Semester wise Syllabus For Postgraduates

CBCS Pattern

Session

2018-20

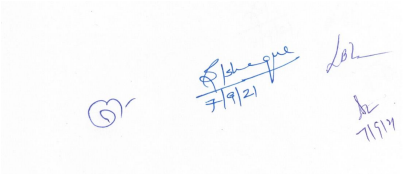
M.Sc. Zoology

S. S. In Zoology &

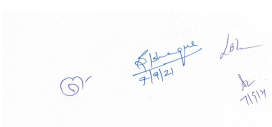
Biotechnology

Vikram University,

Ujjain

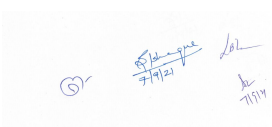


Preamble: Institutional infrastructures of colleges and universities within the country are incomparable and uneven, and they function with an additional variation of adopting different road maps for teaching and learning process. Thus, we have different syllabi, teaching methods, hands-on-training, and different learning outcomes. Introducing uniformity, whenever and wherever tried, has obviously not worked with the desired outcome. Added to this, failure to keep pace with the advancing knowledge base, half-hearted engagement and integration with other disciplines, and poor-transfer of skill sets to the students to negotiate efficiently with the changing needs, have made it essential to graduate from incremental inputs to syllabi revisions alone, to the use of disruptive approaches to reshape the subjectspecific course structures, with measurable learning outcomes. The approach, if adopted, is bound to generate opinions of teachers and students alike to resist the change. However, the intention is to understand the subject of Zoology in the evolving biological paradigm in modern times; where, living beings need to be understood at the level of atomic interactions; and comparative systems of organisms need to be studied through the prism of integrated chemical, physical, mathematical and molecular entities to appreciate the inner working of different organisms at morphological, cellular, molecular, interactive and evolutionary levels. The syllabi could be shaped with a customised approach depending on the institutional infrastructure and geographical location, yet it should cater, in principle, to the expected learning outcomes more or less uniformly. For example, in diverse geographical domains with diverse skill sets, examples illustrated in detail for teaching and hands on exposure and field work could differ by involving the study of available species across the ladder of evolution, yet the comparative biology taught should provide a uniform level of understanding of the subject. After all, the purpose is to understand inner working of livingbeings by comparing various systems within invertebrates and vertebrates i.e., from a single cell protozoan to multicellular humans, and develop a comprehensive understanding and appreciation of the differences through ICT tools and well-designed hands on practical exposures along with the field work. Added to this, if the same principle is followed to understand different phyla through the ladder of evolution and compare cardinal features for classification



involving both morphological and molecular tools, along with associated field and lab work, the final product would be better trained without rote learning. Diversity in the life forms need to be understood by a Zoologist for its socio-economic capital, in case a student is interested in entrepreneurship, through applied aspects of Zoology; and by a career-researcher as a ladder towards multiscale hierarchical systems, where chemical and physical principles would apply from molecules to self-assembled and organized organisms. The vibrancy to synthesize out of the knowledge gained and come out with disruptive outcomes, would define the learning outcomes of PG students.

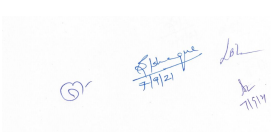
Apart from the above mentioned attributes expected of a UG/PG student related to the subject area of Zoology to be studied in an integrated and cross-disciplinary manner with a comprehensive understanding of all living systems, their relationship with the eco-system, and unravelling of their application value; the scale, character and rigour of which may vary from one institution to the other, it would, however, be mandatory to bring in uniformity in the learning outcomes with respect to the 'broad-range skill sets' related-to-the-discipline of the study and the 'Social skills'. Within the broad-range skill sets related to the discipline, what would be required is to impart and assess the quality of critical thinking, analytical and scientific reasoning, reflective thinking, information and digital literacy, and problem-solving capacity. These are part of the defined characteristic attributes to be demonstrated by a UG/PG in any discipline, as defined by the Core Committee on LOCF of UGC. On similar lines, what is expected of the social skills is to imbibe values for cooperative team work, moral and ethical awareness and reasoning, multicultural competence, leadership readiness and qualities and self- directed and lifelong learning attitude. Again, this has been a general guideline defined by the UGC Core Committee. It is obvious all of us together need to meet the challenge to bring in these attributes within each subject area of study, in the present case the subject of Zoology. As regards the fine nuances of how to organize the course structure in Zoology and Aquaculture (the latter being a part of the subject of Applied Zoology, may not necessarily require separate emphasis) within the framework of expectations of the learning outcome, I provide a



few steps of specific details for general debate and course corrections, wherever required

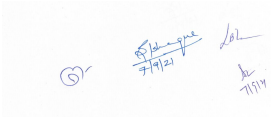
Introduction: Zoology deals with the study of animal kingdom specially the structural diversity, biology, embryology, evolution, habits and distribution of animals, both living and extinct. As it covers a fascinating range of topics, the modern zoologists need to have insight into many disciplines. The learning outcomes-based curriculum framework for a B.Sc. degree in Zoology is designed to cater to the needs of students in view of the evolving nature of animal science as a subject. The framework is expected to assist in the maintenance of the standard of Zoology degrees/programmes across the country by reviewing and revising a broad framework of agreed expected graduate attributes, qualification descriptors, programme learning outcomes and course-level learning outcomes. The framework, however, does not seek to bring about uniformity in syllabi for a programme of study in Zoology, or in teaching learning process and learning assessment procedures. Instead, the framework is intended to allow for flexibility and innovation in programme design and syllabi development, teaching learning process, assessment of student learning levels.

Nature and extent of the M.Sc. degree Programme in Zoology: M.Sc. Zoology course will help to understand the behaviour, structure and evolution of animals. Zoologists use a wide range of approaches to do this, from genetics to molecular and cellular biology, as well as physiological processes and anatomy, whole animals, populations, and their ecology. The scope of Zoology as a subject is very broad, the course also offers knowledge about latest aspects of zoology. The intention is to understand the subject of Zoology in the evolving biological paradigm in modern times where, living beings need to be understood at the level of atomic interactions; and comparative systems of organisms need to be studied through the prism of integrated chemical, physical, mathematical and molecular entities to appreciate the inner working of different organisms at morphological, cellular, molecular, interactive and evolutionary levels. The key areas of study within the disciplinary/subject area of Zoology comprise of Systematics, taxonomy & evolution, Structure and functions of invertebrates, Biostatistics, Biodiversity, Wildlife, Biomolecules and metabolism,



Immunology, Animal Physiology, Instrumentation, Molecular Cell Biology, Genetics, Anatomy of Vertebrates, Developmental Biology, Animal Behaviour, neurophysiology, Ecotoxicology, Ichthyology etc. The M.Sc. degree programme in Zoology also deals with skill enhancement courses such as Aquaculture, economic Zoology, Tools and techniques, Fish culture etc. The course also offers specializations in the field of Molecular Endocrinology & Reproductive Technology and Limnology and Fish Productivity. The depth and breadth of study of individual topics dealt with would vary with the nature of specific Zoology programmes. As a part of the efforts to enhance the interest and employability of graduates of Zoology programmes, the curricula for these programmes are expected to include learning experiences that offer opportunities for higher studies and research at reputed laboratories.

Aims of the Masters Degree Program in Zoology: Zoology is the study of all animal life; from primitive microscopic malaria-causing protozoa to large advanced mammals, across all environmental spheres from red deer in mountain forests to dolphins in deep oceans, and from underground burrowing voles to golden eagles in the skies. Some of these animals are useful to us and we nurture them as pets or livestock, some are serious pests or disease-causing and some are simply splendid and awe-inspiring. No matter what our relation with the animals is, we need to understand their behaviour, population dynamics, physiology and the way they interact with other species and their environments. It provides students with the knowledge and skill base that would enable them to undertake further studies in Zoology and related 12 areas or in multidisciplinary areas that involve advanced or modern biology and help develop a range of generic skills that are relevant to wage employment, self-employment and entrepreneurship. The modern era requires a classical zoologist with a modern approach to master many subjects of Zoology. There is a need for the students to compete with the globe, therefore, the main focus of this curriculum is to enable the student to be professionally competent and successful in a career. Having Zoology as backbone of the curriculum, this course, with the department centric electives will enhance the skills required to perform research in laboratory and experimental research. The students can choose to focus on a “whole animal” or a “bits of animals” approach. The “whole animal” pathway makes the students proficient in the



identification and study of animals while the latter approach provides the skills required to pursue laboratory and experimental work such as disease research, DNA technologies, wildlife forensics etc. The curriculum can be modified to such extent that a student at M.Sc. level can be a specialist in immunology, , animal behaviour or entomology. A student who is M.Sc. in zoology is also given priorities in jobs like malaria officer, Fisheries officer, environmental pollution board, in different aspects of research involving zoological aspects. A student of Zoology can also work as an entrepreneur in different field like, sericulture, apiculture, lac-culture, fish-culture, aquaculture etc. For such specializations, the curriculum needs to focus on special skills to maximise the students' employment probability, for example few skills needed by industry may include the species-specific monitoring for key species, handling of dangerous/ poisonous/ wild animals and the use of Geographic Information Systems (GIS) for data collection.

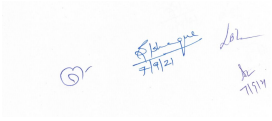
Duration of the course

M.Sc. Zoology will be a full time two year program to be covered in 4 semesters each of six months duration. The first year of the program will complete the first and second semester and the second year will complete third and fourth semester, The maximum duration of the program shall be twice of the minimum duration of the program that is eight year.

Admission to the course

The number of seats shall be in accordance with directives by the university. A candidate after having B.Sc. with at least 50% marks from a recognized university with zoology subject in graduation shall be eligible for admission to the course. The admission to the course will be on basis of merit and according to guidelines from university and government of Madhya Pradesh. After the term end examination at the end of each semester the students will be provisionally admitted to next semester. Each semester will be followed by a brake not exceeding 15 days.

Continuous Evaluation



During the semester a teacher offering the course will do the continuous evolution of the students at three points of time by conducting three tests of 20 marks each. Of these, two must be written tests and third may be written test/quiz/seminar/assignment for theoretical courses. Marks obtained in two best tests out of three will be awarded to the students.

Attendance

Students who have less than 75% attendance will not be allowed to appear in the end semester examination and will be declared as fail in that semester.

Tuition fees

The admitted candidate shall pay the course fee in addition to tuition fee and such other fees as prescribed by the university

End semester Examination

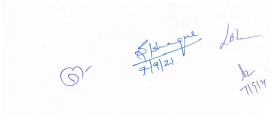
There shall be end semester examination at the end of first, second, third semester, and fourth semesters respectively. The semester examination will be conducted every year normally in December and June or on the dates declared by the academic calendar of the university. A student proceeding to appear in end semester examination should submit his/her application through head of the department on prescribed form along with required examination fees etc. to the registrar of the university. Each student has to appear in the end semester examination otherwise will be awarded "Ab" grade in the course. The scheme of marks for evaluating the various components of the dissertation will be followed as per given the syllabus.

Attendance

Students who have less than 75% attendance will not be allowed to appear in the end semester examination and will be declared as fail in that semester.

Tuition fees

The admitted candidate shall pay the course fee in addition to tuition fee and such other fees as prescribed by the university



Program objectives: The program has following objectives i.e. a student obtaining M.Sc. degree in Zoology will acquire knowledge in following fields-

(1) Develop understanding on the diversity of life with regard to protists, non chordates and chordates.

(2) A student will develop ability to group animals on the basis of their morphological characteristics/ structures.

(3) He will also Develop critical understanding how animals changed from a primitive cell to a collection of simple cells to form a complex body plan.

(4) He will learn to examine the diversity and evolutionary history of a taxon through the construction of a basic phylogenetic cladistics tree.

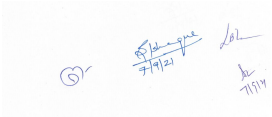
(5) A student will be able to understand how morphological change due to change in environment helps drive evolution over a long period of time.

(6) The project assignment will also give them a flavour of research to find the process involved in studying biodiversity and taxonomy besides improving their writing skills.

(7) It will further enable the students to think and interpret individually due to different animal species chosen.

Learning Outcomes of the Course: The course will have following learning outcomes-

(1) It will help to demonstrate in-depth knowledge and understanding about the fundamental concepts, principles and processes underlying the academic field of Zoology and its different subfields (animal diversity, principles of ecology, comparative anatomy and developmental biology of vertebrates, physiology and biochemistry, genetics and evolutionary biology, animal biotechnology, applied Zoology, aquatic biology, immunology, reproductive biology, and insect, vectors and diseases, apiculture, aquarium fish keeping, medical diagnostics, and sericulture)



(2) The course will provide procedural knowledge that creates different types of professionals in the field of Zoology and related fields such as, apiculture, aquarium fish keeping, medical diagnostics, and sericulture, etc.

(3) The course will also help to impart skills related to specialization areas within Zoology as well as within subfields of Zoology, including broader interdisciplinary subfields (Chemistry, Physics and Mathematics).

(4) The course will allow Zoology professionals to study extinct animals by specializing in Paleozoology, on the different types of birds in Ornitholog; opt for studying Herpetology and Arachnology, the branches dealing with the study of snakes and spiders, respectively.

(5) The student will be able to appreciate the complexity of life processes, their molecular, cellular and physiological processes, their genetics, evolution and behaviour and their interrelationships with the environment.

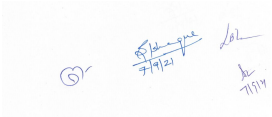
(6) The student shall be able to develop study concepts, principles and theories related with animal behaviour and welfare.

(7) He/ She shall be able to understand and interpret data to reach a conclusion • Design and conduct experiments to test a hypothesis.

(8) He/ She shall understand scientific principles underlying animal health, management and welfare.

(9) The student will be able accept the legal restrictions & ethical considerations placed for animal welfare.

(10) The student shall also be able to understand fundamental aspects of animal science relating to management of animals.



M.Sc. Zoology Semester-I

Scheme of teaching and examination under semester pattern Choice Based Credit System (CBCS) for M.Sc. Program in SS in Zoology and Biotechnology wef 2018-20 Academic session

Serial No.	Course Code	Title of Course		Marks			
			Course Type	Internal Examination Marks	University Examination Marks	Total Marks	Credits
1.	ZOL 101	Paper1: Bio Systematics, Taxonomy and Evolution	Core	40	60	100	5
2.	ZOL 102	Paper 2: Structure and function of Invertebrates	Core	40	60	100	5
3.	ZOL 103	Paper 3: Biostatistics Biodiversity & Wild life	Core	40	60	100	5
4.	ZOL 104 ZOL 105	Paper 4: Biomolecules and Metabolism Or Microbiology	Generic Elective	40	60	100	5
5.	ED 106	Paper 5: Entrepreneurship Development	Skill Development Course	30	50	80	4
6.	ZOL 107	Practical based on theory papers	Core	16	24	40	2
7.	ZOL 108	Comprehensive Viva (Virtual credit)	Core	-	80	80	4
		Total Marks		206	394	600	30

Any 01 out of 02 Elective can be opt

Elective papers shall be taught only if faculty is available

Common course offered by University

M.Sc. Zoology Semester-II

Scheme of teaching and examination under semester pattern Choice Based Credit System (CBCS) for M.Sc. Program in SS in Zoology and Biotechnology wef 2018-20 Academic session

Serial No.	Course Code	Title of Course		Marks			
			Course Type	Internal Examination Marks	University Examination Marks	Total Marks	Credits
1.	ZOL 201	Paper 1: Immunology and Animal Physiology	Core	40	60	100	5
2.	ZOL 202	Paper 2: Population Ecology and Environmental Physiology	Core	40	60	100	5
3.	ZOL 203	Paper 3: Molecular cell Biology and Genetics	Core	40	60	100	5
4.	ZOL 204 ZOL 205	Paper :4 Tools and Techniques in Biology OR Enzyme Technology/MOOC	Generic Elective	40	60	100	5
5.	CS 206	Paper 5: Communication Skills	Skill Development Course	30	50	80	4
6.	ZOL 207	Practical based on theory papers	Core	16	24	40	2
7.	ZOL 208	Comprehensive Viva (Virtual credit)	Core	-	80	80	4
		Total Marks		206	394	600	30

Any 01 out of 02 Elective can be opt

Elective papers shall be taught only if faculty is available

Common course offered by University

M.Sc. Zoology Semester-III

Scheme of teaching and examination under semester pattern Choice Based Credit System (CBCS) for M.Sc. Program in SS in Zoology and Biotechnology wef 2018-20 Academic sessions

Serial No.	Course Code	Title of Course		Marks			
			Course Type	Internal Examination Marks	University Examination Marks	Total Marks	Credits
1.	ZOL 301	Paper 1: Comparative Anatomy of Vertebrates	Core	40	60	100	5
2.	ZOL 302	Paper 2: Developmental Biology	Core	40	60	100	5
3.	ZOL 303	Paper 3: Animal Behaviour.	Core	40	60	100	5
4.	ZOL 304 ZOL 305	Paper 4: Aquaculture OR Genomics and Proteomics	Generic Elective	40	60	100	5
5.	PD 306	Paper 5: Personality Development	Skill Development Course	30	50	80	4
6.	ZOL 307	Practical based on theory papers	Core	16	24	40	2
7.	ZOL 308	Comprehensive Viva (Virtual credit)	Core	-	80	80	4
		Total Marks		206	394	600	30

Any 01 out of 02 Elective can be opt

Elective papers shall be taught only if faculty is available

Common course offered by University

M.Sc. Zoology Semester-IV

Scheme of teaching and examination under semester pattern Choice Based Credit System (CBCS) for M.Sc. Program in SS in Zoology and Biotechnology wef 2021-22 Academic session

Serial No.	Course Code	Title of Course		Marks			
			Course Type	Internal Examination Marks	University Examination Marks	Total Marks	Credits
1.	ZOL 401	Paper 1: Neurophysiology and Ecotoxicology	Core	40	60	100	5
2.	ZOL 402	Paper 2 1. Ichthyology 2. Environmental Biotech	Core	40	60	100	5
3.	ZOL 403	Paper 3 Economic Zoology	Core	40	60	100	5
4.	ZOL 404 ZOL 405	Paper 4 Mol. Endocrinology and Reproductive Technology OR Limnology and Fish Productivity	Generic Elective	40	60	100	5
5.	TM 406	Tourism Management	Skill Development Course	30	50	80	4
6.	ZOL 407	Practical based on theory papers	Core	16	24	40	2
7.	ZOL 408	Comprehensive Viva (Virtual credit)	Core	-	80	80	4
		Total Marks		206	394	600	30

Any 01 out of 02 Elective can be opt
Elective papers shall be taught only if faculty is available
Common course offered by University

Grand Total of all 4 Semesters:
Total Credits = 120(Each credits is equal 20 marks)
Total Marks = 2400

TABLE: GRADES, GRADE POINTS AND RANGE OF PERCENTAGE OF MARKS

Letter Grade	Grade Points	Percentage Range of Marks
O - Outstanding	10	Above 80.0%
A^+ - Excellent	9	Above 70.0 - 80.0%
A - Very Good	8	Above 60.0 - 70.0%
B^+ - Good	7	Above 55.0 - 60.0%
B - Above Average	6	Above 50.0 - 55.0%
C - Average	5	Above 45.0 - 50.0%
P - PASS	4	40.0 - 45.0%
F - FAIL	0	Less than 40.0%
Ab - Absent	0	--

Note: While calculating percentage of Marks and for determination of the Grade rounding of Marks **shall not be done**.

The Computation of Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA)

The UGC recommended the following procedure to The Computation of Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA):

i. The SGPA is the ratio of sum of the product of the number of credits with the Grade points scored by a student in all the courses taken by a student and the sum of the number of credits of all the courses undergone by a student, i. e.

SGPA (Si) = Σ (Ci x Gi) / Σ Ci
Where, Ci – is the number of credits of the i^{th} course and
Gi –is the Grade Point scored by the student in the i^{th} course

ii. The CGPA is also calculated in the same manner taking into account all the courses undergone by a student overall the semesters of a program, i. e.

CGPA = Σ (Ci x Si) / Σ Ci
Where, Si –is the SGPA of the i^{th} semester and
Ci –is the Total number of credits in that semester.

iii. The SGPA and CGPA shall be rounded off to 2 decimal points and reported in the transcripts.

Illustration of computation of SGPA and CGPA and format for Transcripts

i. Computation of SGPA and CGPA

Illustration for **SGPA**

Course	Credit	Grade Letter	Grade Point	Credit Point (Credit x Grade)
Course- 1	3	A	8	3 x 8 = 24
Course- 2	4	B+	7	4 x 7 = 28
Course- 3	3	B	6	3 x 6 = 18
Course- 4	3	O	10	3 x 10 = 30
Course- 5	3	C	5	3 x 5 = 15
Course- 6	4	B	6	4 x 6 = 24
	20			**139**

Thus, **SGPA = 139/ 20 = 6.95**

Illustration for **CGPA**

Points	Semester- 1	Semester- 2	Semester- 3	Semester- 4	Semester- 5	Semester- 6
Credits	20	22	25	26	26	25
SGPA	6.9	7.8	5.6	6.0	6.3	8.0

Thus, **CGPA** = 20x6.9 + 22x7.8 + 25x5.6 + 26x6 + 26x6.3 + 25x8 / 144 = **6.73**

ii. **Transcript (Format)**: Based on the above, on Letter Grades, grade points and SGPA and CGPA, the Vikram University may issue the transcript for each semester and a consolidated transcript indicating the performance in all semesters.

Vikram University, Ujjain
School of Studies in Zoology & Biotechnology
M.Sc. Zoology
Semester I
Paper I
Core. ZOL PG 101 Biosystematics, Taxonomy and evolution

Learning Outcomes: The paper Imparts knowledge about biosystematics, basics of classification, binominal nomenclature and regarding various theories of evolution, evolutionary process such as variation, speciation, natural selection, origin of primates and man. It enables students to understand the patterns and processes of evolution above the species level and appreciate the differences between the three methods of phylogenetic analysis, evolutionary systematics, and cladistics.

Unit- 1

1. Definition and basic concepts of biosystematics.
2. History of classification.
3. Theories of biological classification:
4. Taxonomic categories and hierarchy categories.
5. International code of zoological nomenclature.
6. Formation of scientific names of various texa.

Unit:- 2

1. Taxonomic characters
2. Taxonomic collection of invertebrate
3. Taxonomic collection of vertebrate
4. Preservation and curetting.
5. Taxonomic Keys
6. Reproductive isolation

Unit:- 3

.

1. Concepts of evolution and theories of organic evolution.
2. Concepts of population genetics, Hardy- Weinberg law of genetic equilibrium.
3. Destabilizing forces: Natural selection, mutation, genetic drift and migration
4. Genetic polymorphism
5. Human Evolution
6. An overview of evolutionary biology

Unit :- 4

1. Modes of speciation.
2. Micro and Macro and mega Evolution.
3. Gene Evolution.
4. Origin of cells & first organism.
5. Taxonomic aids: museum, Herbarium, Taxidermy, Zoos.
6. Darwinism and neo Darwinism

Semester I Paper-I

SUGGESTED READING MATERIAL

1. M. Koto-The. Biology of biodiversity-Springer
2. E.O. Wilson-Biodiversity-Academic Press Washington.
3. G.G.-Simpson-Principle of animal taxonomy Oxford IBH Publication ompany.
4. E-Mayer-Elements of Taxonomy
5. Bastchelet-F-Introduction to mathematics for life scientists Springer Verlag, Berling.
6. Skoal R.R. and F.J.Rohiff Biometry-Freeman, San-Francisco.
7. Snecdor, G.W. and W.G. Cocharan Statisical Methods of affiliated-East-West Press, New Delhi.
8. Murry J.D. Mathematical Biology-Springer, Verlag, Berlin.

Vikram University, Ujjain
School of Studies in Zoology & Biotechnology
M.Sc. Zoology
Semester I
Paper II

Core. ZOL PG 102 STRUCTURE AND FUNCTION OF INVERTEBRATES

Learning Outcomes: The paper imparts knowledge regarding the various Invertebrates species and the regulatory processes. With the study of this paper students gain knowledge in the areas of responses to systematic position, general organization and affinities of all invertebrates. The students will be well equipped to become very competent in research or teaching fields after completion of this course.

UNIT –I

1. Origin of metazoan.
2. Organization of Coelom: Acoclomates , Pseudocoelomates , Coelomates.
3. Locomotion in Protozoa(amoeboid flageller and cilliary movement)
4. Locomotion in Ecinodermata.
5. Hydrostatic movement in colentetra
6. Locomotion in Annelida

UNIT –II

1. Patterns of Feeding and digestion in lower metazoa,: Mollusca, & Annelida
2. Filter feeding in polychaeta.
3. Organs of respiration: gills, lungs and trachea.
4. Mechanism of respiration in insects.
5. Respiratory Pigments in invertebrates.
6. Coral reef & their formation.

UNIT – III

1. Excretion in lower invertebrates.
2. Excretion in higher invertebrates.
3. Mechanism of osmoregulation**.**
4. Metamorphosis in insects
5. Modification mouth parts in insects
6. Parasitic adaptation in Platyhelminthes and Aschelminthes.

UNIT – IV

1. Primitive Nervous systems-Coelentetra and Echinodermata.
2. Structure, affinity and Life History of Phoronida and Ectoprocta
3. Larval forms in Mollusca.
4. Larvae forms in Echinodermata
5. Larval form Crustacea
6. Larval form echinodermata

Semester I Paper-II

SUGGESTED READING MATERIAL

1. Hyman, L.H. The invertebrates, Nol. I. Protozoa through Ctenophora, McGraw Hill Co., New York
2. Barrington, E.J.W. Invertebrate structure and function. Thomas Nelson and Sons Ltd., London.
3. Jagerstein, G. Evolution of Metazoan life cycle, Academic Press, New York & London.
4. Hyman, L.H. The Invertebrates. Vol. 2. McGraw Hill Co., New York.
5. Hyman, L.H. The Invertebrates. Vol. 8. McGraw Hill Co., New York and London.
6. Barnes, R.D. Invertebrates Zoology, III edition. W.B. Saunders Co. Philadelphia.
7. Russel-Hunter, W.D. A biology of higher invertebrates, the Macmillan Co. Ltd., London.
8. Hyman, L.H. The Invertebrates smaller coelomate groups, Vol. V.Mc.Graw Hill Co., New York.
9. Read, C.P. Animal Parasitism. Parasitism. prentice Hall Inc., New Jersey.
10. Sedgwick, A.A. Student text book of Zoology. Vol. I,II and III. Central Book Depot, Allahabad.
11. Parker, T.J., Haswell W.A. Text book of Zoology, Macmillan Co., London.

Vikram University, Ujjain
School of Studies in Zoology & Biotechnology
M.Sc. Zoology
Semester I
Paper III
Core ZOL PG 103 Bio-statistics, Biodiversity and Wildlife

Learning Outcomes: The paper imparts students knowledge about endangered species but also to every organism, and Conservation increases awareness and understanding of how human life depends on preserving animal species and natural ecosystems. The paper also imparts knowledge about wildlife, wildlife conservation, habitat conservation and biostatistics. It also explains descriptive statistics, explains correlation and regression and fundamental concept of Hypothesis testing.

Unit – I Bio statistics

1. Experimental designing and sampling theory
2. Mean, Median & Mode.
3. Student 't' test
4. Graphical representation of data (Column, Bar, Line, pie).
5. Standard deviation.
6. Standard Error.

Unit – II Biodiversity

1. Concept and principle of biodiversity
2. Causes for the loss of biodiversity
3. Biodiversity conservation methods
4. Medicinal uses of forest plants
5. Biodiversity hot spots
6. Biodiversity monitoring and documentation

Unit – IV Wild life

1. Values of wildlife: positive and negative
2. Wildlife protection Act
3. Conservation of wildlife in India
4. Endangered and threatened species
5. Red Data book
6. Crocodile breeding project in M.P.

Unit – IV

1. National Parks and Sanctuaries
2. Project Tiger
3. Wildlife in M.P. with references to reptiles, birds and mammals
4. Endangered birds and Their conservation
5. Biospheres reserve

Semester I Paper-III

SUGGESTED READING MATERIAL

1. Jorgenserr, S.E. Fundamental of Ecological modeling Elsevier New York
2. Lenderen D. Modelling in behavioral ecology. Chapman & Hall London U.K.
3. Sokal, R.R. and F. J. Rohit Biometry Freeman San Francisco
4. Snedecor, G.W. and W.G. cochran, statistical methods, Affiliated East, West Press New Delhi (Indian ed.)
5. Pelon, E.C. The interpretation of ecological data : A promer on classification and ordivation.
6. A. lewis – Biostatics
7. B.K. Mahajan Methods in Biostatics
8. V.B. Saharia wildlife in India
9. S.K. Tiwari wildlife in central India
10. Georgs & Wilians statistical method
11. R.K. Tondon Biodiversity Texonomy & Ecology
12. M.P. Arora An Introduction to prevantology
13. P.C. Kotwal Biodiversity and conservation
14. M. Koto : The Biology of Biodiversity. Springer.
15. E. O. Wildon : Biodiversity. Academic Press Washington.
16. G.G. Simpson : Principles of Animal Taxonomy. Oxford IBH Publication Company.
17. E. Mayer : Elements of Taxonomy.
18. Dobzansky : Biosystematics.
19. Dallela and Sharma : Animal Taxonomy and Museology.
20. Dodzhansky: The Genetics and origin of species. Columbia University Press.
21. Futuyama D.I. Evolutionary Biology. INC Publishers Dunderland.
22. Jha A.P. : Genes and Evolution – John Publication, New Delhi.

Vikram University, Ujjain
School of Studies in Zoology & Biotechnology,
M.Sc. Zoology
Semester I
Paper IV
Core ZOL PG 104 Biomolecules and Metabolism

Learning Outcomes: The paper explains structure of biomolecule and bioenergetics, fundamental understanding of Proteins, explains enzyme catalysis and kinetics and describes metabolism-catabolism and describes different pathways of metabolism. The paper also explains structure and composition of nucleic acids and the fundamental concept of DNA Replication.

Unit – I

1. Chromatographic methods of separation and purification of Proteins
2. Electrophoretic methods of separation and purification of Proteins.
3. Elucidation of primary structure of protein.
4. Elucidation of secondary structure of protein.
5. Elucidation of tertiary structure of protein.
6. Elucidation of quaternary structure of protein.

Unit- II

1. Molecular structure of DNA
2. Different types of RNA in Eukaryotic cells and their role
3. Molecular structure of transfer RNA
4. Molecular Mechanism of DNA damage
5. Various modes of DNA repair
6. Molecular mechanism of DNA replication.

UNIT- III

1. Enzymes: Terminology and classification.
2. Mechanism of Enzyme Action.
3. Regulation of Enzyme action.
4. High Energy compounds.
5. Concept of laws of Thermodynamics.
6. Concept of Free energy.

Unit- IV

1. Pathways of gluconeogenesis.
2. Pathways of glycolysis.
3. Pathway of tricarboxylic cycle.
4. Pathways of Beta – oxidation of fatty acids.
5. Respiratory chain complexes and mechanism of electron Trans port system.
6. Mechanism of ATP synthesis and oxidative phosporylation.

Semester I Paper-IV

SUGGESTED READING MATERIAL

1. Voet, D. and J.G. Voet. Biochemistry John Wiley & Sons.
2. Freifelder, D. Physical Biochemistry W.H. Freeman & Co.
3. Segal, I.H. Biochemical calculations John Wiley and Sons
4. Creighton, T.E. Protein Structure and Molecular Properties W.H. Freeman & Co.
5. Freifelder, D. Essentials of Molecular Biology
6. Wilson, K. and K.H. Goulding A Biologists Guide to Principals and Techniques of Practical Biochemistry
7. Cooper, T.G. Tools of Biochemistry
8. Hawk, Practical Physiological Chemistry
9. Garret, R.H. and C.M. Grisham. Biochemistry. Saunders college Publishers

10 Fundamentals of Biochemistry 3rd edition by D. Voet, JG Voet, CW. Pratt, John Wiley & Sons
11 Principles of Biochemistry 5th edition by Nelson, Cox and Lehinger, WH Freeman & Company
12 Molecular Cell Biology by Lodish, Berk, Kaiser, Kreiger, Scott, Zipursky, Darnell
13 Biochemistry with clinical correlations by TJ Devlin, Wiley Leiss
14 Biochemistry by Zubey, Macmilan Publishing Company, New York
15 Biochemistry by CK Mathews, KE Van Holde, The Benjamin Cummings Publishing Company, Melano Park.

Vikram University, Ujjain
School of Studies in Zoology & Biotechnology,
Session 2018-20

M.Sc. Zoology Semester I

Practical based on paper 101-104

Learning Outcomes: The practical will teach students about dissecting various invertebrates like Aquilla, Prawn, Sepia. Loligo, Grasshopper, Honey bee etc. It will also provide students knowledge about different adaptations, biodiversity and wildlife. The students will also be acquainted with techniques like cell division etc.

Total marks 16+24=40

(A) Internal Examination 16 Marks

Exercise:-

1. Practical Records
2. *Viva – Voce*
3. Exercise on Mean, Median, Mode, Standard deviation, Standard error and Student "t" test
4. Cell division preparation of slide on Meiosis &Mitosis

(B) University Examination 24 Marks

1. Spotting – Classification and identification of various phylum. 06
2. One major dissection of various systems of invertebrates – Squilla, Prawn, Sepia, Loligo. 02
3. One minor dissection- Grasshopper, Honeybee, Echinus, Starfish, Aplysia. 02
4. Mounting material - permanent mount 02
5. Spotting related with Adaptation. homologies, analogies and modification of mouth parts 02
6. Problem based on Biodiversity and wild life. Mammals and Fishes group 06
7. Museum keeping, Preservation, Categorization , Naming and Preparation of Museum Specimens. 04

Total Marks (16+24)

Vikram University, Ujjain
School of Studies in Zoology & Biotechnology
M.Sc. Zoology
Semester II
Paper I
Core ZOL PG 201 Immunology and Animal Physiology

Learning Outcomes: The paper develops understanding for the fundamental concept of Innate and adaptive immunity, develops the basic concepts of antigenicity and immunogenicity, describes the molecular structure and function of Major histocompatibility complex and describes the types of hypersensitivity. The second section of the paper deals with Animal physiology where paper describes the mechanism of action of pheromones, the fundamental concepts of physiology of digestion, patterns of nitrogen excretion, osmoregulation and thermoregulation.

Unit – I

1. Component of innate and acquired immunity.
2. Cells of the immune system.
3. Organs of immune system.
4. T cell lineage, receptor and activation.
5. B cell lineage, receptor and activation.
6. Immunoglobin structure and class.

Unit – II

1. Structure and function of major histo-compatibility/ (MHC) complex
2. Antigen processing and presentation.
3. Types of hypersensitivity.
4. Auto immunity and autoimmune diseases.
5. Types and applications of ELISA.
6. Compliment pathway.

Unit – III

1. Patterns of nitrogen excretion in different animal groups.
2. Comparative physiology of digestion.
3. Osmoregulation in different animal groups.
4. Thermoregulation in homeotherms, poikilotherms and hibernation.
5. Comparative study of mechanoreception.
6. Comparative study of photoreception.

Unit – IV

1. Comparative study of phonoreception.
2. Comparative study of chemoreception.
3. Bioluminescence as means of communication among animals.
4. Pheromones as means of communication among animals.
5. Chromatophores and regulation of their function among animals.
6. Hormones, their classification and chemical nature.

Semester II Paper-I

SUGGESTED READING MATERIAL

1. EJW Barrington-General & comparative Endocrinology-Oxford, Claredon Press
2. R.H. Williams-Text Book of Endocrinology-W.B. Saunders
3. C.R. Martin- Endocrine Physiology-Oxford University Press.
4. Molecular Cell Biology-J. Darnell, H. Lodish and D. Baltimore-Scientific American Book USA
5. Molecular Biology of the cell-B. Alberts, D-Bray, J.Lewis, M. Raff, K. Roberts and J.D. Watson, Garland Pub. New York.

Vikram University, Ujjain
School of Studies in Zoology & Biotechnology
M.Sc. Zoology
Semester II
Paper II
Core ZOL PG 202 Population Ecology and Environmental Physiology

Learning Outcomes: The paper describes the history, introduction and nature of ecosystem, explains the bio-geochemical cycles and laws. The paper also explains and describes population & community ecology and narrates on different freshwater and eco-physiological adaptations. The second section of the paper deals with environmental limiting factors, intra and inter specific relationships, sustainable development, mutualism, homeostasis and effect of yoga and meditation on body.

Unit I

1. Populations and their characters.
2. Conservation management of natural resources.
3. Environmental impact assessment.
4. Population regulation: Extrinsic and intrinsic mechanisms.
5. Population growth curves.
6. Habitat and niche.

Unit II

1. Adaptations: Levels of adaptations.
2. Significance of body size and adaptation.
3. Fresh water environment.
4. Eco-physiological adaptations to fresh water environments.
5. Eco-physiological adaptations to terrestrial environments.
6. Physiological adaptation to parasitic habitats.

Unit III

1. Environmental limiting factors.
2. Inter and intra-specific relationships.
3. Sustainable development.
4. Mutualism, evolution of plant pollinator interaction.
5. Community structure.
6. Ecological succession.

Unit IV

1. Concept of homeostasis.
2. Endothermic and physiological mechanism of regulation of the body temperature.
3. Physiological response to oxygen deficient stress.
4. Physiological response to body exercise.
5. Meditation and their effects.
6. Yoga and their effects.

Semester II Paper-II

SUGGESTED READING MATERIAL

1. Cherrett, J.M. Ecological Concepts. Blackwell Science Publication, Oxford, U.K.
2. Elseth, B.D. and K.M. Baumgartner, population Biology, Van Nostrand Co., New York.
3. Jorgensen,S.E. Fundamentals of ecological modeling. Elsevier, New York.
4. Krebs, C.J. Ecology. Harper and Row, New York.
5. Krebs,C.J. Ecological Methodology. Harper and Row , New York.
6. Eckert, R. Animal Physiology: Mechanism and Adaptation. W.H. Freeman and Co., New York.
7. Hochachka, P.W. and G.N., Somero. Biochemical adaptation. Priceton, New Jersey.

Vikram University, Ujjain
School of Studies in Zoology & Biotechnology
M.Sc. Zoology
Semester II
Paper III
Core ZOL PG 203 Molecular Cell Biology and Genetics

Learning Outcomes: The paper provides basic knowledge about structure of cell and cell organelles, it provides basic understanding about transport across cell membrane, cell signaling and cell to cell interaction. The second half of the paper deals with modern cytological techniques like genetic counselling, prenatal diagnosis, transgenic animals and gene therapy. It also provides elementary idea of genomics, proteomics, gene mapping and human genome project.

Unit – I

1. Molecular organization of Plasma Membrane
2. Transport across cell membrane
3. Microfilaments- structure and Function
4. Microtubes - structure and Function
5. Modes of cell signaling
6. Signaling from plasma membrane to nucleus

Unit – II

1. Gap junctions (connexins)
2. Integrins
3. Ultra structure of nuclear Envelop(NE) and transport of RNA & import of Proteins
4. Genome organization- Hierarchy in organization
5. Chromosomal organization of genes and non-coding DNA
6. Genetic code -universal and exceptional

Unit – III

1. Basic concept of dosage compensation in mammals
2. Cytogenetics of human chromosomes
3. Prenatal diagnosis & genetic screening
4. Genetic counseling
5. Human gene therapy
6. Transgenic animals & their applications

Unit- IV

1. The normal human karyotype
2. Elementary idea of gene mapping in human
3. Molecular basis of mutations
4. Concept of Genomics
5. Functional genomics: Proteomics
6. The Human Genome Project: overview & ELSI program

Semester II Paper-III

SUGGESTED READING MATERIAL

1. J. Darnell, H. Lodish and D. Baltimore molecular cell biology scientific American book. Inc. USA
2. B. Alberts D. Bray, J. Lewis, M. raff, K. roberts and J.D. Wattson. molecular biology of the cell. Garland Publishing Inc. New York.
3. John R. W. animal cell culture A practical approach masters. Irl. Press
4. Alberts et. al Essentials cell biology garland publishing Inc. New York 1998
5. J.M. Barry molecular biology
6. Philip E. Hartman Gene Action
7. L.C. Dunn, principals of Genetics
8. A.M. Winchester genetics
9. Edgar Alterbrg Genetics
10. L.C. Dunn genetics and the origin of species
11. Bengt A. Kihlman actions of chemicals of dividing cells

Vikram University, Ujjain
School of Studies in Zoology & Biotechnology
M.Sc. Zoology
Semester II
Paper IV

Core ZOL PG 204 Tools and Techniques in Biology

Learning Outcomes: The study of this paper teaches students about the basic and fundamental principles behind the working of some common instruments like microscope, spectrophotometer, centrifuge, microtome etc. The paper also imparts knowledge about some recent biotechnological techniques like DNA sequencing, tissue culture, Polymerase Chain reaction. Northern, Southern and Western blotting which enables students to get acquaintedwith recent trends and techniques in scientific sanario.

Unit :- 1

1. Principle and Applications of Light Microscope
2. Principle and Applications of Phase Contrast microscope.
3. Principle and Applications of Confocal microscope
4. Principle and Applications of Electron microscope
5. Spectrophotometer.
6. Types and application of Centrifuge .

Unit:- 2

1. Cryopreservation and Freeze drying techniques.
2. Column chromatography.
3. Thin Layer Chromatography.
4. Gel Electrophoresis.
5. HPLC.
6. Radioisotopes techniques in biology.

Unit:- 3

1. Types and application of Microtome.
2. Tissue fixation and complete procedure for staining.
3. Biosensor and its application.
4. Essential component and preparation of culture media.
5. Sterilization, Inoculation & Microbial identification (bacteria, fungi).
6. Organ ablation (ovariectomy, and adrenalectomy)

Unit:- 4

1. Chromosome banding techniques
2. Human Karyotype preparation and its significance.

3. Southern Blotting, Northern Blotting and Western Blotting.
4. Polymerase Chain Reaction.
5. DNA sequencing.
6. Tissue culture techniques.

Semester II Paper-IV

SUGGESTED READING MATERIAL

1. Introduction to instrumental analysis-Robert Braun-McGraw Hill.
2. A biologist Guide to principles and Techniques of Practical Biochemistry-K, Wilson and K.H. Goulding ElBS Edn.
3. Clark & Swizer. Experimental Biochemistry. Freeman, 2000.
4. Locquin and Langeron. Handbook of Microscopy. Butterwaths, 1983
5. Boyer. Modern Experimental Biochemistry. Benjamin, 1993
6. Freifelder. Physical Biochemistry. Freeman, 1982.
7. Wilson and Wlaker. Practical Biochemistry. Cambridge, 2000.
8. Cooper. The Cell-A Molecular Approach. ASM, 1997
9. John R.W. Masters. Animal Cell culture- A practical approach. IRL Press.
10. Robert Braun. Introduction to instrumental analysis. McGraw Hill

Vikram University, Ujjain
School of Studies in Zoology & Biotechnology,
M.Sc. Zoology Semester II
Practical based on paper 201-204

Learning Outcomes: The practical's will provide students with the knowledge about testing blood groups, analysing pH, nitrogenous samples, the students will also learn about handling basic instruments and solving problems related to Hardy Weinberg equation and will also learn many problems based on immunology.

Total marks 16+24 = 40

(A) **INTERNAL EXAMINATION** **16 Marks**

Exercise:

1. Practical Record
2. Viva-voce/ Oral test
3. Experiment on Haematology: Blood group, Total and differential counts.
4. Demonstration of Enzyme Action, and pH.
5. Detection of Nitrogenous products in samples.

(B) **UNIVERSITY EXIMINATION** **24 Marks**

1. Comments upon the structure and application of analytical instruments 10

   i) Colorimeter
   ii) Spectrophotometer
   iii) Ultracentrifuge
   iv) ESR and NMR Spectrometer

   v) Microtome
   vi) HPLC

2. Problem based on human genetic diseases 03
3. Exercise based on immunology. 03
4. Problem based on Hardy Weinberg law 03
5. Demonstration of chromosome polymorphism in any insect population 03
6. Lagging chromosome, Chromosome bridge, Micronuclei study in permanent slides. 02

Total Marks (16+24) 40

Vikram University, Ujjain
School of Studies in Zoology & Biotechnology,
M.Sc. Zoology
Semester III
Paper I
Core ZOL PG 301Comparative Anatomy of Vertebrates

Learning Outcomes: The paper imparts a basic understanding about vertebrates as it explains the origin of chordates, structure of integuments, respiratory, circulatory and digestive system. It compares the anatomy of different systems like nervous system, peripheral and autonomic systems and urogenital systems. The paper also makes students aware about origin and evolution of vertebrates and tries of explain the different types and modes of adaptations.

Unit – I

1. Origin of Chordata.
2. Development, structure and functions of integument and its derivatives (glands, scales, feathers and hairs)
3. Respiratory system comparative account of respiratory organs.
4. Comparative account of Digestive System.
5. Comparative anatomy of heart.

Unit – II

1. Blood circulation in various vertebrate groups.
2. Comparative anatomy of urogenital system in vertebrate.
3. Comparative account of organs of olfaction and taste
4. Comparative anatomy of brain and spinal cord (CNS)
5. Comparative account of peripheral and autonomic nervous system

Unit – III

1. Comparative account of lateral line system.
2. Comparative account of electroreception.
3. Flight adaptations in vertebrates.
4. Aquatic adaptations in birds.
5. Aquatic adaptations in mammals.

Unit –I V

1. Origin, evolution general organization of Ostracoderms.
2. General organization, characters of cyclostomes.
3. Origin, evolution general organization of early Gnathostomes.
4. General account of Elasmobranchi, Holocephali.
5. General account of Dipnoi.

Semester III Paper-I

SUGGESTED READING MATERIAL

1. Carter, G.S. Structure and habit in vertebrate evolution – Sedgwick and Jackson, London.
2. Kingsley, J.S. Outlines of Comparative Autonomy of Vertebrates, Central Book Depot. Allahabad,
3. Kent, C.G. Comparative anatomy of vertebrates
4. Malcom Jollie, Chordata morphology. East – West Pres Pvt. Ltd., New Delhi.
5. Milton I lildergrand. Analysis of vertebrate structure. IV. Ed. John Wiley and Sons Inc., New York.
6. Smith, H.S. Evolution of Chordata structure. Hold Rinchart and Winstoin Inc. New York.
7. Sedgwick, A.A. Students Text Book of Zoology, Vol.II.
8. Walter, H.E. and Sayles, L.D. Biology of vertebrates, MacMillan & Co. New York.
9. Romer, A.S. Vertebrate Body, IIIrd Ed. W.B. Saunders Co., Philadelphia
10. Young J.Z. life of vertebrates. The oxford University Press, London
11. Parker & Haswell to III Rev. by Marshall willians latested Macmillan Co. ltd.
12. Young J.Z. Life of mammals. The Oxford University Press, London
13. Weichert, C.K. and Presch, W. Elements of chordate anatomy, 4th Ed. McGraw Hall Book Co., New York.

Vikram University, Ujjain
School of Studies in Zoology & Biotechnology,
M.Sc. Zoology
Semester III
Paper II
Core ZOL PG 302 Developmental Biology

Learning Outcome: The paper allows students to gain knowledge about gametogenesis, cleavage mechanisms, gastrulation and role of hormones in metamorphosis and regeneration. The paper also provides basic knowledge about the process of spermatogenesis, Ovulation, Fertilization, Superovulation, cell commitment, cell fate and cell lineage. The last part of the paper makes students aware about recent techniques like stem cell, cell diversification and stem cell disorders.

Unit I

1. Comparative account of gonads in mammals and invertebrate.
2. Spermatogenesis:
3. Biochemistry of Semen: Semen composition and formation, assessment of sperm function.
4. Fertilization: Pre-fertilization events, Post fertilization events.
5. Biochemistry of fertilization.
6. Hormones and their role in reproduction.

Unit- II

1. Ovarian follicular growth and differentiation
2. Oogenesis and vitellogenesis and ovulation and ovum transport in mammals.
3. Biology of sex determination and sex differentiation a comparative account.
4. Multiple ovulation and embryo transfer technology.
5. Invitro oocytes maturation.
6. Super ovulation

Unit – III

1. Cell commitment and differentiation.
2. Cell fate and cell lineages.
3. Germ cell determinants and germ cell migration.
4. Development of gonands.
5. Malanogenesis.

Unit –IV

1. Cell diversification in early Amphibian embryo,.
2. Stem cell : Types (totipotency and pleuripotency) and Application.
3. Embryonic stem cells and significance.
4. Connective tissue cell family
5. Hemopoietic stem cells : Blood cells formation.
6. Stem cell disorders, Stem cell therapy.

Semester III Paper-II

SUGGESTED READING MATERIAL

1. Long J.A. Evan H.M. 1922 : the Oestrous cycle in the Rat and its associated phenomenon.
2. Nalbandou. A.C. – Reproductive physiology
3. Prakash A.S. 1965-66 Marshall's, Physiology Reproduction (3 Vol.)
4. Gilbert, S.F. Developmenal Biology , Sinauer Associated Inc. Massachulsetts.
5. Ethan Bier, The cold spring Harbor laboratory Press, New York.
6. Balinsky B.I. Introduction to Embryology sanders, Philadelphia.
7. Berril N.J. and Karp. G. Development Biology. McGraw Hill New York.
8. Davidson, E.H. Gene Activity During Early Development. Academic Press, New York.

Vikram University, Ujjain
School of Studies in Zoology & Biotechnology
M.Sc. Zoology
Semester III
Paper III
Core ZOL PG 303 Animal Behavior

Learning Outcomes: The paper teaches students about the relationship of behaviour and Cognition, it explains about rhythmic behaviours and social behaviours and explain feeding, Reproductive behaviour and describes behaviour assessment.

UNIT I-

1. Scope, Significance and aim of Ethology.
2. Animal psychology, classification of behavioral patterns, analysis of behavior (ethogram)
3. Reflexes and complex behavior
4. Perception of the environment: mechanical, electrical, chemical, olfactory, auditory and visual.
5. Evolution and ultimate causation: Inheritance behavior and relationships.

UNIT II-

1. Natural and hormonal control of behavior.
2. Genetic and environmental components in the development of behavior.
3. Motivation: Drive, timing, and interaction of drives, physiological basis of motivation.
4. Communication: chemical, Visual, light and audio.
5. Brood care in invertebrates.

UNIT III –

1. Ecological aspects of behavior: Habitate selection, food selection, optimal foraging theory, anti-predator defenses.
2. Homing territoriality, dispersal, host parasite relations.
3. Biological rhythms: Circadian and circannual rhythms,
4. Orientation and navigation.
5. Learning and memory: Conditioning, habituation, insight learning, association learning, reasoning.

UNIT IV-

1. Reproductive behavior. strategies, mating systems, courtship,
2. Sexual selection,
3. Parental care.
4. Social behavior. aggregations, schooling in fishes,
5. flocking in birds,
6. Social organization in insects and primates.

Semester III Paper-III

SUGGESTED READING MATERIAL

1. Eibl-Eibesfeldt, I. Ethlogy. The biology of Behaviour. Holt, Rineheart & Winston, New York.
2. Gould, J.L. The mechanism and Evolution of Behaviour.
3. Kerbs, J.R. and N.B. davies : Behaviourable Ecology. Blackwell, Oxford, U.K.
4. Hinde, R.A. Animnal Behaviour : A Synthesis of Ethology and Comparative Psychology. McGraw Hill, New York.
5. Alcock, J. Animal Behaviour : An Evolutionary approach. Sinauer Assoc. Sunderland, Massachsets, USA.
6. Bradbury, J.W. and S.L. Vehrencamp. Principles of Animal Communication. Sinauer Assoc. Sunderland, Massachsets, USA.

Vikram University, Ujjain
School of Studies in Zoology & Biotechnology
M.Sc. Zoology
Semester III
Paper IV
Core ZOL PG 304 Aquaculture

Learning Outcomes: The paper teaches students about the basic concepts of aquaculture, it to understand the techniques involved in aquaculture practices, to get a detailed information about aquaculture, to provide a basic idea about the importance of live feed in culture systems. The learners will be aware of all the techniques involved in aquaculture. At the end of the course, student can able to gain the knowledge on the aquaculture practices.

Unit-1

1. Aquaculture: history, definition, scope & importance.
2. Abiotic & biotic factors of water necessary for fish life.
3. Inland cultivable fishes and their crop potential.
4. General ecological characteristics of reservoirs of India
5. Ecology of fish culture pond .

Unit-2

1. Fish culture: composite fish culture techniques
2. Fresh water Prawn culture.
3. Sewage fed fish culture.
4. Paddy cum fish culture
5. Frog culture.
6. Larvivorous fish and their significance

Unit-3

1. Fish breeding in natural conditions and bundh breeding.
2. Stripping and hypophysation breeding technique
3. Transport of live fish & seed.
4. Plankton and its role in fisheries.
5. Common weeds of fish ponds and methods of their eradication.
6. Culture of Air Breathing fishes

Unit-4

1. Water pollution, its effects on fisheries and methods of its abetment.
2. Common fish diseases & their control
3. Preservation & processing of fish.
4. By products of Fish Industry & Their utility.
5. Economic importance of fishes.

Semester III Paper-IV

SUGGESTED READING MATERIAL

1. C.B.L. Shrivastava: Fishes of India
2. Jhingran: Fish and fisheries of India
3. S.S. Khana: An Introduction to Fish
4. R.S. Rath: Fresh Water Aquaculture
5. Gopal Ji Shrivastava: Fishes of UP & Bihar
6. H.D. Kumar: Sustainability & Management of Aquaculture & Fisheries
7. A.J.K. Mainan: Identification of Fishes
8. R. Sanatam: A Manual of fresh Water Aquaculture
9. S.K. Gupta : Fish & Fisheries
10. P.D. Pandey : Fish & Fisheries
11. K.P. Vishwas: Fish & Fisheries

Vikram University, Ujjain
School of Studies in Zoology & Biotechnology,
M.Sc. Zoology Semester III
Practical based on paper 301-304

Learning Outcome: The practices will teach students about solving exercises on developmental biology, comparative anatomy and embryology. The students will learn to solve exercises on environmental biology.

Total marks 16+24=40

(A) **Internal Examination** **16 Marks**

Exercises:-

1. Practical Record
2. *Viva- Voce*
3. Exercise based on comparative anatomy
4. Study of Museum of Vertebrates

(B) **University Examination** **24 Marks**

1.	Exercise based on Developmental biology	04
2.	Spotting on Vertebrates.	02
3.	Major Exercise (estimation of DO, pH, Alkalinity, Hardness of Water)	06
4.	Exercise on embryology and animal behavior	06
5.	Spotting on fishes	06

Total Marks 40 (16+24)

Vikram University, Ujjain
M.Sc. Zoology
Semester IV
Paper I
Core ZOL PG 401 Neurophysiology and Eco-toxicology

Learning Outcomes: The paper teaches about basic concepts of neuron and synaptic physiology, it also certifies neural and hormonal control of the behavior, neurotransmitter and neurodegenerative diseases. The paper also focuses on general principles of environmental biology, biotic and abiotic factors of ecosystem, kinds of environmental pollution and indicator organisms. Students can define the main taxonomic and phylogenetic relationships among the fishes. Students can recognize the main characters used to define the main branches of fish taxonomy. Students can provide an explanation and examples of morphological, behavioural, and physiological adaptations in fishes.

UNIT I –

1. Introduction to neurophysiology.
2. Neuron morphology
3. Syneptic physiology.
4. Animal psychology.
5. Reflexes and complex behavior.
6. Perception of the environment: mechanical, electrical, chemical, olfactory, auditory and visual.

UNIT II –

1. Neural and hormonal control of behavior.
2. Genetic and environmental components in the development of behavior.
3. Motivation: Drive, timing and interaction of drives, physiological basis of motivation.
4. Neurotransmitters and receptors.
5. Action potential propagation.
6. Neurodegenerative diseases.

UNIT III –

1. General principles of Environmental Biology with emphasis on ecosystems.
2. Abiotic and biotic factors of ecosystems.
3. Communities of the environment, their structure & significance.
4. Energy flow in environment: Ecological energetic.
5. Recycling and reuse technologies for solid and liquid waste in environment conservation.

UNIT IV –

1. Kinds of environmental pollution and their control methods.
2. Radioactive compounds and their impact on the environment.
3. Pesticides, types, nature and their effects on environment.
4. Important heavy metals and their role in environment.
5. Environmental indicator organisms.

Semester IV Paper-I

SUGGESTED READING MATERIAL

1. **G. W. Jenkins and G.J. Tortora : Anatomy and Physiology, III Edition, John Weley and sons.**
2. **Elaine N. Marieb: Human anatomy and Physiology, Sixth edition, Pearson**
3. **R.H.S. Carpenter: Neurophysiology, IV ed.**
4. **A. R. Crossman and D. Neary: Neuroanatomy, III ed. Elesevier Publication.**
5. "Psychoneuroendocrinology: Brain, Behavior, and Hormonal Interactions" by Clarissa S Holmes.
6. Clark: Elements of ecology
7. Odum: Fundamentals of Ecology
8. South Woods: Ecological methods.
9. Trivedi and Goel: Chemical and biological methods for water pollution studies

Vikram University, Ujjain
School of Studies in Zoology & Biotechnology,

M.Sc. Zoology
Semester IV
Paper II

Elective ZOL 402 Ichthyology (Fish)

Learning Outcomes: The paper allows understanding of the taxonomic and phylogenetic relationships of fish and fish-like vertebrates within the context of all vertebrate groups. The paper also imparts knowledge about the main patterns of morphological, behavioural, and physiological diversification that have allowed fish populations to occupy different ecological roles.

Unit-1

1. Classification of fishes as proposed by Berg
2. Fish integument
3. Locomotion
4. Fish growth and Age determination
5. Biology of some food fishes
6. Cultivable fishes

Unit-2

1. Food and feeding habits of fish
2. Accessory respiratory organs
3. Air bladder and its functions
4. Weberian ossicles their homologies and functions.
5. Fish Behavior

Unit-3

1. Sound producing organs
2. Deep sea adaptations
3. Hill stream adaptions
4. Migration in fishes
5. Viviparity in fishes
6. Poisonous and venomous fishes.

Unit-4

1. Coloration in fish
2. Parental care in fishes
3. Sexual cycle and fecundity
4. Early development and hatching
5. Luminous organs in fishes
6. Ecology of fishes

Semester IV Paper-II

SUGGESTED READING MATERIAL

1. Leo.S.Berg Classification of fishes (fossiliged & Recent).
2. Francis day Vol I & II Fishes of India.
3. C.B.LShrivastava, Fish Biology.
4. K.S.Mishra: An aid to classification of Fishes.
5. Gopalji Shrivastava: Indian of fishes of U.P.& Bihar.
6. B.Qurashi: Identification of fishes.
7. W.D.Rusell: Aquatic Productivity.
8. A.J.K.Mainan: Identification of fishes.
9. K.F.Lagler: Icthyology.
10. N.R.Rao: An Introduction of fishes.
11. J.F.Norman: An History of fishes.
12. S.S.Khanna: An Introduction of fishes.
13. R.L.Rath: Fresh water Aquaculture.
14. H.R.Singh: Advance in fish Biodiversity.
15. H.D.Kumar: Sustanibility & Management of Aquaculture & Fisheries.
16. Arugun & Natarajan: Fresh water Aquaculture.
17. Arugun & Natarajan: Santanu-Costal Aquaculture.
18. R.Sanatham: A manual of fresh water Aquaculture.

School of Studies in Zoology & Biotechnology
Session 2018-20

M.Sc. Zoology
Semester IV
Paper III
Elective ZOL PG 403 Economic Zoology

Learning Outcomes: Economic zoology should have aroused the students to ponder upon the importance of various useful and destructive organisms from honeybees to cattle, and viruses, mosquitoes to poisonous snakes. The paper allows study of various techniques like sericulture, apiculture, lac culture and fish culture. The study of these techniques allows students to develop them as entrepreneur

Unit- 1

1. Economic importance of Protozoa.
2. Economic importance of Mollusca.
3. Economic importance of Annelida.
4. Economic importance of Insects.
5. Economic importance of snakes
6. Economic importance of Mammalia.

Unit- 2

1. Sericulture
2. Apiculture
3. Lac culture
4. Pearl culture
5. Vermi culture
6. Aqua culture

Unit- 3

1. Poultry farming
2. Disease of poultry and their control
3. Piggery farming
4. Goat farming
5. Dairy science and its industrial aspects.

Unit – 4

1. Economic importance of fish and fish by product.
2. Pisci culture
3. Common pest of vegetables
4. Stored grain pests and their control.
5. Integrated pest management.

Practical:

1. Preparation of protozoan slide.
2. Microtomy for preparation of slides.
3. Collection, identification and preservation of animals.
4. Preparation of permanent slide of certain helminthes.
5. Study of developing embryos.
6. Preparation of bed for rearing silk worm larvae.
7. Silk worm rearing techniques.
8. Preparation of skeletons.
9. Dissection of honeybee, prawn, fish and sepia.
10. Honeybee rearing techniques.

SUGGESTED READING MATERIAL

1. **Chakraborty, C. & Sadhu, A. K.** 2000. Biology Hatchery and Culture Technology of Tiger Prawn and Giant Freshwater Prawn. Daya Publishing House. x+102pages, figs., plates.
2. **Dash M.C.** 1994. Brackish Water Prawn Culture. Palani Paramount Publications. 232 pages.
3. **Dholakia, A. D.** 2004. Fisheries and Aquatic Resources of India. Daya Publishing House. xxx + 413pages, figs., tables, index.
4. **Harvey, B. & Carolsfeld, J.** 1993. Induced breeding in tropical fish culture. Ottawa, Ont., IDRC, x + 144 pages.
5. **Horvath, L., Tamas, G., Seagrave, C.** Carp and Pond Fish Culture. Wiley-Blackwell. 188 pages.
6. **Jangi, B. S.** 1991. Economic Zoology. CRC, first edition (June 1, 1991), 200 pages.
7. **Jawaid Ahsan, Sinha, S. P.** 2008. A Handbook of Economic Zoology. S. Chand Group Publ. 272 pages.
8. Jawaid Ahsan and Subhas Prasad Sinha: A Hand Book on Economic Zoology: S. Chand Publ.
9. G.S. Shukla: Economic Zoology.
10. A. Rathore Applied and Economic Zoology, Publisher: Daya Publishing Hou

Vikram University, Ujjain
School of Studies in Zoology & Biotechnology,

M.Sc. Zoology
Semester IV
Paper III (E-2)

Elective ZOL PG 404 (E-1) Molecular Endocrinology and Reproductive Technology

Learning Outcomes: This paper provides as a foundation for the further study of endocrinology at the cellular & molecular level as well as it provides a firm basis for understanding normal hormonal control. The module will describe basic endocrinology and its regulation in man. The paper discusses the underlying pathologies of important endocrine diseases and will provide a basic understanding of the molecular mechanisms of hormone action and will include a description of the main hormone receptors and their signal transduction pathways.

Unit-1

1. Definition and scope of molecular endocrinology.
2. Chemical nature of hormones
3. Purification and characterization of hormones
4. Production of hormone by r DNA technology.
5. Methods for production of hormone
6. Neurohormone and neural messengers

Unit-2

1. Posta glandin and its biosynthesis.
2. Eicosanoids and hormone action.
3. Concentration and transport of hormones in the blood.
4. Genetic analysis of hormonal disorders.
5. Hormone and aging
6. Hormone and antagonism

Unit-3

1. Extraction and estimation of pregnanediol from urine.
2. Extraction of Gonadotrophin.
3. Extraction and purification of estrogen from urine
4. Diagnosis of pregnancy by the urine
5. Bioassay of Androgen.
6. Bioassay of progesterone.

Unit-4

1. Contraception.
2. Multiple ovulation and embryo transfer technology.
3. Study of estrous cycle by vaginal smear technology.
4. Surgical techniques- castration, overiectomy, vasectomy, tubectomy and laprotomy.
5. Hormonal regulation of continues breeders
6. Hormonal regulation of seasonal breeders

Semester IV Paper-III

SUGGESTED READING MATERIAL

1. Benjimine Lewin – Genes VII/ VIII, oxford University press.
2. Lodies etal – Molecular Cell Biology
3. Zarrow, M.X., Yochin J.M. and Machrthy, J.L.- Experimental Endocrinology.
4. Chatterji C.C.- Human Physiology(vol-II)
5. Bentley,P.J. – Comparative Vertebrate Endocrinology
6. Chinoy, NJ Rao, M.V., Deshraj, K.J. and High land , H.N. – Essential techniques in reproductively physiology and Endocrinology.
7. Norris, D.O.- Vertebrate Endocrinology.

School of Studies in Zoology & Biotechnology

M.Sc. Zoology
Semester IV
Paper III (E-2)
Elective ZOL PG 405 Limnology & Fish Productivity

Learning Outcomes: The general aim of the course is to give students knowledge relevance for their future career in limnology, in research or with an applied focus. The paper allows students to analyse and evaluate abiotic and biotic conditions in aquatic systems and account for structure and dynamics in biogeochemical cycles and organism communities. The students could carry out basic sampling and analyses in freshwater field/laboratory systems, plan and carry out experiment/field studies, present and evaluate experiment/field studies both orally and in writing.

Unit- 1

1. Basic principle and development of science of limnology.
2. Origin of Lake.
3. Classification of Lake system of the world
4. Saprobien System indicator organisms and water quality monitoring
5. Aquatic macrophytes and their control
6. Morphometry of Lake- use of various morphometric Parameter

Unit- 2

1. Light and its relation in fresh water
2. Heat and its relation in fresh water
3. Role of oxygen in fresh water.
4. Role of carbon – dioxide in fresh water
5. Role of organic and inorganic carbon in fresh water.
6. Reverine fisheries

Unit- 3

1. Freshwater ecosystem and communities- Lentic and lotic environment
2. Aspects of primary productivity in fresh water.
3. Role of physic-chemical characteristics in fresh water.
4. Plankton its role in fresh water.
5. Characteristics of Bethic Biota and their significance

Unit- 4

1. Fresh water resources in India and their quality.
2. Wetland and its management.
3. Fishery and management of reservoir.
4. Inland fish breeding.
5. Fish production in pond and its management
6. Recycling of organic wastes with reference to fish culture.

Semester IV Paper-III

SUGGESTED READING MATERIAL

1. E.P. Odum- Fundamental of Ecology
2. R.G. Wetzel- Limnology
3. P.S. Welsch- Limnology
4. R.G. Wetzel- Laboratory guide of Limnology
5. J. Schwocrble- Principlr of Limnology
6. K.A. Ruttner- Fundamentals of Limnology
7. Hutchinson- A Treatise on Limnology Vol .1-2
8. V.G. Cole- Limnology
9. G.A. Cole – Limnology
10. W.T. Edmondson- fresh water Biology
11. R.W. Pennak- Fresh Water invertebrates on N. America
12. J.G. Needham and P.R. Neendam – A guide to fresh water invertebrate
13. G.T. Tonpi- Fresh water animals of India
14. S. Krishan Swamy- A guide to the study of fresh water organism
15. G.W. Prescott- Fresh Water Algae.
16. Deshikachary – A guide for identification of Algae.
17. Published by International Biological program - I.B.P. Hand Books Nos. 1&2
18. H.L. Goltermann- Chemical analysis of fresh waters.

Vikram University, Ujjain
School of Studies in Zoology & Biotechnology,
Session 2018-20

M.Sc. Zoology
Semester IV

Practical –Based on paper 404 & 405

Endocrinology (Elective)

Learning Outcomes: The practical training of Molecular Endocrinology will teach students about surgical and experimental techniques applied in the subject, the students will also learn techniques like castration and different learn different histochemical techniques.

(A) Internal examination

Exercises:- MM Marks 16

1.	Experiments on molecular endocrinology/ Reproductive technology	04
2.	Surgical/ Experimental Techniques	02
3.	Histochemical/ Histological techniques	04
4.	Study of specimens (Spotting)	02
5.	Practical Record	02
6.	Viva- Voce	02
	Total	**16**

Limnology (Elective)

Learning Outcomes: The practical aspect of the paper will teach students about analyzing water quality, estimating plankton density and analyzing water quality of any water body.

Exercises:- MM Marks 16

1.	Major Limnological Exercise	04
2.	Minor Limnological Exercise	02
3.	Spotting	04
4.	Estimation (Two)	02
5.	Practical Record	02
6.	Viva- Voce	02
	Total	**16**

Practical – I Based on paper401,402 & 403

Learning Outcomes: The practices of this semester will teach students about understanding animal behavior, dissecting accessory respiratory organs, students will also learn about identification of local fishes and about identifying and commenting about different spots.

(A) University examination

Exercises:- **MM Marks 24**

1.	Exercise based on Neurophysiology and Eco-toxicology	05
2.	Exercise based on Economic Zoology	05
3.	Minor dissection of fish	05
4.	Study of museum specimens (Spotting)	05
5.	Practical Record	02
6.	Viva- Voce	02
	Total	**24**