible and good citizens.
4) All round development of the students.
5) To educate and encourage students for attaining perfection in pranayama.

Outcomes: By the end of this programmed, the students will understand and inculcate:

1) Importance of being physically, mentally and emotionally balanced person.
2) Social, moral, ethical values & responsibilities of a good citizen.
3) Perfection in performing asanas.
4) Complete knowledge of pranayama. Knowledge of physical and physiological deformities and their remedies.

Unit –I **(7.5 Hrs)**

Srimad Bhagavad Gita -

General introduction, purpose and importance of Srimad Bhagavad Gita, definitions of Yoga in Srimad Bhagavad Gita, utility and comprehensiveness of Yoga. Nature of soul, Sthit Pragya, Karma Yoga and its Principles, Yogi's Characteristics.

Unit –II **(7.5 Hrs)**

Sankhya Darshan-

General Introduction, Three praman's (pratyaksha, Anuman and shabda), Prakriti and Purush in detail.

Unit –III **(7.5 Hrs)**

Seven Chakras ,Yogic food -

Seven Chakras - (Root chakra, Sacral chakra, Solar chakra , Heart chakra, Throat chakra , Third eye chakra , Crown chakra). Yogic diet, when to eat, 5 vital energies.

Unit –IV **(7.5 Hrs)**

Asanas, Pranayams and Bandhas: -

Asanas-

A. In Standing Position:- Garudasana, Padhastasana, Parsvakonasana , Bakasana.
B. In Sitting Position: Ushtrasana, Akarna Dhanurasana, **J**anu-Sirsasan
C. In laying on Back (Supine Position): Sarvangasan, Matsyasan, Chakrasana
D. In laying on abdomen (Prone Position): Dhanurasana, Bhujangasana, Shalabhasan.

Pranayam: Suryabhedana pranayama, Chandrabhedana pranayama.

Bandhas: 1) **J**alandhara Bandha 2) Uddiyana Bandha 3) Mula Bandha 4) Maha Bandha.

REFERENCES:

1) Swami Kuvalyananda: Asana, Kaivalyadhama, Lonavla, 1993.
2) Swami Satyananda Saraswati: Asana, Pranayama, Bandha, Mudra, Bihar School of Yoga, Munger, 2006.
3) Srimad Bhagwat Gita , Geeta Press , Gorakhpur.

4) Baldev Upadhyay- Indian Philosophy
5) Agarwal M M: Six systems of Indian Philosophy, Chowkhambha Vidya Bhawan,varanai, 2010.
6) Radhakrishnan S: Indian Philosophy, Oxford University, UK (Vol. I & II) Il Edition,2008.
7) Swami Vivekanand yoga prakashana, S-VYASA yoga University, Bangalore, 2020.
8) Patanjali International Yoga Foundation, 2020.

INSTITUTEOFSCIENCE, NAGPUR

(An Autonomous Institute of Government of Maharashtra)

ZOOLOGY SYLLABUS

B. Sc. Semester-III Zoology

Course category: DSC

Course code: BZODSCT5

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

Total Credits: 2 Hours: 30

Course objectives:

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

Course outcomes:

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

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

Unit –I **(7.5 Hrs)**

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

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

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

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

Unit –II **(7.5 Hrs)**

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

2.2) Migration and Accessory respiratory organs in fishes

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

2.4) Parental care and Neotony in Amphibia

Unit –III **(7.5 Hrs)**

3.1) Gametogenesis and type of eggs

3.2) Fertilization of egg

3.3) Post fertilization development of fish

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

Unit –IV **(7.5 Hrs)**

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

B. Sc. Semester-III Zoology
Course category: DSC
Course code: BZODSCT6
Paper–II: Basics of Genetics

Total Credits: 2 Hours: 30

Objectives:

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

Outcomes:

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

Unit –I **(7.5 Hrs)**

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

Unit –II **(7.5 Hrs)**

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

Unit –III **(7.5 Hrs)**

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

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

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

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

Unit –IV **(7.5 Hrs)**

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

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

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

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

B. Sc. Semester-III Zoology
Course category: DSC
Course code: BZODSCP3
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: 40

1. Anatomical observation and explanation of given system of fish	08
2. Identification and comment on spots (1 to 5)	10
3. Genetics experiment- Monohybrid or dihybrid ratio	08
4. Genetics study- Karyotypes, syndromes, genetic traits in man	04
5. Permanent stained preparation	02
6. Submission of certified practical record	06
7. Viva voce	02

REFERENCES:

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

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

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

Recommended Books for Basics of Genetics:

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

B. Sc. Semester-III Zoology
Course category: MINOR
Course code: BZOMINT1
Paper–I: Life and Diversity of Chordates-I (Protochordata to Amphibia)

Total Credits: 2 Hours: 30

Course objectives:

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

Course outcomes:

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

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

Unit –I **(7.5 Hrs)**

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

Unit –II **(7.5 Hrs)**

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

Unit –III **(7.5 Hrs)**

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

Unit –IV **(7.5 Hrs)**

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

B. Sc. Semester-III Zoology
Course category: MINOR
Course code: BZOMINT2
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: BZOMINP1
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: 40

1. Anatomical observation and explanation of given system of fish	08
2. Identification and comment on spots (1 to 5)	10
3. Genetics experiment- Monohybrid or dihybrid ratio	08
4. Genetics study- Karyotypes, syndromes, genetic traits in man	04
5. Permanent stained preparation	02
6. Submission of certified practical record	06
7. Viva voce	02

REFERENCES:

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: BZOVSEC5
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: 40**
1. Identification and comment on spots (1 to 5)	10
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	03
5. Submission of certified practical record	05
6. Viva voce	02

References:

1. Abrol, D. P. (1997). Bees and Beekeeping. Kalyani Publisher, New Delhi.
2. Abrol, D. P. (2010). A Comprehensive guide to Bees and Beekeeping. Scientific Publisher, New Delhi.

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

INSTITUTEOFSCIENCE, NAGPUR

(An Autonomous Institute of Government of Maharashtra)

ZOOLOGY SYLLABUS

B. Sc. Semester-IV Zoology

Course category: DSC

Course code: BZODSCT7

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

Total Credits: 2 Hours: 30

Course objectives:

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

Course outcomes:

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

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

Unit –I **(7.5 Hrs)**

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

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

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

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

Unit –II **(7.5 Hrs)**

2.1 Modern theories of evolution : Darwinism and Neo-Darwinism

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

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

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

Unit –III **(7.5 Hrs)**

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

3.2 Structure of hen’s egg

3.3 Development of chick up to premitive streak stage

3.4 Development of extra embryonic membranes in chick and functions

Unit –IV **(7.5 Hrs)**

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

4.2 Stem cells : Sources, types and their use in human welfare
4.3 Biological clock : Diurnal and rhythmic behavior in birds and mammals
4.4 Role of pheromones in reproductive behavior

B. Sc. Semester-IV Zoology
Course category: DSC
Course code: BZODSCT8
Paper–II: Molecular Biology

Total Credits: 2 Hours: 30

Objectives:

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

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

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

Unit –I (7.5 Hrs)

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

Unit –II (7.5 Hrs)

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

Unit –III (7.5 Hrs)

3.1 DNA Replication: Modelsof DNA replication (Semiconservative), Meselson Stahl experiments. Mechanism of replication, Enzymes and proteins involved in replication
3.2 Prokaryotic transcription: Mechanism of transcription: initiation, elongation, and termination, regulation and termination.
3.3 Post-transcriptional modification- 5’ cap formation- 3’ end processing and polyadenylation-splicing
3.4 Inhibitors of transcription: Alfa- Amanitin and actinomycin D.

Unit –IV **(7.5 Hrs)**

4.1 Genetic Code: Characteristics of genetic code
4.2 Prokaryotic translation : Mechanism of Initiation, elongation and termination
4.3 Gene regulation: Lac Operon concept.
4.4 Inhibitors of translation: Tetracycline, Steptomycinacting on prokaryotes, Cycloheximide, Ricin acting on eukaryotes and Puromycin and Actinomycin acting on both.

B. Sc. Semester-IV Zoology
Course category: DSC
Course code: BZODSCP4
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: 40**

1. Identification and comment on spots (1 to 5) 10
2. Detection of Barr body in blood/ blood group/ staining of DNA and RNA in blood by Methyl green pyronin method 07
3. Isolation of genomic DNA from given source/ Estimation of DNA by colorimetric or diphenylamine method 07

4. Estimation of protein by biuret or Lowry method/ Demonstration of agarose gel Electrophoresis 07
5. Submission of certified practical record 06
6. Viva voce 03

REFERENCES:

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

1. T. B. of Zoology vol II – Parker & Haswell
2. T. B. of Vertebrate Zoology -S. N. Prasad
3. Chordate Zoology –E. L. Jorden and P. S. Verma
4. Vertebrate Zoology – Vishwanath
5. Zoology of Chordates – Nigam H. C.
6. Phylum: Chordata – Newman H.H.
7. Biology of Vertebrates –Walter & Sayles
8. The Vertebrate Body – Romer A. S.
9. Comparative Anatomy of the Vertebrates – Kingslay J. D.
10. The Biology of Amphibia – Noble G. K.
11. Snakes of India – Gharpura K. G.
12. Life of Mammals – Young J.Z.
13. Vertebrates – Kotpal R. L.
14. Introduction to Chordates – Majupuria T.C.
15. Vertebrate Zoology – Dhami & Dhami
16. T. B. Vertebrate Zoology – Agrawal
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: BZOMINT3

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

Total Credits: 2 Hours: 30

Course objectives:

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

Course outcomes:

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

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

Unit –I **(7.5 Hrs)**

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

Unit –II **(7.5 Hrs)**

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

Unit –III **(7.5 Hrs)**

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

Unit –IV **(7.5 Hrs)**

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

B. Sc. Semester-IV Zoology
Course category: MINOR
Course code: BZOMINT4

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: BZOMINP2
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: 40

1. Identification and comment on spots (1 to 5)	10
2. Detection of Barr body in blood/ blood group/ staining of DNA and RNA in blood by Methyl green pyronin method	07
3. Isolation of genomic DNA from given source/ Estimation of DNA by colorimetric or diphenylamine method	07
4. Estimation of protein by biuret or Lowry method/ Demonstration of agarose gel Electrophoresis	07
5. Submission of certified practical record	06
6. Viva voce	03

REFERENCES:

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

1. T. B. of Zoology vol II – Parker & Haswell
2. T. B. of Vertebrate Zoology -S. N. Prasad
3. Chordate Zoology –E. L. Jorden and P. S. Verma
4. Vertebrate Zoology – Vishwanath
5. Zoology of Chordates – Nigam H. C.
6. Phylum: Chordata – Newman H.H.
7. Biology of Vertebrates –Walter & Sayles
8. The Vertebrate Body – Romer A. S.
9. Comparative Anatomy of the Vertebrates – Kingslay J. D.
10. The Biology of Amphibia – Noble G. K.
11. Snakes of India – Gharpura K. G.
12. Life of Mammals – Young J.Z.
13. Vertebrates – Kotpal R. L.
14. Introduction to Chordates – Majupuria T.C.
15. Vertebrate Zoology – Dhami & Dhami
16. T. B. Vertebrate Zoology – Agrawal
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: BZOVSEC6
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: 40**
1. Identification and comment on spots (1 to 6)	12
2. Determination of pH/ transparency/ hardness of water	05
3. Estimation of dissolved oxygen/ alkalinity	07
4. Estimation of BOD/ chlorides in water	07
5. Submission of visit report	02
6. Submission of certified practical report	05
7. Viva voce	02

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

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