RADHA GOVIND UNIVERSITY
RAMGARH, JHARKHAND

DEPARTMENT OF ZOOLOGY

NEP FYUGP CURRICULUM

ZOOLOGY HONOURS/HONOURS WITH RESEARCH PROGRAMME

SUBJECT CODE = 15

FOR UNDERGRADUATE COURSES UNDER
RADHA GOVIND UNIVERSITY

Implemented w.e.f.
Academic Session 2025-26 & onwards

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HIGHLIGHTS OF FYUGP CURRICULUM

PROGRAMME DURATION

- The Full-time, Regular UG programme for a regular student shall be for a period of four years with multiple entry and multiple exit options.
- The session shall commence from the **1st of July**.

ELIGIBILITY

- The selection for admission will be primarily based on the availability of seats in the Major subject and marks imposed by the institution. Merit point for selection will be based on marks obtained in the Major subject at Class 12 (or equivalent level) or the aggregate marks of Class 12 (or equivalent level) if the Marks of the Major subject is not available. Reservation norms of the Government of Jharkhand must be followed as amended in times.
- UG Degree Programmes with Double Major shall be provided only to those students who secure a minimum of 75% overall marks or 7.5 CGPA or higher.
- Other eligibility criteria, including those for multiple entry, will be in light of the UGC Guidelines for Multiple Entry and Exit in Academic Programmes offered in Higher Education Institutions.

ADMISSION PROCEDURE

- The reservation policy of the Government of Jharkhand shall apply in admission and the benefit of the same shall be given to the candidates belonging to the State of Jharkhand only. The candidates of other states in the reserved category shall be treated as General category candidates. Other relaxations or reservations shall be applicable as per the prevailing guidelines of the University for FYUGP.

VALIDITY OF REGISTRATION

- Validity of a registration for FYUGP will be for a maximum of **Seven years** from the date of registration.

ACADEMIC CALENDAR

- An Academic Calendar will be prepared by the University to maintain uniformity in the UG Honours/ Honours with Research Programmes and PG Diploma Programmes, running in the colleges under the university (Constituent/Affiliated).
- **Academic Year:** Two consecutive (one odd + one even) semesters constitute one academic year.
- **Semester:** The Odd Semester is scheduled from **July to December,** and the Even Semester is from **January to June**. Each week has a minimum of 40 working hours spread over 6 days.
- Each semester will include Admission, coursework, conduct of examination and declaration of results, including semester break.
- To undergo an 8-week summer internship/ apprenticeship during the summer camp, the Academic Calendar may be scheduled for academic activities as below:
  a) Odd Semester: **From the first Monday of August to the third Saturday of December**
  b) Even Semester: **From the first Monday of January to the third Saturday of May**
- An academic year comprising 180 working days in the least is divided into two semesters, each semester having at least 90 working days. With six working days in a week, this would mean that each semester will have 90/ 6 = 15 teaching/ working weeks. Each working week will have 40 hours of instructional time.
- Each year, the University shall draw out a calendar of academic and associated activities, which shall be strictly adhered to. The same is non-negotiable. Further, the Department will make all reasonable endeavours to deliver the programmes of study and other educational services as mentioned in its Information Brochure and website. However, circumstances may change, prompting the Department to reserve the right to change the content and delivery of courses, discontinue or combine courses and introduce or withdraw areas of specialization.

PROGRAMME OVERVIEW/ SCHEME OF THE PROGRAMME

- Undergraduate degree programmes of either 3 or 4-year duration, with multiple entries and exit points and re-entry

options within this period, with appropriate certifications such as:

- UG Certificate after completing 1 year (2 semesters) of study in the chosen fields of study, provided they complete one vocational course of 4 credits during the summer vacation of the first year or internship/ Apprenticeship in addition to 6 credits from skill-based courses earned during the first and second semesters.,
- UG Diploma after 2 years (4 semesters) of study diploma provided they complete one vocational course of 4 credits or internship/ Apprenticeship/ skill based vocational courses offered during the first year or second year summer term, in addition to 9 credits from skill-based courses earned during the first, second, and third semester.
- Bachelor's Degree after a 3-year (6 semesters) programme of study,
- Bachelor's Degree (Honours) after a 4-year (8 semesters) programme of study.
- Bachelor's Degree (Honours with Research) after a 4-year (8 semesters) programme of study to the students undertaking a 12-credit Research component in the fourth year of FYUGP.

CREDIT OF COURSES

The term 'credit' refers to the weightage given to a course, usually in terms of the number of instructional hours per week assigned to it. The workload relating to a course is measured in terms of credit hours. It determines the number of hours of instruction required per week over a semester (minimum 15 weeks).

a) One hour of teaching/ lecture or two hours of laboratory /practical work will be assigned per class/interaction.
One credit for Theory = 15 Hours of Teaching
One credit for Practicum = 30 Hours of Practical work
One credit for Internship = 02 Weeks of Practical experience

b) For credit determination, instruction is divided into three major components:
Hours (L) – Classroom Hours of one hour duration.
Tutorials (T) – Special, elaborate instructions on specific topics of one hour duration
Practical (P) – Laboratory or field exercises in which the student has to do experiments or other practical work of a two-hour duration.
Internship – For the Exit option after any academic year of a Four-year U.G. Programme for the award of U.G. Certificate, U.G. Diploma, U.G. Degree (Level 4.5, 5 or 5.5 respectively), Students can either complete two 4-week internships worth 2 credits each or one 8-week internship for all 4 credits. This practical experience connects academic learning with real-world applications, offering valuable exposure to professional environments in their fields of study

CHANGE OF MAJOR OR MINOR COURSES

- The change of Major or Minor courses may be allowed only once after the Second Semester and before the third Semester in the FYUG Programme, depending on the provisions laid by the FYUGP and the conditions laid by the Institution. **However, the student must clear the papers (Mid Sem & End Sem both) from the previous semesters of the new subject opted in the next Examination of the coming session.**

CALCULATION OF MARKS FOR THE PURPOSE OF THE RESULT

- Students' final marks and the result will be based on the marks obtained in the Semester Internal Examination and End Semester Examination organized taken together.
- Passing in a subject will depend on the collective marks obtained in the Semester internal and End Semester University Examination. However, students must pass in Theory and Practical Examinations separately.

PROMOTION CRITERIA

First degree programme with a single major (160+4=164 credits):

i. The Requisite Marks obtained by a student in a particular subject will be the criteria for promotion to the next Semester.
ii. No student will be detained in odd Semesters (I, III, V & VII).
iii. To get promotion from Semester-II to Semester-III a student will be required to pass in at least 75% of the Courses in an academic year, a student has to pass in minimum 11 papers out of the total 14 papers. It is further necessary

to procure pass marks in minimum of 50% papers of the current semester i.e. the student has to pass in 4 papers out of 7 papers in Semester-II.

iv. To get promotion from Semester-IV to Semester-V (taken together of Semester I, II, III & IV) a student has to pass in minimum of 20 papers out of the total 26 papers. It is further necessary to procure pass marks in minimum of 50% papers of the current semester i.e. the student has to pass in 3 papers out of 6 papers in Semester-IV.

v. To get promotion from Semester-VI to Semester-VII (taken all together of Semester I, II, III, IV, V & VI) a student has to pass in minimum of 27 papers out of the total 36 papers. It is further necessary to procure pass marks in minimum of 50% papers of the current semester i.e. the student has to pass in 3 papers out of 5 papers in Semester VI.

vi. However, it will be necessary to procure pass marks in each of the papers before completion of the programme.

First degree programme with dual major (192+4=196 credits):

i. Please refer to the FYUGP Regulations for the detailed provisions of Double Major and Dual Degrees.

ii. No student will be detained in odd Semesters (I, III, V & VII).

iii. To get promotion from Semester-II to Semester-III a student will be required to pass in at least 75% of the Courses in an academic year, a student has to pass in minimum 11 papers out of the total 15 papers. It is further necessary to procure pass marks in minimum of 50% papers of the current semester i.e. the student has to pass in 4 papers out of 8 papers in Semester-II.

iv. To get promotion from Semester-IV to Semester-V (taken together of Semester I, II, III & IV) a student has to pass in minimum 20 papers out of the total 27 papers. It is further necessary to procure pass marks in minimum of 50% papers of the current semester i.e. the student has to pass in 4 papers out of 7 papers in Semester-IV.

v. To get promotion from Semester-VI to Semester-VII (taken all together of Semester I, II, III, IV, V & VI) a student has to pass in minimum 28 papers out of the total 37 papers. It is further necessary to procure pass marks in minimum of 50% papers of the current semester i.e. the student has to pass in 3 papers out of 6 papers in Semester VI.

vi. However, it will be necessary to procure pass marks in each of the papers before completion of the programme.

PUBLICATION OF RESULTS

- The examination result shall be notified by the Controller of Examinations of the University in different newspapers and the same is to be posted also on the University website.
- If a student is found indulging in any malpractice/ unfair means during an examination, the examination taken by the student for the semester will be cancelled. The candidate has to reappear in all the papers of the session with the students of the next session, and his one year will be detained. However, marks secured by the candidate in all previous semesters will remain unaffected.
- There shall be no Supplementary or Re-examination for any subject. Students who have failed in any subject in an even semester may appear in the subsequent even semester examination to clear the backlog. Similarly, the students who have failed in any subject in an odd semester may appear in the subsequent odd semester examination to clear the backlog.

Regulations related to any concern not mentioned above shall be guided by the Regulations of the Radha Govind University for FYUGP.

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COURSE STRUCTURE FOR FYUGP **'HONOURS/ RESEARCH/ PG DIPLOMA'**

Table 1: Credit Framework for Four-Year Undergraduate Programme (FYUGP) under State Universities of Jharkhand [Total Credits = 164]

Academic Level	**Level of Courses**	**Semester**	**MJ**: Discipline Specific Courses – Core or Major (80)	**AC**: Associated core courses from discipline/ Interdisciplinary/ vocational (8)		**ELC**: Elective courses may be opted from four paths [Follow table 2] (24)	**MDC**: Multidisciplinary Courses (From a pool of Courses) (9)	**AEC**: Ability Enhancement Courses (Modern Indian Language and English) (8)	**SEC**: Skill Enhancement Courses (9)	**VAC**: Value Added Courses (6)	**IKS**: (i) Indian Knowledge System (2) & **SA**: (ii) Social awareness (2)	**RC**: Research Courses (4+8)/ **AMJ**: Advanced Courses instead of Research (4+4+4)/ **PGD:** PG Diploma Level 6 (4+4+4)		**Total Credits**	**IAP**; Internship/Apprenticeship/ Project/ Vocational course/ Dissertation (4) **In between Sem I to Sem-VI**
	1	2	3 (Major- 80)	4 (Minor-32)			5	6	7	8	9	10	11	12	13
Level 4.5	Level 100-199: **Foundation or Introductory courses**	**I**	4	4	---	---	3	2	3	2	2	---	---	**20**	4
		II	4	---	4	---	3	2	3	2	2	---	---	**20**	
		Exit Point: Undergraduate Certificate provided with Summer Internship/ Project/ Vocational course/ Dissertation (4 credits)													
Level 5	Level 200-299: **Intermediate-level courses**	**III**	4+4	---		4	3	2	3	---	---	---	---	**20**	
		IV	4+4+4	---		4	---	2	---	2	---	---	---	**20**	
		Exit Point: Undergraduate Diploma provided with Summer Internship/ Project/ Vocational course/ Dissertation (4 credits)													
Level 5.5	Level 300-399: **Higher-level courses**	**V**	4+4+4+4	---		4	---	---	---	---	---	---	---	**20**	
		VI	4+4+4+4	---		4	---	---	---	---	---	---	---	**20**	
		Exit Point: Bachelor's Degree with Summer Internship/ Project/ Vocational course/ Dissertation (4 credits)												**124**	
Level 6	Level 400-499: **Advanced courses** Hons with Research (>7.5 CGPA)/ Honours/ PG Diploma	**VII**	4+4+4	---		4	---	---	---	---	---	4	4	**20**	---
		VIII	4+4	---		4	---	---	---	---	---	8	4+4	**20**	
		Exit Point: Bachelor's Degree with Honours/ Honours with Research/ PG Diploma Level 6												**164**	

Note: Honours students not undertaking research will do 3 courses for 12 credits in lieu of a Research project.

Table 2: Options for Elective Minor Courses

Path A	Path B	Path C	Path D
ELC-A; Elective courses from Interdisciplinary Subjects 1 & 2 (24)	**ELC-B**; Elective courses from discipline (24)	**ELC-C**; Elective courses from vocational (24)	**ELC-D**; Elective courses from discipline for Double Major (48)
This pathway may be recommended for students who wish to develop core competency in multiple disciplines of study. In this case, the credits for the minor pathway shall be distributed among the constituent disciplines/subjects. If students pursuing FYUGP are awarded a UG Degree in a Major discipline, they are eligible to mention their core competencies in other disciplines of their choice if they have earned 12 credits each from pathway courses of two particular disciplines. In the first three years of FYUGP, this pathway is composed of one Major discipline with 60 credits from 15 courses, and two other disciplines, with 12 credits from 3 courses in each discipline. In this pathway, if the students choose one of the two disciplines for 12 credits in one discipline then they should choose a different discipline for the other 12 credits. If the students continue to the fourth year of FYUGP, the students need to earn an additional 4 credits in both disciplines.	This pathway may be recommended to those students who wish for an in-depth study in more than one discipline with a focus on one discipline (Major) and relatively less focus on the other (Minor). If students exit at the end of the third year of FYUGP, they are awarded a Major Degree in a particular discipline and a Minor in another discipline of their choice, if they earn a minimum of 24 credits from the courses in the Minor discipline. If the students continue to the fourth year of FYUGP, they should earn a minimum of 32 credits in the Minor discipline, to be eligible for a UG Degree (Honours) with a Major and a Minor. For this, in the fourth year, they should earn an additional minimum of 8 credits through 2 courses in the Minor discipline.	This pathway may be recommended to those students who wish for exposure to a vocational discipline in addition to the in-depth study in the Major discipline. The credit requirements for Major and Vocational Minor disciplines in this pathway are the same as those for Major with Minor pathway, except that the Minor courses are in a vocational discipline. If students exit at the end of the third year of FYUGP, they are awarded a Major Degree in a particular discipline and a Minor in vocational discipline of their choice, if they earn a minimum of 24 credits from the Vocational courses. If the students continue to the fourth year of FYUGP, they should earn a minimum of 32 credits in the vocational discipline. For this, in the fourth year, they should earn an additional minimum of 8 credits through 2 courses in the Vocational discipline.	To secure the required minimum credits in each discipline, students who wish to opt for a Double Major should include the credits earned by them from the Multi-Disciplinary Courses, Skill Enhancement Courses, and Value-Added Courses offered by the respective Major disciplines. The Double Major pathway is extended to the fourth year. Shifting to a double major from a minor in the third semester will be allowed subject to clearance of the courses of double major (not studied earlier) in succeeding sessions. In the fourth year, the student can continue to earn the required credits in either Major A or Major B to qualify for a UG Degree (Honours)/ UG Degree (Honours with Research) in A or B. If he/she opts to continue with Major B in the fourth year, he/she should earn an additional 16 credits of 300-399 level in Major B through mandatory online courses. The institution will not provide the courses in physical mode in the fourth year of this segment.

Table 3: Credit Distribution in Elective Minor Courses during the Four Years of FYUGP

Academic Level	**Level of Courses**	**Semester**	**Path A** **ELC**; Elective courses from Interdisciplinary Subjects 1 & 2 (24)		**Path B** **ELC**; Elective courses from the discipline (24)	**Path C** **ELC**; Elective courses from vocational (24)	**Path D** **ELC**; Elective courses from the discipline for Double Major (64)
	1	2	3A. Subject 1	3B. Subject 2	4	5	6
Level 4.5	Level 100-199: **Foundation or Introductory courses**	**I**	---	---	---	---	4+4
		II	---	---	---	---	4+4
		Exit Point: Bachelor's Degree with Hons. with Research					
Level 5	Level 200-299: **Intermediate-level courses**	**III**	4	---	4	4	4+4
		IV	---	4	4	4	4+4
		Exit Point: Bachelor's Degree with Hons.					
Level 5.5	Level 300-399: **Higher-level courses**	**V**	4	---	4	4	4+4
		VI	---	4	4	4	4+4
		Exit Point: P.G. Diploma Degree					
Level 6	Level 400-499: **Advanced courses** Hons with Research (>7.5 CGPA)/ Honours/ PG Diploma	**VII**	4	---	4	4	4+4
		VIII	---	4	4	4	4+4
		Exit Point: (A) Bachelor's Degree with Hons. with Research/ (B) Bachelor's Degree with Hons./ (C) P.G. Diploma Degree					

COURSES OF STUDY FOR FOUR-YEAR UNDERGRADUATE PROGRAMME 2025 onwards

Table 4: Semester-wise Course Code and Credit Points for Single Major during the First Three Years of FYUGP

Semester	Common, Introductory, Major, Minor, Vocational & Internship Courses		Credits	
	Code	Papers	Paper	Semester
I	AEC-1	Language and Communication Skills (MIL-1; Modern Indian language Hindi/ English)	2	7 Papers (20 credits)
	VAC-1	Value Added Course-1	2	
	IKS-1	Indian Knowledge System (foundation Course)	2	
	SEC-1	Skill Enhancement Course-1	3	
	MDC-1	Multi-disciplinary Course-1	3	
	AC-1	Associated core courses from discipline/ Interdisciplinary/ vocational	4	
	MJ-1	Major paper 1 (Disciplinary/ Interdisciplinary Major)	4	
II	AEC-2	Language and Communication Skills (MIL-1; Modern Indian language English/ Hindi)	2	7 Papers (20 credits)
	VAC-2	Value Added Course-2	2	
	SA	Social Awareness Activities	2	
	SEC-2	Skill Enhancement Course-2	3	
	MDC-2	Multi-disciplinary Course-2	3	
	AC-2	Associated core courses from discipline/ Interdisciplinary/ vocational	4	
	MJ-2	Major paper 2 (Disciplinary/ Interdisciplinary Major)	4	
III	AEC-3	Language and Communication Skills (MIL-2; MIL including TRL)	2	6 Papers (20 credits)
	SEC-3	Skill Enhancement Course-3	3	
	MDC-3	IKS as a Multi-disciplinary Course-3	3	
	ELC-1	Elective courses from discipline/ Interdisciplinary/ vocational	4	
	MJ-3	Major paper 3 (Disciplinary/ Interdisciplinary Major)	4	
	MJ-4	Major paper 4 (Disciplinary/ Interdisciplinary Major)	4	
IV	AEC-4	Language and Communication Skills (MIL-2; MIL including TRL)	2	6 Papers (20 credits)
	VAC-3	Value Added Course-3	2	
	ELC-2	Elective courses from discipline/ Interdisciplinary/ vocational	4	
	MJ-5	Major paper 5 (Disciplinary/ Interdisciplinary Major having IKS)	4	
	MJ-6	Major paper 6 (Disciplinary/ Interdisciplinary Major)	4	
	MJ-7	Major paper 7 (Disciplinary/ Interdisciplinary Major)	4	
V	ELC-3	Elective courses from discipline/ Interdisciplinary/ vocational	4	5 Papers (20 credits)
	MJ-8	Major paper 8 (Disciplinary/ Interdisciplinary Major)	4	
	MJ-9	Major paper 9 (Disciplinary/ Interdisciplinary Major)	4	
	MJ-10	Major paper 10 (Disciplinary/ Interdisciplinary Major)	4	
	MJ-11	Major paper 11 (Disciplinary/ Interdisciplinary Major)	4	
VI	ELC-4	Elective courses from discipline/ Interdisciplinary/ vocational	4	5 Papers (20 credits)
	MJ-12	Major paper 12 (Disciplinary/ Interdisciplinary Major)	4	
	MJ-13	Major paper 13 (Disciplinary/ Interdisciplinary Major)	4	
	MJ-14	Major paper 14 (Disciplinary/ Interdisciplinary Major)	4	
	MJ-15	Major paper 15 (Disciplinary/ Interdisciplinary Major)	4	
Total Credits, excluding one Internship (IAP) of 4 credits =			**120**	**120**

Note: It is mandatory to take One Internship of 4 credits in any one of the semesters during the first three years in FYUGP or before exit at any of the exit points if a student wishes to opt for the same.

Table 5A: Semester-wise Course Code and Credit Points for Single Major during the Fourth Year of FYUGP for Bachelor's Degree (Honours with Research)

Semester	Common, Introductory, Major, Minor, Vocational & Internship Courses		Credits	
	Code	Papers	Paper	Semester
VII A	ELC-5	Elective courses from discipline/ Interdisciplinary/ vocational	4	5 Papers (20 credits)
	MJ-16	Major paper 16 (Research Methodology)	4	
	MJ-17	Major paper 17 (Disciplinary/Interdisciplinary Major)	4	
	MJ-18	Major paper 18 (Disciplinary/Interdisciplinary Major)	4	
	RC-1	Research proposal – Planning & Techniques (Disciplinary/Interdisciplinary Major)	4	
VIII A	ELC-6	Elective courses from discipline/ Interdisciplinary/ vocational	4	4 Papers (20 credits)
	MJ-19	Major paper 19 (Disciplinary/Interdisciplinary Major)	4	
	MJ-20	Major paper 20 (Disciplinary/Interdisciplinary Major)	4	
	RC-2	Research Internship/Field Work/Project/Dissertation/Thesis	8	
		Total Credits, excluding one Internship of 4 credits =	**160**	**160**

Table 5B: Semester-wise Course Code and Credit Points for Single Major during the Fourth Year of FYUGP for Bachelor's Degree (Honours)

Semester	Common, Introductory, Major, Minor, Vocational & Internship Courses		Credits	
	Code	Papers	Paper	Semester
VII B	ELC-5	Elective courses from discipline/ Interdisciplinary/ vocational	4	5 Papers (20 credits)
	MJ-16	Major paper 16 (Disciplinary/Interdisciplinary Major)	4	
	MJ-17	Major paper 17 (Disciplinary/Interdisciplinary Major)	4	
	MJ-18	Major paper 18 (Disciplinary/Interdisciplinary Major)	4	
	AMJ-1	Advanced Major pape-1 (Disciplinary/Interdisciplinary Major)	4	
VIII B	ELC-6	Elective courses from discipline/ Interdisciplinary/ vocational	4	5 Papers (20 credits)
	MJ-19	Major paper 19 (Disciplinary/Interdisciplinary Major)	4	
	MJ-20	Major paper 20 (Disciplinary/Interdisciplinary Major)	4	
	AMJ-2 AMJ-3	Advanced Major paper-2 (Disciplinary/Interdisciplinary Major) Advanced Major paper-3 (Disciplinary/Interdisciplinary Major)	4 4	
		Total Credits, excluding one Internship of 4 credits =	**160**	**160**

Table 5C: Semester-wise Course Code and Credit Points for Single Major during the Fourth Year of FYUGP for Bachelor's Degree (with Postgraduate Diploma)

Semester	Common, Introductory, Major, Minor, Vocational & Internship Courses		Credits	
	Code	Papers	Paper	Semester
VII C	ELC-5	Elective courses from discipline/ Interdisciplinary/ vocational	4	5 Papers (20 credits)
	MJ-16	Major paper 16 (Disciplinary/Interdisciplinary Major)	4	
	MJ-17	Major paper 17 (Disciplinary/Interdisciplinary Major)	4	
	MJ-18	Major paper 18 (Disciplinary/Interdisciplinary Major)	4	
	JOC-1	Skill based Job Oriented paper (Disciplinary/Interdisciplinary Major)	4	
VIII C	ELC-6	Elective courses from discipline/ Interdisciplinary/ vocational	4	5 Papers (20 credits)
	MJ-19	Major paper 19 (Disciplinary/Interdisciplinary Major)	4	
	MJ-20	Major paper 20 (Disciplinary/Interdisciplinary Major)	4	
	JOC-2	Skill based Job Oriented paper (Disciplinary/Interdisciplinary Major)	4	
	JOC-3	Skill based Job Oriented paper (Disciplinary/Interdisciplinary Major)	4	
		Total Credits, excluding one Internship of 4 credits =	**160**	**160**

AIMS OF BACHELOR'S DEGREE PROGRAMME IN ZOOLOGY

The broad aims of the Bachelor's Degree programme in Zoology are:

The B.Sc. Zoology programme equips graduates with an in-depth understanding of animal diversity, taxonomy, anatomy, physiology, genetics, evolution, ecology, and behavior, enabling them to connect structure and function across molecular, organismal, and ecosystem levels.

It develops strong practical competence in laboratory and field techniques, including microscopy, dissection (virtual), specimen preparation, histology, physiological and molecular assays, biodiversity surveys, and ecological data collection, supported by statistical analysis, bioinformatics, and modern digital tools.

Students learn to critically analyze biological problems, design and conduct experiments, interpret scientific data, and apply concepts to address environmental challenges, biodiversity loss, and sustainability issues.

The programme nurtures ethical responsibility in animal handling, research practices, and conservation activities, while enhancing communication skills for effective dissemination of scientific knowledge through reports, presentations, and outreach. Graduates gain awareness of global biodiversity concerns, climate change impacts, and the relevance of Sustainable Development Goals, fostering a lifelong learning mindset.

The programme also prepares students for careers in teaching, research, environmental management, public health, biotechnology, forestry, wildlife conservation, and allied life science sectors, with the ability to integrate interdisciplinary knowledge for societal benefit.

PROGRAM LEARNING OUTCOMES

The broad aim of the bachelor's degree programme in Zoology is to acquire Knowledge and Understanding as follows:

(i) In-depth knowledge and understanding of 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)

(ii) 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.

(iii) Skills related to specialization areas within Zoology as well as within subfields of Zoology, including broader interdisciplinary subfields (Zoology, Physics, and Mathematics).

- Over the years, Zoologists have been able to find many differences within the same breed of animal species. As a Zoology professional one can study extinct animals by specializing in Paleozoology, on the different types of birds in Ornithology, or opt for studying Herpetology and Arachnology, the branches dealing with the study of snakes and spiders, respectively
- Appreciate the complexity of life processes, their molecular, cellular, and physiological processes, their genetics, evolution and behaviour and their interrelationships with the environment.
- Study concepts, principles, and theories related to animal behaviour and welfare.
- Understand and interpret data to reach a conclusion
- Design and conduct experiments to test a hypothesis.
- Understand scientific principles underlying animal health, management, and welfare.
- Accept the legal restrictions & ethical considerations placed on animal welfare.
- Understand fundamental aspects of animal science relating to the management of animals.

The core courses would fortify the students with in-depth subject knowledge concurrently; the discipline-specific electives will add additional knowledge about applied aspects of the program as well as its applicability in both academia and industry. Generic electives will introduce integration among various interdisciplinary courses. The skill enhancement courses would further add additional skills related to the subject as well as other than the subject. In brief, the students who graduate with this type of curriculum would be able to disseminate subject knowledge along with the necessary skills to suffice their capabilities for academia, entrepreneurship and Industry. For each syllabus, the course content has been divided into four units with a breakup of the topics to be covered to provide the students a better understanding of the main theme represented in the title of each unit. Such type of design is to indicate the breadth of content to be taught thus ensuring more or less uniform coverage of information on a certain theme. The teacher has to take up the contents in such a manner by asking questions and answering them that the whole process appears to be an interesting narrative with topics falling in line rather than appearing as unrelated complex terms. Learning will be more enjoyable and imbibing if appropriate examples are cited from our daily lives.

SEMESTER WISE COURSES IN ZOOLOGY HONOURS **2025 onwards**

Table 6: Semester-wise Course Code and Credit Points

Semester	Courses		Examination Structure			
	Code	Courses in NEP FYUGP Syllabus of Zoology Session 2025-26 & onwards	Credits	Mid Semester Theory (F.M.)	End Semester Theory (F.M.)	End Semester Practical/ Viva (F.M.)
I	MJ-1	Invertebrate Diversity & Economic Zoology	4	25	75	---
	SEC-1	Wildlife Conservation and Management	3	---	75	---
II	MJ-2	Ecology and Biostatistics	4	25	75	---
	SEC-2	Sericulture, Apiculture, Pearl Culture & Prawn Culture	3	---	75	---
III	MJ-3	Cell Biology and Biochemistry	4	25	75	---
	MJ-4	Practical-I	4	---	---	100
	SEC-3	Elementary Computer Application Softwares	3	---	75	---
IV	MJ-5	Indian Knowledge System in Zoology	4	25	75	---
	MJ-6	Animal Physiology	4	25	75	---
	MJ-7	Practical-II	4	---	---	100
V	MJ-8	Molecular Biology	4	25	75	---
	MJ-9	Vertebrate Diversity & Comparative Anatomy	4	25	75	---
	MJ-10	Genetics & Ethology	4	25	75	---
	MJ-11	Practical-III	4	---	---	100
VI	MJ-12	Developmental Biology	4	25	75	---
	MJ-13	Endocrinology & Immunology	4	25	75	---
	MJ-14	Evolution	4	25	75	---
	MJ-15	Practical-IV	4	---	---	100
VII	MJ-16	Research Methodology	4	25	75	---
	MJ-17	Advanced Biochemistry and Biotechnology	4	25	75	---
	MJ-18	Practical-V	4	---	---	100
	AMJ-1/	Advanced Immunology and Methods in Biology	4	25	75	---
	RC-1	Research Planning & Techniques	4	25	75	---
VIII	MJ-19	Toxicology, Histology and Histochemistry	4	25	75	---
	MJ-20	Practical-VI	4	---	---	100
	AMJ-2	Advanced Cell Biology & Molecular Genetics	4	25	75	---
	AMJ-3/	Advanced Major Practical-VII	4	---	---	100
	RC-2	Project Dissertation/ Research Internship/ Field Work	8	50	---	150

***** It is mandatory to take Either One Internship of 4 credits or Two Internships of 2 credits each in any one of the semesters during the first three years in FYUGP or before exit at any of the exit points if a student wishes to opt for the same.

Table 7: Semester-wise Course Code and Credit Points of Minor Courses in Zoology

Courses		Examination Structure			
Code	**Minor Courses in NEP FYUGP Syllabus of Zoology** Session 2025-26 & onwards	**Credits**	**Mid Semester Theory (F.M.)**	**End Semester Theory (F.M.)**	**End Semester Practical/ Viva (F.M.)**
MN-A	Introductory Zoology	4	15	60	25
MN-B	Fundamentals of Zoology	4	15	60	25
MN-C	Animal Diversity	4	15	60	25
MN-D	Food Nutrition And Health	4	15	60	25
MN-E	Environment & Public Health	4	15	60	25
MN-F	Human Anatomy and Histology	4	15	60	25
MN-G	Comparative Physiology	4	15	60	25

INSTRUCTION TO QUESTION SETTER

SEMESTER INTERNAL EXAMINATION (SIE):

There will be Only One Semester Internal Examination in Major, Minor and Research Courses, which will be organized at college/institution level. However, Only One End semester evaluation in other courses will be done either at College/ Institution or University level depending upon the nature of course in the curriculum.

A. (SIE 10+ CAS 5=15 marks):

There will be two group of questions. **Question No.1 will be very short answer type in Group A** consisting of five questions of 1 mark each. **Group B will contain descriptive type** two questions of five marks each, out of which any one to answer.

The Semester Internal Examination shall have two components. (a) One Semester Internal Assessment Test (SIA) of 10 Marks, (b) Class Attendance Score (CAS) of 5 marks.

B. (SIE 20+CAS 5=25 marks):

There will be two group of questions. **Group A is compulsory** which will contain two questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 will be short answer type** of 5 marks. **Group B will contain descriptive type** two questions of ten marks each, out of which any one to answer.

The Semester Internal Examination shall have two components. (a) One Semester Internal Assessment Test (SIA) of 20 Marks, (b) Class Attendance Score (CAS) of 5 marks.

Conversion of Attendance into score may be as follows:

Attendance Upto 45%, 1mark; 45<Attd.<55, 2 marks; 55<Attd.<65, 3 marks; 65<Attd.<75, 4 marks; 75<Attd, 5 marks.

END SEMESTER UNIVERSITY EXAMINATION (ESE):

A. (ESE 50 marks):

There will be two group of questions. **Group A is compulsory** which will contain one question. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. Group B will contain descriptive type five questions of fifteen marks each, out of which any three are to answer.

B. (ESE 60 marks):

There will be two group of questions. **Group A is compulsory** which will contain three questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 & 3 will be short answer type** of 5 marks. Group B will contain descriptive type five questions of fifteen marks each, out of which any three are to answer.

C. (ESE 75 marks):

There will be two group of questions. **Group A is compulsory** which will contain three questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No. 2 & 3 will be short answer type** of 5 marks. Group B will contain descriptive type six questions of fifteen marks each, out of which any four are to answer.

D. (ESE 100 marks):

There will be two group of questions. **Group A is compulsory** which will contain three questions. **Question No.1 will be very short answer type** consisting of ten questions of 1 mark each. **Question No. 2 & 3 will be short answer type** of 5 marks. Group B will contain descriptive type six questions of twenty marks each, out of which any four are to answer.

FORMAT OF QUESTION PAPER FOR MID/ END SEMESTER EXAMINATIONS

Question format for **15 Marks**:

Subject/ Code

F.M. =15 **Time** = 1 Hr. Exam Year

General Instructions:

i. **Group A** carries very short answer-type compulsory questions.
ii. **Answer 1 out of 2** subjective/ descriptive questions given in **Group B**.
iii. Answer in your own words as far as practicable.
iv. Answer all subparts of a question in one place.
v. Numbers in the right indicate full marks for the question.

Group A

1. [5x1=5]
   i. .....
   ii. .....
   iii. .....
   iv. .....
   v. .....

Group B

2. ..... [10]
3. ..... [10]

Note: There may be subdivisions in each question asked in Theory Examination.

Question format for **20 Marks**:

Subject/ Code

F.M. =20 **Time** = 1 Hr. Exam Year

General Instructions:

i. **Group A** carries very short answer-type compulsory questions.
ii. **Answer 1 out of 2** subjective/ descriptive questions given in **Group B**.
iii. Answer in your own words as far as practicable.
iv. Answer all subparts of a question in one place.
v. Numbers in the right indicate full marks for the question.

Group A

1. [5x1=5]
   i. .....
   ii. .....
   iii. .....
   iv. .....
   v. .....
2. ..... [5]

Group B

3. ..... [10]
4. ..... [10]

Note: There may be subdivisions in each question asked in the Theory Examination.

Question format for **50 Marks**:

Subject/ Code

F.M. =50 **Time** = 1.5 Hrs. Exam Year

General Instructions:

i. **Group A** carries very short answer-type compulsory questions.
ii. **Answer 3 out of 5** subjective/ descriptive questions given in **Group B**.
iii. Answer in your own words as far as practicable.
iv. Answer all subparts of a question in one place.
v. Numbers in the right indicate full marks for the question.

Group A

1. [5x1=5]
   i. .....
   ii. .....
   iii. .....
   iv. .....
   v. .....

Group B

2. ..... [15]
3. ..... [15]
4. ..... [15]
5. ..... [15]
6. ..... [15]

Note: There may be subdivisions in each question asked in the Theory Examination.

Question format for **60 Marks**:

Subject/ Code

F.M. =60 **Time** = 3 Hrs. Exam Year

General Instructions:

i. **Group A** carries very short answer-type compulsory questions.
ii. **Answer 3 out of 5** subjective/ descriptive questions given in **Group B**.
iii. Answer in your own words as far as practicable.
iv. Answer all subparts of a question in one place.
v. Numbers in the right indicate full marks for the question.

Group A

1. [5x1=5]
   i. .....
   ii. .....
   iii. .....
   iv. .....
   v. .....
2. ..... [5]
3. ..... [5]

Group B

4. ..... [15]
5. ..... [15]
6. ..... [15]
7. ..... [15]
8. ..... [15]

Note: There may be subdivisions in each question asked in the Theory Examination.

Question format for **75 Marks**:

Subject/ Code

F.M. =75 **Time** = 3 Hrs. Exam Year

General Instructions:

i. **Group A** carries very short answer-type compulsory questions.
ii. **Answer 4 out of 6** subjective/ descriptive questions given in **Group B**.
iii. Answer in your own words as far as practicable.
iv. Answer all subparts of a question in one place.
v. Numbers in the right indicate full marks for the question.

Group A

1. [5x1=5]
   i. .....
   ii. .....
   iii. .....
   iv. .....
   v. .....
2. ..... [5]
3. ..... [5]

Group B

4. ..... [15]
5. ..... [15]
6. ..... [15]
7. ..... [15]
8. ..... [15]
9. ..... [15]

Note: There may be subdivisions in each question asked in the Theory Examination.

Question format for **100 Marks**:

Subject/ Code

F.M. =100 **Time** = 3 Hrs. Exam Year

General Instructions:

i. **Group A** carries very short answer-type compulsory questions.
ii. **Answer 4 out of 6** subjective/ descriptive questions given in **Group B**.
iii. Answer in your own words as far as practicable.
iv. Answer all subparts of a question in one place.
v. Numbers in the right indicate full marks for the question.

Group A

1. [10x1=10]
   i. ..... vi. .....
   ii. ..... vii. .....
   iii. ..... viii. .....
   iv. ..... ix. .....
   v. ..... x. .....
2. ..... [5]
3. ..... [5]

Group B

4. ..... [20]
5. ..... [20]
6. ..... [20]
7. ..... [20]
8. ..... [20]
9. ..... [20]

Note: There may be subdivisions in each question asked in the Theory Examination.

SEMESTER I

I. MAJOR COURSE –MJ 1:

INVERTEBRATE DIVERSITY & ECONOMIC ZOOLOGY

Marks: 25 (5 Attd. + 20 SIE: 1Hr) + 75 (ESE: 3Hrs) = 100	**Pass Marks: Th (SIE + ESE) = 40**

(Credits: Theory-04) **60 Hours**

Course Objectives:

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

1. Animal diversity ranging from Protista up to Mammalia.
2. The biology, transmission, and preventive strategies of major infectious and communicable diseases.

Course Learning Outcomes:

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

1. Develop an understanding on the diversity of life about Protista, non-chordates and chordates
2. Grouping of animals on the basis of their morphological characters, and the evolutionary history of a taxon
3. Explain causative pathogens, vectors, and control measures for common human infectious diseases.

Course Content:

GROUP – A: INVERTEBRATE DIVERSITY

UNIT I: Kingdom Protista **(04 Lectures)**

General characters and classification up to classes; Locomotion & reproduction in Protozoa

UNIT II: Phylum Porifera **(05 Lectures)**

General characters and classification up to classes; Canal System

UNIT III: Phylum Cnidaria **(04 Lectures)**

General characters and classification up to classes; Polymorphism in Hydrozoa & Coral reef

UNIT IV: Phylum Ctenophora

General characters and classification **(01 Lecture)**

UNIT IV: Phylum Platyhelminthes **(04 Lectures)**

General characters and classification up to classes; Life history of *Taenia solium*

UNIT V: Phylum Nemathelminthes **(04 Lectures)**

General characters and classification up to classes; Life history of *Ascaris lumbricoides* and its parasitic adaptations

UNIT VI: Phylum Annelida **(04 Lectures)**

General characters and classification up to classes; Metamerism in Annelida

UNIT VII: Phylum Arthropoda **(04 Lectures)**

General characters and classification up to classes; Vision in Insects

UNIT VIII: Phylum Mollusca **(04 Lectures)**

General characters and classification up to classes; Torsion & detorsion in gastropods

UNIT IX: Phylum Echinodermata **(04 Lectures)**

General characters and classification up to classes; Water-vascular system in Asteroidea

GROUP – B: ECONOMIC ZOOLOGY

UNIT I: Major infectious and communicable diseases: malaria, filaria, tuberculosis, cholera, and AIDS, their vectors, pathogens, and prevention. **(10 Lectures)**

UNIT II: Cattle and livestock diseases, their pathogen (helminths) and vectors (ticks, mites, *Tabanus, Stomoxys*). **(07 Lectures)**

UNIT III: Pests of sugar cane (*Pyrilla perpusiella*), oilseed *(Achaeajanata),* and rice *(Sitophilus oryzae).* **(05 Lectures)**

Suggested Readings:

Text Books:

1. Pechnek, J.A.2000. Biology of Invertebrates. Tata McGraw-Hill Publishing Company.
2. E L Jordan and Verma, Invertebrate Zoology, S. Chand Publishing, India
3. Park, K. (2021). *Park's textbook of preventive and social medicine* (26th ed.). Banarsidas Bhanot Publishers.

Reference Books:

GROUP – A:

1. Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2002). The
2. Invertebrates: A New Synthesis, III Edition, Blackwell Science
3. Young, J. Z. (2004). The Life of Vertebrates. III Edition. Oxford university press.
4. R L Kotpal, Invertebrate Zoology, Rastogi Publications, India

GROUP – B:

1. Soulsby, E. J. L. (1982). *Helminths, arthropods and protozoa of domesticated animals* (7th ed.). Baillière Tindall.
2. David, B. V., & Ramamurthy, V. V. (2016). *Elements of economic entomology* (10th ed.). Scientific Publishers.

II. SKILL ENHANCEMENT COURSE- SEC 1:
WILDLIFE CONSERVATION AND MANAGEMENT

Marks: 75 (ESE: 3Hrs) = 75	**Pass Marks: Th (ESE) = 30**

(Credits: Theory-03) **45 Hours**

Course Objectives:

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

1. Wildlife management and the tools used by wildlife managers.
2. Methodologies for biodiversity monitoring, conservation and management issues of vertebrate pests, wildlife conflict and overabundant species, wildlife health, and diseases.

Course Learning Outcomes:

On successful completion of this course, the student will be able:

1. To understand the wildlife richness of an area and prepare an inventory report.
2. To study the causes of its depletion.
3. To know the distinction between wildlife sanctuary, National Park, and the Biosphere Reserve.
4. To understand the concept of home range –the territory of big cats. concept of pug-mark, difference of pug-marks between male and female big cats, remote sensing, and geographic information system.
5. To know the reasons for the entry of wild animals (elephant and leopard) into human dwellings.
6. To understand strategies for the conservation of wildlife.

Course Content:

UNIT I: Value of wildlife and need for its conservation (12 Lectures)

1. Definition, value and importance of wildlife; Causes of depletion of wildlife;
2. Inventory and classification of wetland and animal inhabitants;
3. Wildlife Sanctuaries and National Parks in India: general strategies and issues;
4. Theories of population dispersal; Animal movement, concept of home range and territory; Tracking movement by remote sensing and GIS.

UNIT II: Population and prey-predator dynamics (12 Lectures)

1. Impact of habitat destruction and fragmentation on wildlife population;
2. Biological parameters such as food, cover, forage, and their effects on wildlife;
3. Density-dependent and independent population regulation;
4. Impact of introduced species on preexisting flora and fauna of wildlife.
5. Predator-prey models and impact of predation (Lotka-Volterra Model and MacArthur Model).

UNIT III: Wildlife Conservation (12 Lectures)

1. Wildlife conservation: ethics and importance of conservation;
2. Wildlife conservation objectives- strategies and issues;
3. Captive breeding techniques, translocation and reintroduction; Restoration of degraded habitat;
4. Human-wildlife Conflict and its mitigation; Sick animal refuges in protected areas.
5. Acts related to wildlife Conservation in India

UNIT IV: Rehabilitation and management (9 Lectures)

1. Type of wildlife management-manipulative, custodial;
2. Management of exotic and invasive species in India.
3. Major diseases of wild animals, and their control; Impact of wildlife tourism.

Project: As per the direction of faculty

Text Books:

1. Ramakrishnan, P. S., Saxena, K. G., & Chandrashekara, U. M. (1996). Conserving the Sacred: For Biodiversity Management. Oxford & IBH Publishing.
2. Alfred, J. R. B., Das, A. K., & Sanyal, A. K. (1998). Wildlife of India: Resources and Conservation. Zoological Survey of India.
3. Rangarajan, M. (2001). India's Wildlife History: An Introduction. Permanent Black.

SEMESTER II

I. MAJOR COURSE- MJ 2:
ECOLOGY AND BIOSTATISTICS

Marks: 25 (5 Attd. + 20 SIE: 1Hr) + 75 (ESE: 3Hrs) = 100	**Pass Marks: Th (SIE + ESE) = 40**

(Credits: Theory-04) **60 Hours**

Course Objectives:
On successful completion of this course the student will be able to understand the scientific background of their environmental canopy for sustainable development.

Course Learning outcomes
After successfully completing this course, the students will be able to:
1. Know the evolutionary and functional basis of animal ecology.
2. Understand what makes the scientific study of animal ecology
3. Understand the interaction of human and natural systems at local and global level.

Course Content:

GROUP A: ECOLOGY

UNIT I: An Overview of Ecology **(05 Lectures)**
1. Structure and function of an ecosystem
2. Food chain and Food web
3. Ecological Pyramids, Energy flow in an ecosystem: Lindeman's trophic dynamic concept
4. Laws of limiting factor: Shelford's law of tolerance
5. Productivity and its management
6. Biome: An introduction and its type.

UNIT II: Population Dynamics: **(10 Lectures)**
1. Population attributes
2. Exponential and logistic growth.
3. Population Regulation –Density-dependent and density-independent factors

UNIT III: Community Ecology: **(15 Lectures)**
1. Community Characters, Analytical and synthetic characters
2. Community Diversity Indices, Simpson's matching coefficient, Bray-Curtis dissimilarity coefficient index. Shannon Weiner diversity index
3. Community Interactions –Positive and Negative Interactions
4. Niche concept: Niche overlap. Gause's principle with laboratory and field examples.
5. Community Dynamics-Succession and climax concept

UNIT IV: Environment Management: **(10 Lectures)**
1. Natural Resources-Types, Importance and Conservation strategies
2. Biogeochemical cycles –Water, Carbon, Nitrogen
3. Biodiversity-Alpha, Beta, Gamma. Hotspots
4. Environmental Pollution - (Air, Water, Soil. and Noise)- Causes, Impact and Management
5. Global Climate Change
6. Environmental Laws in India

UNIT V: Environmental movements: **(05 Lectures)**
1. Chipko movement
2. Silent valley
3. Sardar Sarovar Mega Dam project.
4. Role of Gender and cultures in environmental conservation

GROUP B: BIOSTATISTICS **(15 Lectures)**
1. Types of data: Primary and secondary data
2. Mean, Median, Mode, Standard Deviation, Standard error, Chi square test, t-test, f-test, ANOVA, Correlation, and Regression Analysis.
3. Basics of statistical software – MS-EXCEL, PAST, and R

Suggested Readings:
Text Books:

1. Mukherjee, B. Fundamentals of Environmental Biology, Silverline Publications, Allahabad 2011
2. Odum, E. P., & Barrett, G. W. (2005). Fundamentals of ecology (5th ed.). Thomson Brooks/Cole.
3. Zar, J.H. (2013) Biostatistical Analysis (5th edition), Pearson.

Reference Books:

1. Riddle M. – Evolution. 2nd edn. Blackwell 1996
2. Piyanka E.R. - Evolutionary Ecology 5th edn Harper Collins 1994
3. Simmons I.G. - The Ecology of Natural Resources 2nd edn ELBS / Edward Arnolds 1983
4. Dash M.C. & Mishra P.C.- Man and Environment McMillan 2001
5. Stiling P. – Ecology: Theories and Applications 4th edn Prentice Hall India 2002
6. Chapman, J. L., & Reiss, M. J. (1999). Ecology: Principles and applications. Cambridge University Press.
7. Smith, T. M., & Smith, R. L. (2012). Elements of ecology (8th ed.). Pearson Education.
8. Principle and procedure of Statistics by G.D Steel & James .H.Torrie, Mac Graw Hills.
9. Milton, J.S. & Tsokos, J.O. (1992) Statistical Methods in the Biological and Health
10. Sciences (2nd edition) McGraw Hill.
11. Daniel, W. W. (2012). Biostatistics: A foundation for analysis in the health sciences (10th ed.). Wiley.
12. Glantz, S. A. (2013). Primer of biostatistics (7th ed.). McGraw-Hill Education.
13. Arora, P. N., & Malhan, P. K. (2007). Biostatistics. Himalaya Publishing House.
14. Banerjee, P. K. (2004). Introduction to biostatistics. S. Chand & Company Ltd
15. Khan & Khanam, Biostatistics

II. SKILL ENHANCEMENT COURSE- SEC 2:
SERICULTURE, APICULTURE, PEARL CULTURE & PRAWN CULTURE

Marks: 75 (ESE: 3Hrs) = 75	**Pass Marks: Th (ESE) = 30**

(Credits: Theory-03) **45 Hours**

Course Objectives:

The student will be able to understand:

1. The required information so that they can start start-ups in this area. They can join organisations engaged in Apiculture and Sericulture.
2. To understand the biology of pearl oysters and their role in pearl culture, various techniques of artificial pearl production and culture systems, and the economic importance, prospects, and challenges of pearl culture in India.
3. To understand the biology and economic value of prawns, their farming practices, seed production, and grow-out techniques, and harvesting, processing, and future prospects of prawn culture in India

Course Learning Outcomes:

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

1. Identify the silkworm and honey bee species and their life cycle.
2. The silk and honey, pearl, and prawn culture & their rearing technology
3. The types of bacterial, fungal, and protozoan pests, diseases, and their control.
   (Please move points 5-7 in the project work)

GROUP- A: SERICULTURE

UNIT I: Introduction **(03 Lectures)**

1. Sericulture: Definition, history, and present status; Silk route.
2. Types of silk worms- Mulberry and non-mulberry.
3. Distribution and Races- Exotic and Indigenous races.
4. Sericulture industry in different states, employment, potential in mulberry and non-mulberry sericulture in India

UNIT II: Biology and Rearing of Silk worm **(07 Lectures)**

1. Life cycle of *Bombyx mori*.
2. Structure of the silk gland and secretion of silk
3. Rearing house and rearing appliances
4. Disinfectants: Formalin, bleaching powder, RKO
5. Basic understanding of Spinning, harvesting, and storage of cocoons, mountages

UNIT III: Pests and Diseases **(02 Lectures)**

1. Pathogenesis of silk worm diseases: Protozoan, viral, fungal, and bacterial control and prevention of pests and diseases

GROUP- B: APICULTURE

UNIT I: Biology of Bee **(03 Lectures)**

1. History, Classification, and Biology of Honey Bee
2. Social Organization of Bee Colony
3. Products of Apiculture Industry and its Uses (Honey, Bees Wax, Propolis), Pollen, etc.
4. Bee Diseases and Enemies, Control and Preventive Measures

UNIT II: Rearing of Bee **(06 Lectures)**

1. Artificial Bee rearing (Apiary), Beehives–Newton and Langstroth
2. Bee Pasturage, Selection of Bee Species for Apiculture
3. Bee Keeping Equipment, Methods of Extraction of Honey (Indigenous and Modern)

UNIT V: Entrepreneurship in Apiculture **(02 Lectures)**

1. Bee Keeping Industry– Recent Efforts, Modern Methods in employing artificial Beehives for cross-pollination in horticultural gardens

GROUP C: PEARL CULTURE

Unit I: Introduction to Pearl Culture **(04 Lectures)**

1. History and importance of pearl culture in India and worldwide, Status of pearl culture industry in India, Major centers and institutes involved (e.g., CMFRI, CIFE)
2. Economic and ornamental value of pearls, Environmental factors, diseases, and constraints in pearl oyster farming, Future prospects, research, and employment opportunities
3. Natural vs. cultured pearls – differences and significance
4. Pearl trade, marketing, and scope in India

Unit II: Biology of Pearl Oysters **(02 Lectures)**

1. Life cycle of pearl oysters (*Pinctada* species)

Unit III: Pearl Formation and Culture Techniques **(03 Lectures)**

1. Understanding of pearl formation – Natural and Artificial culture

2. Culture systems: raft culture, cage culture, long-line culture

Unit IV: Pearl Oyster Hatchery and Rearing (02 Lectures)

1. Hatchery techniques for spat production, Larval rearing, and settlement
2. Nursery practices and grow-out systems
3. Basics of Harvesting techniques and grading of pearls (based on lustre, size, shape, and colour)

GROUP D: PRAWN CULTURE

Unit I: Introduction and Biology of Prawns (04 Lectures)

1. Importance of prawn culture in aquaculture and economy
2. Life cycle of a freshwater: *Macrobrachium rosenbergii* and its breeding habits

Unit II: Basics of Culture Techniques and Management (04 Lectures)

1. Site selection and construction of prawn farms (ponds, hatcheries)
2. Seed production and hatchery techniques (larval rearing, post-larvae management)
3. Basics of Grow-out practices: stocking density, feeding, and water quality management
4. Basics of Monoculture vs. polyculture practices
5. Common diseases of prawns and their management

Unit III: Harvesting, Processing, and Prospects (03 Lectures)

1. Basics of Harvesting techniques and post-harvest handling
2. Basics of Preservation, processing, storage methods, Prawn marketing, and export potential
3. Status of prawn culture in India – prospects and challenges

Project/ Field plans (select any one):

1. **Study of Silkworm Life Cycle and Cocoon Production:** Collect silkworm eggs (disease-free laying, DFL). Rear larvae under controlled conditions, feeding mulberry leaves, or record larval growth (instar stages) and cocoon formation. Estimate cocoon weight and silk filament length.
2. **Survey and Analysis of Honey Bee Colony and Honey Yield:** Visit a local apiary and study hive structure. Record number of bees (workers, drones, queen). Observe foraging activity and flower preference. Collect honey samples and test for quality (pH, sugar content).
3. **Mantle Grafting Technique and Pearl Formation Observation:** Collect pearl oysters from coastal waters/hatchery. Perform mantle grafting and nucleus insertion (demonstration/field visit). Maintain oysters in cage/raft culture system. Observe survival, shell health, and nacre deposition.
4. **Growth Performance of Prawns under Different Feeding Regimes:** Set up small culture tanks/ponds with prawn juveniles. Feed groups with formulated feed vs. natural feed. Measure body weight and length at intervals. Record survival and growth efficiency.

Suggested Reading

Textbooks:

1. A Textbook of Sericulture, Hemraj, Vinesh Publication, India
2. Prost, P.J. (1962). *Apiculture*. Oxford and IBH, New Delhi.
3. Alagarswami, K. (1991). *Pearl culture in India*. Central Marine Fisheries Research Institute, Indian Council of Agricultural Research.
4. Kumar, M. S. (2017). *Shrimp and prawn farming in India*. New India Publishing Agency.

Reference Books:

1. Handbook of Practical Sericulture: S.R. Ullaland M.N. Narasimhanna CSB, Bangalore
2. Appropriate Sericultural Techniques; Ed. M.S. Jolly, Director, CSR & TI, Mysore.
3. A Guide for Bivoltine Sericulture; K. Sengupta, Director, CSR & TI, Mysore 1989.
4. Bisht D.S., *Apiculture*, ICAR Publication.
5. Singh S., *Bee keeping in India*, Indian council of Agricultural Research, New Delhi.
6. Jameson, J. D. (1991). *The development of pearl culture: An introduction*. Oxford & IBH Publishing.
7. Pillai, C. S. G. (2007). *Aquaculture in India*. New Age International Publishers.
8. Kutty, M. N., & Valenti, W. C. (2010). *Culture of giant river prawn (Macrobrachium rosenbergii)*. Wiley-Blackwell.

SEMESTER III

I. MAJOR COURSE- MJ 3:
CELL BIOLOGY AND BIOCHEMISTRY

Marks: 25 (5 Attd. + 20 SIE: 1Hr) + 75 (ESE: 3Hrs) = 100	**Pass Marks: Th (SIE + ESE) = 40**

(Credits: Theory-04) **60 Hours**

Course Objectives:

1. To equip the students with all the information required to understand the role of cellular composition.
2. To understand the biochemistry of biomolecules are their role in the cell.

Course Learning Outcomes:

After completing this course, the students will be able to

1. Understand the functioning of various cell organelles and the intricate cellular mechanisms involved.
2. Acquire knowledge of different pathways related to cell signaling and apoptosis.
3. Learn the structure and functions of biomolecules.
4. Understand the cellular metabolism.

Course Content:

GROUP- A: CELL BIOLOGY

UNIT I: A general concept of prokaryotic and eukaryotic cells, The Cell theory **(01 Lecture)**

UNIT II: General structure of different cell organelles - Mitochondria, Golgi complex. Endoplasmic Reticulum, Nucleus, Chromosome, Ribosome, Microbodies, and Lysosome **(10 Lectures)**

UNIT III: Cytoskeleton-Composition and function- Microtubules and microfilaments. **(02 Lectures)**

UNIT IV: Cell membrane structure: Chemical composition of the Plasma membrane of the Erythrocyte, Active and Passive transport, Diffusion and Osmosis, Membrane pumps and gates. **(05 Lectures)**

UNIT V: Cell cycle: **(09 Lectures)**

1. A brief introduction to cell cycle, its various phases, Checkpoints, and its regulation.
2. Mitosis and Meiosis
3. Apoptosis and Cancer

UNIT-VI: Cell-Cell Communication **(05 Lecture)**

1. Cell signaling, Regulation of signaling pathways. (GPCR and RTK)
2. Cell Adhesion Molecules and ECM

UNIT VII: Cell Culture:

1. Basic components of cell culture **(04 Lectures)**
2. Somatic cell hybridization.

GROUP B: BIOCHEMISTRY

UNIT I: Carbohydrates: **(12 Lectures)**

1. Structure and classification of carbohydrates.
2. Metabolism of carbohydrates: Glycolysis, Krebs cycle, ETS and ATP synthesis.
3. Glycogenesis, Gluconeogenesis, Glycogenesis HMP shunt.

UNIT II: Lipids: **(03 Lectures)**

Structure and classification of lipids: Simple, Compound, and Derived lipids.

UNIT III: Proteins **(05 Lectures)**

1. Amino acids: structure and classification.
2. Types of protein structures and biological significance.
3. Catabolism of Amino acid: Transamination & Deamination.

UNIT V: Enzymes **(04 Lectures)**

1. Nomenclature and classification.
2. Enzyme kinetics: K_m Equation, Organic reactions and their mechanism, Regulation of Enzyme action, Addition, Elimination and Substitution reactions.
3. Coenzymes and Isoenzymes.
4. Enzyme inhibition: Competitive, Non-Competitive and Feedback inhibitions.

Suggested Readings:

Text Books:

1. Molecular Biology of the Cell – Alberts et al. (Garland Science)
2. Cox, M.M and Nelson, D.L. (2008). Lehninger Principles of Biochemistry, V Edition, W.H. Freeman and Co., New York.

Reference Books:

1. Molecular Cell Biology – Lodish et al. (W.H. Freeman)
2. Cell and Molecular Biology: Concepts and Experiments – Gerald Karp (Wiley)
3. Animal Cell Culture and Technology, Rastogi et al, Rastogi Publications, India
4. Satyanaryana, U. and Chakrapani, U. (2023). Biochemistry, Elsevier and Books & Allied
5. Berg, J.M., Tymoczko, J.L. and Stryer, L. (2007). Biochemistry, VI Ed, W.H. Freeman and Co., New York.
6. Murray, R.K., Bender, D.A., Botham, K.M., Kennelly, P.J., Rodwell, V.W. and Well, P.A. (2009,). Harper's Illustrated Biochemistry, XXVIII Edition, International Edition, The McGraw-Hill Companies Inc.
7. Hames, B.D. and Hooper, N.M. (2000). Instant Notes in Biochemistry, II Edition, BIOS Scientific Publishers Ltd., U.K.
8. Harper, et al. (2023). Harper's Illustrated Biochemistry, Lang

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II. MAJOR COURSE- MJ 4:
PRACTICAL-I

Marks: Pr (ESE: 6Hrs) =100	**Pass Marks: Pr (ESE) = 40**

(Credits: Practical-04) **120 Hours**

Instruction to Question Setter for
End Semester Examination (ESE):

There will be one Practical Examination of 6Hrs duration. Evaluation of Practical Examination will be as per the following guidelines:

1. *Experiment* *= 60 marks*
    a. *Experiment (related to cell biology or biochemistry):* *= 20 marks,*
    b. *Spotting (2 slides and 3 specimens):* *= 4 x 5 = 20 marks,*
    c. *Statistical analysis:* *= 20 marks*
2. *Practical record notebook* *= 15 marks*
3. *Viva-voce* *= 25 marks*

Practical:

GROUP A

Museum Specimens: *Pheretima, Carcinus, Palaemon, Octopus, Pila, Asterias, Antedon, Balanoglossus, Petromyzon, Herdmania, Amphioxus, Labeo, Hyla, Ichthyophis, Axolotl larva, Naza, Python*, Feathers of birds, *Pteropus,* Aquatic mammals (Whale- *Cetaceans*).
Slides: *Paramecium, Sycon, Obelia, Taenia solium, Wuchereria, Ascaris (male and female),*

GROUP B

1. Estimation of Dissolved Oxygen (DO) in water sample
2. Calculation Shannon Weiner Diversity Index
3. Calculation of mean, standard deviation and standard error.
4. Calculation of correlation coefficient values, Regression analysis and finding out the probability
5. Student's t – test dependent and independent, hand calculation and calculation using MS-Excel.
6. ANOVA - hand calculation and calculation using MS-Excel.

GROUP C

1. Preparation of a temporary stained squash of onion root tip to study various stages of mitosis.
2. Study various stages of meiosis from permanent slides.
3. Preparation of a permanent slide to show the presence of Barr body in human female blood cells/cheek cells.
4. Preparation of a permanent slide to demonstrate:
    a. DNA by Feulgen reaction
    b. DNA and RNA by MGP
    c. Mucopolysaccharides by PAS reaction
    d. Proteins by Mercury bromophenol blue/Fast Green.

Reference Books:

1. Invertebrate Practical by S. S. Lal
2. Principles and Techniques of Biochemistry and Molecular Biology: Wilson and Walker, edited by Hofmann.
3. Experimental procedures in Life Sciences: S. Rajan
4. Basic techniques in Biochemistry, Microbiology and Molecular Biology: Akanchha Jain
5. Mahajan's methods in Biostatistics for Medical students and Research workers.
6. Elements of Biostatistics by Satguru Prasad, Rastogi Publication, India.

III. SKILL ENHANCEMENT COURSE- SEC 3:
ELEMENTARY COMPUTER APPLICATION SOFTWARES

Marks: 75 (ESE: 3Hrs) = 75	**Pass Marks: Th (ESE) = 30**

A Common Syllabus for FYUGP (Credits: Theory-03) **45 Hours**

Instruction to Question Setter
*There will be **objective type test** consisting of **Seventy-five questions of 1 mark each**. Students are required to mark their answer on **OMR Sheet** provided by the University.*

Course Objectives:

The objective of the course is to generate qualified manpower in the area of Information Technology (IT) and Graphic designing which will enable such person to work seamlessly at any Offices.

1. Basic Concept of Computer: What is Computer, Applications of Computer, Types of computer, Components of Computer System, Central Processing Unit (CPU) **(3 Lectures)**

2. Concepts of Hardware: Input Devices, Output Devices, Computer Memory, Types of Memory, processing Concept of Computer **(4 Lectures)**

3. Operating system: Operating System, Functions of Operating System (Basic), Introduction to Windows 11, Working on Windows 11 environment, Installation of Application Software, My Computer, Control Panel, searching techniques in windows environment, Basic of setting **(6 Lectures)**

4. Concept of Software: What is Software, Types of Software, Computer Software- Relationship between Hardware and Software, System Software, Application Software, some high level languages **(4 Lectures)**

5. Internet & its uses: Basic of Computer networks; LAN, WAN, MAN, Concept of Internet, Applications of Internet; connecting to internet, what is ISP, World Wide Web, Web Browsing software's, Search Engines, URL, Domain name, IP Address, using e-governance website, Basics of electronic mail, getting an email account, Sending and receiving emails. **(6 Lectures)**

6. Microsoft Word: Word processing concepts, Creation of Documents, Formatting of Documents, Formatting of Text, Different tabs of word 2016 environment, Formatting Page, Navigation of Page, Table handling, Header and footer, Page Numbering, Page Setup, Find and Replace, Printing the documents **(7Lectures)**

7. Microsoft Excel (Spreadsheet): Spreadsheet Concepts, Creating, Saving and Editing a Workbook, Inserting, Deleting Work Sheets, Formatting worksheet, Excel Formula, Concept of charts and Applications, Pivot table, goal seek, Data filter, data sorting and scenario manager, printing the spreadsheet **(6 Lectures)**

8. Microsoft Power Point (Presentation Package): Concept and Uses of presentation package, Creating, Opening and Saving Presentations, working in different views in Power point, Animation, slide show, Master Slides, Creating photo album, Rehearse timing and record narration **(5 Lectures)**

9. Digital Education: Introduction & Advantages of digital Education, Concept of e-learning, Technologies used in e learning **(4 Lectures)**

Reference Books

1. Nishit Mathur, *Fundamentals of Computer*, APH publishing corporation (2010)
2. Neeraj Singh, *Computer Fundamentals (Basic Computer)*, T Balaji, (2021)
3. Joan Preppernau, *Microsoft Power Point 2016 step by step*, Microsoft press (2015)
4. Douglas E Corner, *The Internet Book* 4th Edition, prentice –Hall (2009)
5. Wallace Wang, *Microsoft Office 2019*, Wiley (January 2018)
6. Noble Powell, *Windows 11 User Guide For Beginners and Seniors*, ASIN, (October 2021)

SEMESTER IV

I. MAJOR COURSE- MJ 5:
INDIAN KNOWLEDGE SYSTEM IN ZOOLOGY

Marks: 25 (5 Attd. + 20 SIE: 1Hr) + 75 (ESE: 3Hrs) = 100	**Pass Marks: Th (SIE + ESE) = 40**

(Credits: Theory-04) **60 Hours**

Course Objectives:

After completion of the course, the learner will be able to understand:

1. Introduce students to indigenous zoological knowledge embedded in Indian traditions.
2. Examine how traditional practices align with or differ from modern zoological science.
3. Promote respect for community-based animal knowledge, conservation, and sustainable use.

Course Learning Outcomes:

On successful completion of this course the student will be know:

1. Explain the foundational concepts of Indian Knowledge Systems (IKS) and their relevance to zoological sciences.
2. Identify and describe traditional animal classifications and compare them with modern scientific taxonomy.
3. Recognize and analyze indigenous conservation practices, such as sacred groves and community-led species protection.
4. Describe key ethnozoological practices including the use of animals in traditional medicine, agriculture, fisheries, and crafts.
5. Critically evaluate the integration of indigenous knowledge with modern zoological research and conservation strategies.
6. Document and reflect on local IKS practices through fieldwork, using appropriate ethical and scientific methods.
7. Develop an appreciation for cultural and ecological diversity and understand the importance of protecting indigenous knowledge for sustainable biodiversity management.

Course Content:

UNIT I: Foundations of Indian Knowledge Systems in Zoology (15 Lectures)

1. Overview of IKS: meaning, scope, historical development.
2. Ancient Indian texts and animals: Rigveda, Atharvaveda, Jataka tales, Panchatantra, Puranas.
3. Indigenous taxonomy: folk classifications vs. Linnaean system.
4. Animal symbolism in Indian art, culture, and philosophy.

UNIT II: Indigenous Animal Ecology and Conservation (15 Lectures)

1. Sacred groves, protected landscapes, and community conservation (e.g., Bishnoi practices).
2. Indigenous knowledge of keystone and indicator species.
3. Traditional ecological calendars (e.g., fish spawning, bird migrations).
4. Human-wildlife coexistence practices and conflict mitigation.

UNIT III: Ethnozoology and Traditional Animal Use (15 Lectures)

1. Ethnozoological practices: animals in traditional medicine (Ayurveda, Siddha, Unani).
2. Animal-derived products: silk, lac, honey, and their indigenous management.
3. Indigenous fisheries and aquaculture systems.
4. Folk veterinary practices: treatments for livestock, poultry, fish.

UNIT IV: Integrating IKS with Modern Zoology (15 Lectures)

1. Case studies of blending IKS and modern conservation (e.g., sea turtle protection, vulture conservation).
2. Ethical considerations: bioprospecting, intellectual property, community rights.
3. Challenges and opportunities in documenting IKS.
4. Student-led discussions on contemporary relevance.

Reference Books:

1. Gadgil & Guha, This Fissured Land: An Ecological History of India
2. Nair, K.K. & Nair, K.P., Ethnozoology of India
3. Select translations from Vedic texts, Jataka stories (for cultural perspectives)
4. FAO reports on traditional fisheries and indigenous knowledge

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II. MAJOR COURSE- MJ 6:
ANIMAL PHYSIOLOGY

Marks: 25 (5 Attd. + 20 SIE: 1Hr) + 75 (ESE: 3Hrs) = 100	**Pass Marks: Th (SIE + ESE) = 40**

(Credits: Theory-04) **60 Hours**

Course Objectives:

1. To provide students an insight into the physiological aspect of different organ systems of the animal body.

Course Learning Outcomes:

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

1. Develop an understanding of various organ systems.
2. Understand the functions of cells, tissues, and organs function at different levels.

Course Content:

UNIT I: Tissue (06 Lectures)

1. Structure and classification of animal tissue.

UNIT II: Digestive System (06 Lectures)

1. Gastrointestinal tract and its associated glands, Mechanical and Chemical digestion of food,
2. Absorption of Carbohydrate, Proteins, and Lipids
3. Gastro-intestinal hormones and their action

UNIT III: Respiratory System (06 Lectures)

1. Histology of trachea and Lungs, Respiratory volumes, Respiratory Pigments, Diffusion, and Transport of respiratory gases, Bohr's effect, Haldane's effect, Chloride shift, Hb-oxygen dissociation curve, Emphysema, and CO-poisoning.

UNIT IV: Circulatory System (06 Lectures)

1. Structure and Working of the Mammalian Heart
2. The cardiac cycle
3. Blood and its components, Blood groups, Rh factor, Blood clotting Mechanism

UNIT V: Skeletal system (06 Lectures)

1. Ultra-structure of Skeletal Muscle, chemical basis of muscle contraction.

UNIT VI: Excretory System (06 Lectures)

1. Kidney: structure and function, Mechanism of urine formation, Counter- Current theory, Ornithine-Arginine cycle

UNIT VII: Reproductive System (08 Lectures)

1. Histology of male and female reproductive organs.
2. Physiology of reproduction in male and female, Accessory Reproductive organs, Methods of Contraception, Reproductive Hormones.
3. Menstrual and Estrus cycles, Placenta: Structure, types, and functions of placenta.

UNIT VIII: Endocrine system: (08 Lectures)

1. Breif introduction of Endocrine glands and their functions

UNIT IX: Nervous System (08 Lectures)

1. Ultrastructure of Neuron, Brain and Spinal cord
2. Physiology of nerve conduction, Reflex Action

Suggested Readings:

Text Books:

1. Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Hercourt Asia PTE Ltd. /W.B. Saunders Company.
2. Ganong's Physiology

Reference Books:

1. Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition John Wiley & sons.
2. Victor P. Eroschenko. (2008). diFiore's Atlas of Histology with Functional correlations. XII Edition. Lippincott W. & Wilkins.
3. Arey, L.B. (1974). Human Histology. IV Edition. W.B. Saunders.
4. DeFiore Atlas of Human histology. Physiology Vandor
5. Verma, P.S., Tyagi B.S. and Agrawal, V. K. Animal Physiology, S. Chand
6. Bacheti & Singh, Animal Physiology,
7. Sastry, K. B. Animal Physiology and Biochemistry, Rastogi Publications, India

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III. MAJOR COURSE- MJ 7:
PRACTICAL-II

Marks: Pr (ESE: 6Hrs) =100	**Pass Marks: Pr (ESE) = 40**

(Credits: Practical-04) **120 Hours**

Instructions to Question Setter for
End Semester Examination (ESE):
There will be one Practical Examination of 6Hrs duration. Evaluation of Practical Examination will be as per the following guidelines:

1. Experiment = 45 marks
- *a) Preparation of temporary mount/ general anatomy/ Muscle twitch/ Reflex action: 10 marks*
- *b) Practical of hematology : 15 marks*
- *c) Spotting : 20 marks*

2. IKS based project = 15 marks
3. Practical record notebook = 15 marks
4. Viva-voce = 25 marks

Practical:

1. General anatomy of digestive, respiratory, muscular, cardiovascular and reproductive system of mammal (Virtual demonstration/ Charts/ Models)
2. Observation of simple muscle twitch in Frog with electrical stimulation (virtual).
3. Demonstration of the unconditioned reflex action (Deep tendon reflex such as knee jerk reflex).
4. Preparation of temporary mounts: Squamous epithelium, Striated muscle fibres and nerve cells of poultry.
5. Study of permanent slides of Mammalian skin, Cartilage, Bone, Spinal cord, Nerve cell, Pituitary, Pancreas, Testis, Ovary, Adrenal, Thyroid and Parathyroid.
6. Preparation of permanent slide of animal tissues or organs (virtual lab).
7. Hematology: Morphology of different blood cells and their count, Blood group determination, haemoglobin estimation, bleeding and clotting time.
8. IKS-based project.

Reference Books:

1. Animal physiology: Omkar, S.C. Nigam
2. Human Microscopic Anatomy: R.V. Krstic, Springer - Verlay

SEMESTER V

I. MAJOR COURSE- MJ 8:
MOLECULAR BIOLOGY

Marks: 25 (5 Attd. + 20 SIE: 1Hr) + 75 (ESE: 3Hrs) = 100	Pass Marks: Th (SIE + ESE) = 40

(Credits: Theory-04) **60 Hours**

Course Objectives:
To equip the students with a comprehensive knowledge of molecular genetics.

Course Learning Outcomes:
After completing this course, the students will be able to develop an understanding of concepts, mechanisms, evolutionary significance, and relevance of molecular biology in the current scenario.

Course Content:

UNIT I: Chemistry of nucleic acids: (08 Lectures)
1. N-bases, Pentose sugar, Nucleosides & Nucleotides.
2. Watson-Crick model of DNA.
3. Types of DNA (A, B & Z), Base pairing, Major & minor grooves of DNA.
4. Basic idea of gene, uninterrupted genes.

UNIT II: DNA Replication in Prokaryotes: (11 Lectures)
1. Semi-conservative DNA replication, Replication fork, DNA polymerases, Phases- initiation, elongation and termination.
2. Errors in DNA and their repair (base excision repair & nucleotide excision repair).

UNIT III: Transcription in Prokaryotes: (10 Lectures)
1. Consensus sequences, Promoter (-35 & -10 elements), RNA polymerases, Phases- initiation, elongation and termination.

UNIT IV: RNA: (08 Lectures)
1. Chemistry of RNA, types of RNA (mRNA, rRNA, tRNA, snoRNA)
2. Structure of mRNA & tRNA (clover-leaf model)
3. Basics of RNA edit, RNAi.

UNIT V: Genetic code: (08 Lectures)
1. History of genetic codes, Features of genetic codes
2. Wobble hypothesis. Central dogma.

UNIT VI: Translation in Prokaryotes *E. coli*: (05 Lectures)
1. Translation factors, charging of tRNAs, Phases- initiation, elongation and termination.

UNIT VII: Operon concept/ Transcription regulation: (05 Lectures)
1. Operon and its types, Lac operon–inducible, constitutive & non-inducible.

UNIT VII: Basics of the genetics of cancer: (05 Lectures)
1. Proto-oncogenes,
2. Gene regulation of the cell cycle.
3. Gene therapy and Stem cell therapy.

Suggested Readings:

Text Books:
1. Lehninger Principles of Biochemistry: Cox & Nelson, MacMillan & Freeman, USA
2. Molecular Biology of Gene: Watson et al., Pearson Publication, USA

Reference Books:
1. Fundamentals of Genetics: Rastogi and Rastogi, Med Tech Science Press
2. Genetics: P. S. Verma and B. K. Agrawal, S. Chand
3. Strickberger's Genetics, Prinitis Hall of India (PHI), Delhi
4. Principles of Genetics: Snustad& Simmons, John Wiley & Sons, USA
5. Modern Genetics Analysis: Integrating Genes and Genomes, Griffith et al., W. H. Freeman & Company, USA
6. Genetics: Russell & Benjamin, Cummings Publishing Company, USA.
7. Gene Regulation: Latchmann, Taylor & Francis, USA
8. Lewin- Gene (latest edition)

II. MAJOR COURSE- MJ 9:
VERTEBRATE DIVERSITY & COMPARATIVE ANATOMY

Marks: 25 (5 Attd. + 20 SIE: 1Hr) + 75 (ESE: 3Hrs) = 100	**Pass Marks: Th (SIE + ESE) = 40**

(Credits: Theory-04) **60 Hours**

Course Objectives:

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

1. Understand animal diversity ranging from Protista up to Mammalia.
2. To understand the comparative aspects of the animal body at the tissue and organ level.
3. To make them aware of the evolution of these organ systems.

Course Learning Outcomes:

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

1. Develop understanding on the diversity of life about protista, non-chordates, and chordates
2. Grouping of animals based on their morphological characters and the evolutionary history of a taxon
3. Develop an understanding of the evolution of vertebrate tissues, organs, and organ systems.
4. Have an overview of the evolutionary concepts.

Course Content:

GROUP- A: VERTEBRATE DIVERSITY

UNIT I: Protochordates **(04 Lectures)**

General features and Phylogeny of Protochordata

UNIT II: Agnatha **(04 Lectures)**

General features of Agnatha and classification of cyclostomes up to classes

UNIT III: Pisces **(04 Lectures)**

General features and Classification up to orders; Osmoregulation in Fishes

UNIT IV: Amphibia **(05 Lectures)**

General features and Classification up to orders; Parental care, Origin of amphibia

UNIT V: Reptiles **(04 Lectures)**

General features and Classification up to orders; Poisonous and non-poisonous snakes, biting mechanism in snakes, Origin of reptiles

UNIT VI: Aves **(04 Lectures)**

General features and Classification up to orders; Flight adaptations in birds & Migration of birds

UNIT VII: Mammals **(04 Lectures)**

General features and Classification up to orders; Marsupials, Origin of mammals

GROUP- B: COMPARATIVE ANATOMY

(Comparative anatomy of Class Fish to Mammalia)

UNIT I: Integumentary System **(04 Lectures)**

Structure, Function, and Derivatives of Integument

UNIT II: Skeletal System **(04 Lectures)**

An overview of Axial and Appendicular Skeleton (Vertebral column & Girdles)

UNIT III: Digestive System **(04 Lectures)**

Alimentary Canal and associated gland

UNIT IV: Respiratory System **(04 Lectures)**

Skin, Gills, Air Sacs, accessory respiratory organs, and Lungs

UNIT V: Circulatory System **(04 Lectures)**

Evolution of Heart and Aortic arches

UNIT VI: Urinogenital System **(04 Lectures)**

Succession of Kidney (Pronephric, Mesonephric, and Metanephric)

UNIT VII: Nervous System **(04 Lectures)**

Comparative account of Central Nervous System, Peripheral Nervous System, and Autonomic Nervous System, in Mammals

UNIT VIII: Sense Organs **(03 Lectures)**

Brief account of Visual and Auditory receptors

Suggested Readings:

Text Books:

1. Verma, B. K., (latest edition). Comparative Anatomy of Vertebrates, S. Chand
2. E L Jordan and Verma, Chordate Zoology and Elements of Animal Physiology, S. Chand Publishing, India
3. Kardong, K.V. (2005) Vertebrates' Comparative Anatomy, Function and Evolution. IV Edition. McGraw-Hill Higher Education.

Reference Books:

Group – A:

1. Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2002). The
2. Invertebrates: A New Synthesis, III Edition, Blackwell Science
3. Young, J. Z. (2004). The Life of Vertebrates. III Edition. Oxford university press.
4. Pough H. Vertebrate life, VIII Edition, Pearson International.

Group - B:

1. Mishra Tripurati, Mishra, D., and Shrivastava, Comparative Anatomy of Vertebrates, Mahavir Publication
2. Kardong, K.V. (2005) Vertebrates' Comparative Anatomy, Function and Evolution. IV Edition. McGraw-Hill Higher Education.
3. Kent, G.C. and Carr R.K. (2000). Comparative Anatomy of the Vertebrates. IX Edition. The McGraw-Hill Companies.
4. Weichert C.K and William Presch (1970). Elements of Chordate Anatomy, Tata McGraw Hills
5. Hilderbrand, M and Gaslow G.E. Analysis of Vertebrate Structure, John Wiley and Sons.
6. Walter, H.E. and Sayles, L.P; Biology of Vertebrates, Khosla Publishing House.

III. MAJOR COURSE- MJ 10:
GENETICS & ETHOLOGY

Marks: 25 (5 Attd. + 20 SIE: 1Hr) + 75 (ESE: 3Hrs) = 100	**Pass Marks: Th (SIE + ESE) = 40**

(Credits: Theory-04) **60 Hours**

Course Objectives:

The students will be able to

1. Study Mendelian genetics, Morgan genetics and Human genetics.
2. Study various approaches to animal behaviour.

Course Learning Outcomes:

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

1. Apply the principles of Mendelian inheritance.
2. Understand the cause and effect of alterations in chromosome number and structure.
3. Discuss and analyse the epigenetic modifications and imprinting and their role in diseases.
4. Develop skills, concepts, and experience to understand all aspects of animal behaviour.

Course Content:

GROUP A: GENETICS

UNIT I: Mendelian Genetics:

1. Pre-Mendelian genetics, Mendel's life, Symbols, and Terminologies, Laws of dominance, segregation & independent assortment, Back cross & test cross
2. Multiple alleles, and Incomplete Dominance.
3. Allelic and Non-allelic Gene Interactions. **(06 Lectures)**

UNIT II: Eukaryotic Chromosomes:

1. Structure & chemical composition of chromosomes.
2. Karyotype, Ideogram, Human karyotype, Lampbrush chromosome **(06 Lectures)**

UNIT III: Linkage:

1. Coupling & repulsion hypothesis, Morgan's view of linkage, kinds of linkage
2. Chromosomal theory of linkage
3. Human chromosomal maps. **(06 Lectures)**

UNIT IV: Crossing over or Gene recombination:

1. Somatic & germinal crossing over, kinds of crossing over, Theories of the mechanism of crossing over.
2. Concept of homologous recombination. **(06 Lectures)**

UNIT V: Sex determination:

1. Basic concept of sex determination, Types of sex determination, Genic balance theory, Chromosomal theory of sex determination. Environmental effect on sex determination,
2. Role of the *SRY* gene in sex determination and the development of gonads. **(06 Lectures)**

UNIT VI: Sex-linked inheritance:

1. Sex chromosomes,
2. X-linked genes (colour blindness & haemophilia in humans), Y-linked nenes and their inheritance
3. Sex-limited & Sex sex-influenced traits. **(04 Lectures)**

UNIT VII: Pedigree analysis:

1. Penetrance & expressivity, Symbols,
2. Pedigree analysis of dominance inheritance (polydactyly in man), Recessive inheritance (cystic fibrosis), and sex-linked inheritance (colour blindness). **(05 Lectures)**

UNIT VIII: Mutation:

1. Historical background, Mutagens, Chromosomal mutation & gene mutation,
2. Chromosomal aberrations, Euploidy & aneuploidy.

GROUP B: ETHOLOGY

UNIT I: General concepts of Ethology: **(08 Lectures)**

1. Basics of Motivation, Fixed Action Pattern
2. Imprinting **(04 Lectures)**

UNIT II: Behaviour and its types:

1. Social organization, Individual and social interaction, Social organization of honey bee and termites
2. Innate and learned behaviour
3. Pheromones influenced behaviour, Genetic basis of behaviour (**05 Lectures)**

UNIT III: Orientation in animals - its nature and types **(02 Lectures)**

Taxis and Kinesis

UNIT IV: Biological rhythms – occurrence and significance **(02 Lectures)**

Suggested Readings:

Text Books:

1. Genetics: Russell & Benjamin, Cummings Publishing Company, USA.
2. Sadguru Prasad- Animal Behaviour, CBS

Reference Books:

1. Strickberger's Genetics, Prinitis Hall of India (PHI), Delhi
2. Principles of Genetics: Snustad & Simmons, John Wiley & Sons, USA
3. Modern Genetics Analysis: Integrating Genes and Genomes, Griffith et al., W. H. Freeman & Company, USA
4. Principles of Genetics: Tamerin, Tata McGraw Hills, Delhi
5. Manning A. & Dawkins M.S. – An Introduction to Animal Behaviour. Cambridge 1995
6. Mathur R. – Animal Behaviour. Rastogi 2002

IV. MAJOR COURSE- MJ 11:
PRACTICAL-III

Marks: Pr (ESE: 6Hrs) =100	**Pass Marks: Pr (ESE) = 40**

(Credits: Practical-04) **120 Hours**

Instructions to Question Setter for
End Semester Examination (ESE):
There will be one Practical Examination of 3 hours duration. Evaluation of Practical Examination will be as per the following guidelines:

1. Experiment = 60 marks
- *a) Practical from Group A : 20*
- *b) Spotting : 20*
- *c) Practical form Group B/Group C : 20*

2. Practical record notebook = 15 marks
3. Viva-voce = 25 marks

Practical:

GROUP A

1. Histochemical tests of nucleic acids
2. Isolation of DNA through gel electrophoresis
3. Study of the PCR of the given sample
4. Study of spectrophotometry for a given sample

Group B

1. Comparative general anatomy of digestive, respiratory, muscular, cardiovascular, and reproductive systems of mammals (Virtual demonstration/ Charts/ Models)
2. Comparison of the Kidney, the Aortic arch, the Heart, the Brain, and the derivatives of the Integument through slides/virtual labs and chart

GROUP C

1. Pedigree analysis of baldness, Thalassemia, Hypertrichosis, PTC taste, Eye Color.
2. Chi-square analyses using seeds/beads/*Drosophila*.
3. Study of human karyotype (normal and abnormal).
4. Chromosomal banding – G-stain
5. Types of nests
6. Study of Migratory Behaviour (virtual)
7. Social Behaviour in Honey Bee and Termite

Reference Books:

1. Introduction to spectroscopy: Pavia, Lapman
2. Birding Basics: Tips, tools, and Techniques for Great Bird watching
3. Lab Manual for Introductory Cytogenetics PLNT3140.
4. Experimental Animal Science – Birds and Insects: Dr. Manoj Kumar Arya and Pawan Kr. Bharti
5. Karyotyping and Data interpretation: Link. Springer

SEMESTER VI

I. MAJOR COURSE- MJ 12: DEVELOPMENTAL BIOLOGY

Marks: 25 (5 Attd. + 20 SIE: 1Hr) + 75 (ESE: 3Hrs) = 100	**Pass Marks: Th (SIE + ESE) = 40**

(Credits: Theory-04) **60 Hours**

Course Objectives:

The students will be able to:

Understand the field of developmental biology and its relevance.

Course Learning Outcomes:

After completing the course, the students will be able to

1. Develop a critical understanding of how a single-celled fertilized egg becomes an embryo and then a fully formed adult by going through three important processes of cell division, cell differentiation, and morphogenesis.
2. Understand how developmental processes and gene functions within a particular tissue or organism can provide insight into functions of other tissues and organisms.

Course Content:

UNIT I: Basic concept of Development (12 Lectures)

1. Basics of induction and specification
2. Phases of Development: Blastogenesis
3. Paracrine factors (FGF, Wnt, TGF) and their receptors.
4. Stem cells

UNIT II: Pre-Embryonic Development (09 Lectures)

1. Gametogenesis: Spermatogenesis, Oogenesis, sperm: types of sperm and Egg membranes.
2. Eggs: types of eggs, Hormonal regulation of gametogenesis.
3. Fertilization (External-Sea urchin and Internal-Chick) & its mechanism.
4. Cleavage. Types of Blastulas and Fate Maps
5. Cell differentiation in the blastula and gastrula stages of the frog
6. Early development of sea urchin, frog, and chick up to gastrulation.

UNIT III: **Early Embryonic Development (09Lectures)**

1. Cleavage. Types of Blastulas and Fate Maps
2. Cell differentiation in the blastula and gastrula stages of the frog
3. Early development of sea urchin, frog, and chick up to gastrulation.

UNIT IV: Post-embryonic Development (15 Lectures)

1. Metamorphosis: Types of Metamorphosis, Metamorphosis in Amphibians
   Hormonal control of metamorphosis in amphibians
2. Regeneration: Types of Regeneration, Epimorphosis, Morphallaxis and Compensatory Regeneration
3. Ageing- Concepts and Theories.

UNIT V: Implications of Developmental Biology (15 Lectures)

1. Teratogenesis: Teratogenic agents and their effect on embryonic development.
2. *In vitro* fertilization (IVF), Ectopic Pregnancy, Embryonic stem cells (ESC), Amniocentesis.

Suggested Readings:

Text Book:

1. Gilbert, S.F.(2010). Developmental Biology, latest Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA.

Reference Books:

1. Chordate Embryology- Developmental Biology, Verma and Agarwal, S. Chand, India
2. Balinsky B.I. and Fabian B. C. (1981). An Introduction to Embryology, V Edition, International Thompson Computer Press.
3. Kalthoff (2008). Analysis of Biological Development, II Edition, McGraw-Hill Publishers.
4. Lewis Wolpert (2002). Principles of Development. II Edition, Oxford University Press

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II. MAJOR COURSE- MJ 13:
ENDOCRINOLOGY & IMMUNOLOGY

Marks: 25 (5 Attd. + 20 SIE: 1Hr) + 75 (ESE: 3Hrs) = 100	Pass Marks: Th (SIE + ESE) = 40

(Credits: Theory-04) **60 Hours**

Course Objectives:

1. To gather the information about endocrine glands, their secretion, functioning, and disorders concerned.
2. To make students aware of the immune system of body and the molecules playing a vital role in defence against various antigenic determinants.

Course Learning Outcomes:

1. Understand different endocrine glands- anatomy, endocrine secretion, functions, and their disorders. Know the mechanism of hormone action.
2. Identify the major cellular and tissue components that comprise the innate and adaptive immune system. Understand how immune responses by T cells and B cells are initiated and regulated.
3. Understand how the immune system distinguishes self from non-self.

Course Content:

GROUP- A: ENDOCRINOLOGY

UNIT I: Principles of Endocrinology (12 Lectures)

1. Endocrine glands
2. Definition and Classification of Hormones.
3. Evolution of peptide hormones and their functions.
4. General mechanism of hormone action, Hormone receptors
5. Regulation of Hormone action (Adrenaline, Thyroxine, and Insulin): Hormone action at the cellular and molecular level, Genetic control of hormone action

UNIT II: Structure, functions, hormonal dysfunction, and disease of endocrine glands in Mammals. (18 Lectures)

Structure, hormones, functions, and regulation of endocrine glands:

1. Pituitary
2. Pineal
3. Thyroid
4. Parathyroid
5. Adrenal
6. Islets of Langerhans
7. Testis
8. Ovary
9. Local endocrine gland
10. Neuro Secretion.

GROUP-B: IMMUNOLOGY

UNIT I: Overview of Immune System (02 Lectures)

1. Introduction to Immunity and Types.
2. Cells & Organs of the Immune System

UNIT II: Innate and Adaptive Immunity (04 Lectures)

1. Anatomical Barriers
2. Inflammation
3. Cells & Molecules involved in Innate Immunity
4. Adaptive Immunity (Cell-mediated & humoral)

UNIT III: Antigens (04 Lectures)

1. Antigenicity & Immunogenicity
2. Immunogens, Adjuvants, and Haptens
3. B and T cell Epitopes.

UNIT IV: Immunoglobulins. (05 Lectures)

1. Structure and function of different types of Ig
2. Antigen – antibody Interactions
3. Immune assays (ELISA and RIA)
4. MAB

UNIT V: Major Histocompatibility Complex (MHC) (04 Lectures)

1. Structure & function of MHC molecules.
2. Structure of T-cell receptor and it's signaling.
3. T Cell development and selections

UNIT VI: Cytokines **(03 Lectures)**

1. Types, Properties, and Functions of Cytokines.

UNIT VII: Complement system **(03 Lectures)**

1. Components and path ways of complement activation.

UNIT VIII: Hypersensitivity **(03 Lectures)**

1. Gell and Coombs classification and brief description of various types of hypersensitivity.

UNIT IX: Vaccines **(02 Lectures)**

1. Introduction to vaccine.
2. Various types of vaccines.

Suggested Readings:

Text Books:

1. Hadley, M. E., & Levine, J. E. (2006). *Endocrinology* (6th ed.). Pearson/Benjamin Cummings.
2. Punt, J., Stranford, S. A., Jones, P. P., & Owen, J. A. (2019). *Kuby Immunology* (8th ed.). Macmillan Learning.

Reference Books:

1. Melmed, S., Polonsky, K. S., Larsen, P. R., & Kornenberg, H. M. (2022). *Williams textbook of endocrinology* (14th ed.). Elsevier.
2. Turner, C. D., & Bagnara, J. T. (1984). *General endocrinology* (6th ed.). W. B. Saunders Company.
3. Nussey, S. S., & Whitehead, S. A. (2001). *Endocrinology: An integrated approach*. BIOS Scientific Publishers.
4. Griffin, J. E., & Ojeda, S. R. (2004). *Textbook of endocrine physiology* (5th ed.). Oxford University Press.
5. Prakash Lohar. (2010). *Endocrinology*. MJP Publishers.
6. Reddy, V. R. (2012). *Principles of endocrinology*. Emkay Publications.
7. Kindit, T.J., Golds by R.A., Osborne, B.A. and Kuby, J (2006). Immunology, VI Edition. W.H. Freeman and Company.
8. David, M., Jonathan, B., David, R.B. and Ivan R. (2006). Immunology, VII Edition, Mosby, Elsevier Publication.
9. Abbas, K. Abul and Lechtman H. Andrew (2003) Cellular and Molecular Immunology. V edition. Saunders Publication.
10. Essentials of Immunology, Gupta, S. K., Arya Publication, India

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III. MAJOR COURSE- MJ 14:
EVOLUTION

Marks: 25 (5 Attd. + 20 SIE: 1Hr) + 75 (ESE: 3Hrs) = 100	Pass Marks: Th (SIE + ESE) = 40

(Credits: Theory-04) **60 Hours**

Course Objectives:

1. Students will be able to understand:
2. Understand the geological timelines, evolutionary theories, evidence of evolution, speciation, population genetics, variations, extinction, and database applications.

Course Learning Outcomes:

Students will be able to demonstrate by the end of the course:

1. Describe and critically analyze various classical and modern evolutionary theories, including Lamarckism, Darwinism, and the modern synthesis.
2. Identify and evaluate different lines of evidence for evolution, such as fossil records, geological strata, adaptive radiations, and anatomical comparisons.
3. Apply mathematical models (e.g., Hardy–Weinberg equation) to real or hypothetical populations to assess evolutionary change.
4. Compare and contrast different species concepts and mechanisms of speciation (e.g., allopatric vs. sympatric).
5. Analyze major extinction events, including their causes and consequences on biodiversity through geological time.
6. Construct phylogenetic trees using sequence alignment and infer evolutionary relationships between organisms.
7. Interpret human evolution from primate ancestors to modern *Homo sapiens*, based on fossil and genetic evidence.

Course Content:

UNIT I: Introduction to Evolutionary Theories (09 Lectures)

1. Historical Review and Concept of Evolution.
2. Theories of Evolution - Lamarckism, Neo-Lamarckism, Darwinism, Neo-Darwinism, and Modern Synthetic Theory, Origin of life

UNIT II: Evidence of Evolution (10 Lectures)

1. Evidence of Evolution
2. Geological Time Scale, Fossil record (types of fossils, transitional forms)
3. Evolution of horse and man

UNIT III: Process of Evolutionary change (09 Lectures)

1. Sources of Variations: Heritable variations and their role in evolution.
2. Natural selection in the context of population genetics.

UNIT IV: Principles of Population Genetics (10 Lectures)

1. Population genetics, Gene pool, Gene Frequency (mathematical approach), and Genetic Drift
2. Hardy–Weinberg law and its Numerical approaches.

UNIT V: Species concept (10 Lectures)

1. Product of Evolution: Micro evolutionary changes (Inter-population variations, clines, races)
2. Species concept. Modes of speciation- allopatric, sympatric.
3. Isolating mechanism
4. Macro evolution (Adaptive Radiation)

UNIT VI: Extinctions (06 Lectures)

1. Background and Mass extinctions (causes and effects)

UNIT VII: Phylogenetic trees (06 Lectures)

1. Multiple sequence alignment
2. Construction of Phylogenetic trees, Interpretation of phylogenetic trees.

Suggested Readings:

Text Books:

1. Douglas, J. Futuyma (1997). Evolutionary Biology. Sinauer Associates.
2. Ridley, M. (2004). Evolution. III Edition. Blackwell Publishing

Reference Books:

1. Rastogi, V. B. (2021). *Organic evolution* (13th ed.). Meerut, India: Rastogi Publications.
2. Verma, P. S., & Agarwal, V. K. (2018). *Evolution*. New Delhi, India: S. Chand Publishing.
3. Kumar, A. (2008). *Principles of evolution*. New Delhi, India: APH Publishing Corporation.
4. Barton, N. H., Briggs, D. E. G., Eisen, J. A., Goldstein, D. B. and Patel, N. H. (2007). Evolution. Cold Spring Harbour Laboratory Press.
5. Hall, B. K. and Hallgrimsson, B. (2008). Evolution. IV Edition. Jones and Bartlett Publishers
6. Pevsner, J. (2009). Bioinformatics and Functional Genomics. II Edition. Wiley- Blackwell.
7. Campbell, N. A. and Reece J. B. (2011). Biology. IX Edition, Pearson, Benjamin, Cummings.
8. Minkoff, E. (1983). Evolutionary Biology. Addison-Wesley

IV. MAJOR COURSE- MJ 15:
PRACTICAL-IV

Marks: Pr (ESE: 6Hrs) =100	**Pass Marks: Pr (ESE) = 40**

(Credits: Practical-04) **120 Hours**

Instructions to the Question Setter for
End Semester Examination (ESE):
There will be one Practical Examination of 6Hrs duration. Evaluation of Practical Examination will be as per the following guidelines:
1. Experiment = 60 marks
- *a. Experiments from Group B: 20*
- *b. Experiments from Group C: 20*
- *c. Spotting (Group A, B, C, and D): 20*

2. Practical record notebook = 15 marks
3. Viva-voce = 25 marks

Practicals:

Group A

1. Study of permanent slides of different developmental stages of Frog and Rabbit
2. Preparation of permanent slides of different incubation stages of Chick embryo.

Group B

1. Study of permanent histological slides of the following endocrine glands in rat: Pituitary, thyroid, adrenal, endocrine pancreas, testis, and ovary.
2. Estimation of the plasma level of any hormone using ELISA.
3. Malarial Strip test.
4. RT-PCR Test
5. Blood Group (Rh) Determination
6. Blood agglutination for antigen–antibody reaction.
7. Formation of hemin crystal

Group C

1. Study of homology in Bat and Bird
2. Analogy in fish and dolphins
3. Serial homology in Prawn
4. Adaptive Radiation in Mammals

Reference Books:

1. An advanced Laboratory manual of Zoology: T. Poddar
2. Manual for the Laboratory diagnosis of Malaria: Abnet Abebe (PDF available on net)
3. PCR Primer – A Laboratory manual: Carl. W. Dieffen bach
4. Real-time PCR handbook (http://www.gene-quantification.de)
5. Textbook of Medical Physiology: G. K. Pal

SEMESTER VII

I. MAJOR COURSE- MJ 16:
RESEARCH METHODOLOGY

Marks: 25 (5 Attd. + 20 SIE: 1Hr) + 75 (ESE: 3Hrs) = 100	**Pass Marks: Th (SIE + ESE) = 40**

(Credits: Theory-04) **60 Hours**

Course Objectives:

After completion of the course, the learner will be able to understand:

1. The basics of research
2. Research problems, various research methods, tools, and ethical practices
3. Basic skills in data collection, analysis, and reporting

Course Learning Outcomes:

Students would be able to understand:

1. Characteristics of good research viz; a comprehensive study of research reviews, gaps, objective, methodology, results, discussion and conclusion with future scope.
2. How to keep ethical considerations and stay away from plagiarism.

Course Content:

UNIT 1: Introduction to Research **(09 Lectures)**

Definition and objectives of research, Types of research: basic, applied, qualitative, quantitative
Steps in the research process, Research questions and hypothesis formulation, Characteristics of good research

UNIT 2: Research Design and Sampling **(09 Lectures)**

Research design: exploratory, descriptive, experimental, Variables and control groups, Sampling methods: probability and non-probability, Sample size determination, Limitations and delimitations

UNIT 3: Data Collection Methods **(09 Lectures)**

Primary and secondary data, Techniques: questionnaires, interviews, observation, case studies
Survey tools and fieldwork, online and offline data collection, Validity and reliability of data

UNIT 4: Data Analysis and Interpretation **(09 Lectures)**

Basics of data organization, Introduction to descriptive statistics: mean, median, mode, standard deviation
Graphical representation: tables, charts, graphs, Introduction to inferential statistics
Use of software tools (e.g., MS Excel, SPSS/R/PAST – demo-based)

UNIT 5: Report Writing and Research Ethics **(09 Lectures)**

Structure of a research report/thesis, Referencing and citation styles (APA/MLA)
Plagiarism and how to avoid it, Intellectual property rights and copyright
Ethical issues in research (including human and animal ethics)

Practical / Project Work **(15 Lectures)**

Framing a research question and writing a short proposal
Designing a sample questionnaire or data collection tool
Collecting mock data and presenting it using graphs or basic statistics
Referencing using software like Zotero, Mendeley
Writing a mini-report based on collected data

Suggested Readings:

Text Book:

1. Kothari, C.R. and Garg, Gaurav, Research methodology: Methods and techniques, New Age International.

Reference Books:

1. Research methodology tailored to Biological Sciences by N. Gurumani, Edi-2021, MJP Publisher, Chennai
2. Online resources: SWAYAM, NPTEL, and Google Scholar.
3. Breakwell, Glynis M. Hammond, S. Fifeschaw, C., Smith, J.A. Research Methods in Zoology, Sage Publication.
4. Kerlinger, Fred N., Foundation of Behavioral Research, Hort, Rinehart and Winston publishing.
5. Ahuja, Ram., Research Methods, Rawat Publications.

II. MAJOR COURSE- MJ 17:
ADVANCED BIOCHEMISTRY AND BIOTECHNOLOGY

Marks: 25 (5 Attd. + 20 SIE: 1Hr) + 75 (ESE: 3Hrs) = 100	**Pass Marks: Th (SIE + ESE) = 40**

(Credits: Theory-04) **60 Hours**

Course Objective

1. To understand the molecular basis of life processes in animals and to develop analytical and critical thinking skills in biochemical research.
2. To familiarize the students with the fundamental principles of biotechnology, various potential applications of biotechnology in Zoology.

Course Learning Outcomes

1. Application of Genetic Engineering Tools: Students will be able to apply molecular biology techniques such as PCR, gene cloning, and CRISPR to study and manipulate genes in animal systems for research or therapeutic purposes.
2. Understanding of Biotechnological Advances in Zoology: Students will critically evaluate and apply biotechnological approaches (e.g., stem cell technology, transgenesis, and animal tissue culture) to solve problems in animal health, reproduction, and conservation.
3. Metabolic and Enzymatic Processes: Students will have a thorough understanding of animal metabolism, enzyme kinetics, and regulation, and their integration in physiological systems.
4. Experimental and Analytical Proficiency: Students will acquire hands-on experience in biochemical techniques (e.g., spectrophotometry, chromatography, electrophoresis) and use them to analyze biological samples to interpret results in the context of animal biochemistry.

Course Content:

UNIT-1: BIOCHEMISTRY

1. **Water as the Basic Molecule of Life** **(04 Lectures)**
   a. Molecular structure and solvent properties of water, tetrahedral geometry, hydrogen bond, thermal properties of water and their biological significance.
   b. Ionization of water, Ion product of water (Kw), Concept of pH, Dissociation of weak acids and weak bases, Henderson-Hasselbalch Equation, Titration curves of strong and weak acids, concept of buffer, buffers in biological systems.
2. **Biological Macromolecules** **(09 Lectures)**
   a. Central role of carbon, Common ring structure, Chirality, and Isomerization in biomolecules.
   b. 2. Composition, structure and functions of monomers and polymers of carbohydrates, lipids, proteins, nucleic acids
   c. Vitamins
3. **Interactions of Macromolecules** **(04 Lectures)**
   a. Stability of Proteins and Nucleic Acids; Stabilizing Interactions such as Vander Waals, Electrostatic, Hydrogen Bonding, Hydrophobic Interactions
   b. Confirmation of proteins: Ramachandran plot, secondary structure, domains, motif and folds, Hydropathy index (HI) of amino acids, isoelectric point (pI) of proteins
4. **Complex biomolecules** **(03 Lectures)**
   a. Glycoproteins: ABO blood group determinants
   b. Lipoproteins: classification and functions of chylomicrons, VLDL, LDL, HDL, and free fatty acid-albumin complex, Cholesterol ratio (CR)
5. **Carbohydrate and Lipid Metabolism** **(15 Lectures)**
   a. Glycolysis, Krebs cycle, ETC, and their energetics & regulation.
   b. Gluconeogenesis: Reaction sequence from pyruvate, gluconeogenesis from amino acids, glycerol, and lactate.
   c. Glycogen metabolism: Glycogenesis, Glycogenolysis, and their regulation.
   d. Significance of the pathways: Hexose Monophosphate (HMP) Shunt as a multifunctional pathway
   e. Fatty acid metabolism: Beta-oxidation of saturated even and odd carbon atoms, and unsaturated fatty acids, metabolism of cholesterol

UNIT-2: BIOTECHNOLOGY

1. **Geome Organization** **(06 Lectures)**
   a. Organization of genomes in prokaryotes and eukaryotes, the C-value paradox, and genome size.
   b. Complexity of viral, bacterial, and eukaryotic genomes, Cot curves, repetitive and non-repetitive DNA sequences.
2. **Methods in Biotechnology** **(09 Lectures)**
   a. Cloning using plasmid plasmid pBR322, pUC19, pJM, pBluescript, detection of recombinants by blue-white screening, cloning in bacteriophage, cosmid, BAC, MAC, and YAC vectors.

b. Chromosome walking, RAPD Microarrays. Strategies of genome separation – Sanger methods and Next Generation Sequencing (NGS).

3. Microbial biotechnology (10 Lectures)

a. Microbial fermentation, Microbial growth kinetics, Design of a fermenter, Organisms used in large scale fermentation.
b. Monoclonal antibodies (mAbs) and their therapeutic applications.
c. HIV therapeutic agents.
d. Production of biopharmaceuticals from transgenic animals – Human Tissue Plasminogen Activator (hTPA) and α-1Antitrypsin (AAT).
e. Environmental biotechnology: Effluent treatment, Bioremediation, Phytoremediation, Biosensors, Biofuels.

Suggested Reading:

Text Books:

1. Lehninger, L. Albert, David, L. Nelson, Michael, M. Cox (Latest edition). Principles of Biochemistry, CBS Publishers and Distributors, Delhi.
2. Medical Biotechnology – S. N. Jogdand – Himalaya Publishing House.

Reference Books:

1. Puri, Dinesh (Latest edition). Textbook of Medical Biochemistry (3rd Edition).
2. Bhagavan N. V. and Chung-Eun Ha (Latest edition). Essentials of Medical Biochemistry (2nd Edition).
3. Harper's Illustrated Biochemistry.
4. Satyanarayana U. and Chakrapani (Latest edition). Biochemistry.
5. Stryer, L (Latest edition), Biochemistry, W.H. Freeman and Company, New York.
6. Smith (Latest edition), Principles of Biochemistry, (7th Edition), McGraw Hill (Mammalian Biochemistry), New York.
7. Voet, D. & Voet, J (Latest edition), Biochemistry, John Wiley and Sons, New York.
8. Fundamentals of Biochemistry – J L Jain, Sunjay Jain, Nitin Jain – S. Chand.
9. Biotechnology- Expanding Horizon by P.D. Singh, Kalyani Publication
10. Cell & Molecular Biology: Concepts & Experiments (6th Edition) – Gerald Karp.
11. iGenetics – A molecular approach (3rdEdition) – Peter J Russell – Pearson Education Inc.
12. Molecular Biology and Biotechnology– KG Ramawat & Shaily Goyal – S. Chand.

III. MAJOR COURSE- MJ 18:
PRACTICAL-V

Marks: Pr (ESE: 6Hrs) =100	**Pass Marks: Pr (ESE) = 40**

(Credits: Practical-04) **120 Hours**

Instruction to Question Setter for

End Semester Examination (ESE):

There will be one Practical Examination of 6Hrs Lectures duration. Evaluation of Practical Examination will be as per the following guidelines:

Practical from UNIT I	*= 20 marks*
Practical from UNIT II	*= 20 marks*
Practical from UNIT III & IV	*= 20 marks*
Practical records	*= 15 marks*
Viva-voce	*= 25 marks*

Practicals:

UNIT I: Slides/ Museum specimen/ Model/ Graph/ Specimen:

1. Slide: Slide of glycogen granules (PAS-stained), b) Slide of mitochondria (Janus Green-stained preparation), c) Electrophoresis gel showing DNA bands, d) Slide of mitotic chromosomes (root tip squash), e) Slide of lipid droplets in liver tissue, f) Slide of bacteria stained with Gram's method
2. Fermenter model, Transgenic mouse model (museum specimen/chart), Research tool –Questionnaire/survey sheet
3. Diagram/model – Ramachandran plot
4. Graph output – Cot curve
5. Specimen – Bioreactor/Biosensor model

UNIT II: Major Experiment

1. Estimation of protein concentration by Lowry' s method.
2. Determination of pH and preparation of a phosphate buffer using Henderson-Hasselbalch equation.
3. Separation of amino acids by paper/TLC chromatography.
4. Demonstration of DNA isolation from onion/ insect leg muscle, etc. material.
5. Determination of enzyme activity- amylase on starch / catalase on H_2O_2.
6. Growth curve of bacteria using spectrophotometer (demo-based).

UNIT III: Minor Experiment / Data Handling

1. Plot a titration curve for a weak acid and determine its pKa.
2. Solve a given dataset for Mean, Median, Mode, Standard Deviation.
3. Represent given data using a suitable chart/graph (histogram, line graph, pie chart).
4. Analyze a RAPD gel image for polymorphism.
5. Interpret an Excel/SPSS output sheet (demo-based).

UNIT IV: Research Methodology Component

1. Frame a research question and hypothesis on the effect of a new antibiotic.
2. Differentiate between basic and applied research with examples.
3. Write short notes on probability vs. non-probability sampling.
4. Prepare references in APA style for: A book, A journal article, A website
5. Write a short note on plagiarism and methods to avoid it.

Reference Books:

1. Kothari, C.R. & Garg, Gaurav. Research Methodology: Methods and Techniques.
2. New Age International Publishers, New Delhi (2019, 4th Edition).
3. Plummer, D.T. An Introduction to Practical Biochemistry. McGraw Hill Education, New Delhi (2017, 3rd Edition).
4. Wilson, Keith & Walker, John. Principles and Techniques of Biochemistry and Molecular Biology.
5. Publisher: Cambridge University Press, Cambridge (2010, 7th Edition).
6. Dubey, R.C. A Textbook of Biotechnology. Publisher: S. Chand Publishing, New Delhi (2016, Revised Edition).
7. Jayaram, N. A Textbook on Zoology Practicals. Publisher: Himalaya Publishing House, Mumbai (2018, 1st Edition).
8. The experimental analysis of distribution and abundance: C.J Krebs
9. Climate change, A very short Introduction: Mark Maslin, Oxford India
10. Design and Analysis of Experiments: D.C Montgomery

IV. ADVANCED MAJOR COURSE- AMJ 1:
ADVANCED IMMUNOLOGY AND METHODS IN BIOLOGY

Marks: 25 (5 Attd. + 20 SIE: 1Hr) + 75 (ESE: 3Hrs) = 100	**Pass Marks: Th (SIE + ESE) = 40**

(Credits: Theory-04) **60 Hours**

(Only for Hons Degree)

Course Objectives:

1. In immunology, learners will explore the structure and function of immune cells, organs, and molecules, along with the mechanisms of innate and adaptive immunity, antigen-antibody interactions, immunological memory, and hypersensitivity reactions.
2. Emphasis is placed on understanding the roles of B and T lymphocytes, cytokines, MHC molecules, and the principles of immunological disorders, vaccination, and host-pathogen interactions.
3. The Methods in Biology component equips students with the theoretical and practical knowledge of core experimental techniques used in modern biology. These include microscopy (light, fluorescence, electron), centrifugation, chromatography, electrophoresis, blotting techniques (Southern, Northern, Western), ELISA, flow cytometry, and molecular biology techniques like PCR, cloning, and gene expression analysis.
4. By integrating these two areas, the course develops the ability to design, conduct, and interpret experiments related to immune functions and biological processes, fostering scientific thinking and preparing students for research and clinical applications.

Course Learning Outcomes:

After completing this course, students will be able to:

1. Understand the immune system – Describe the components and functions of the innate and adaptive immune responses, including key immune cells, organs, antibodies, antigens, and signaling pathways.
2. Explain immunological mechanisms – Demonstrate knowledge of immune processes such as antigen processing and presentation, immune memory, tolerance, vaccination, autoimmunity, and hypersensitivity.
3. Apply experimental techniques – Understand the principles, procedures, and applications of key biological methods such as microscopy, centrifugation, chromatography, gel electrophoresis, blotting, ELISA, flow cytometry, and molecular cloning.
4. Interpret immunological and molecular data – Analyze and interpret results from laboratory experiments involving immunological assays and molecular biology techniques.
5. Design experiments – Develop the ability to plan and execute basic experiments in immunology and cell/molecular biology, with attention to accuracy, controls, and reproducibility.

Course Contents:

UNIT-I: ADVANCED IMMUNOLOGY

1. Immune System Architecture and Cell Signaling: (09 Lectures)

a. Advanced overview of innate and adaptive immunity.
b. Antigen recognition: MHC complex, antigen processing and presentation.
c. Immune cell receptors: T-cell receptor, B-cell receptor, co-stimulatory molecules.
d. Signal transduction pathways in immune responses.

2 Immunogenetics and Immune Regulation: (08 Lectures)

a. Organization and genetics of immunoglobulin and T-cell receptor genes.
b. Somatic recombination, hypermutation, and class switching.
c. Mechanisms of immune tolerance, central and peripheral.
d. Cytokine networks, immune checkpoints, and regulation.

3 Immunopathology and Disease: (08 Lectures)

a. Hypersensitivity reactions (Types I–IV).
b. Autoimmunity: mechanisms and major autoimmune diseases.
c. Immunodeficiencies: primary and acquired (e.g., HIV/AIDS).
d. Tumor immunology: cancer immunosurveillance, immunoediting.

4 Applied and Emerging Immunology: (05 Lectures)

a. Vaccinology: traditional and modern vaccine design, mRNA vaccines.
b. Immunodiagnostics: ELISA, flow cytometry, immunofluorescence.
c. Introduction to immunoinformatics and systems immunology.

UNIT-II: METHODS IN BIOLOGY

1. Molecular biology and recombinant DNA methods: (14 Lectures)

a. Isolation and purification of RNA, DNA (genomic and plasmid) and proteins, different separation methods; analysis of RNA, DNA, and proteins by one and two-dimensional gel electrophoresis, isoelectric focusing gels. Molecular cloning of DNA or RNA fragments in bacterial and eukaryotic systems.
b. Isolation of specific nucleic acid sequences; generation of genomic and cDNA libraries in plasmid, phage, cosmid, BAC, and YAC vectors.

c. *In vitro* mutagenesis and deletion techniques.
d. Gene knock-out in bacterial and eukaryotic organisms.
e. Protein sequencing methods, detection of post-translational modification of proteins.
f. DNA sequencing methods, strategies for genome sequencing.
g. Methods for analysis of gene expression at RNA and protein levels. RAPD and AFLP techniques.

2. Immunotechniques: (06 Lectures)

a. Antibody generation, detection of molecules using ELISA, RIA, western blot, immunoprecipitation, flow cytometry, and immunofluorescence microscopy, detection of molecules in living cells, *in situ* localization by techniques such as FISH and GISH.

4. Radiolabeling techniques: (04 Lectures)

a. Properties of different types of radioisotopes normally used in biology, and their detection
b. Measurement, incorporation of radioisotopes in biological tissues and cells, molecular imaging of radioactive material, and safety guidelines.

5. Microscopic techniques: (06 Lectures)

a. Visualization of cells and subcellular components by light microscopy, resolving powers of different microscopes, microscopy of living cells, scanning and transmission microscopes,
b. Different fixation and staining techniques for EM, freeze-etch

Suggested Readings:

Text Books:

1. Kuby Immunology, Jenni Punt, Sharon Stranford, Patricia Jones, Judy Owen, W.H. Freeman and Company, Address: 41 Madison Avenue, New York, NY 10010, USA
2. Principles and Techniques of Biochemistry and Molecular Biology, Editors: Keith Wilson, John Walker, Publisher: Cambridge University Press, Address: University Printing House, Shaftesbury Road, Cambridge CB2 8BS, UK

Reference Books:

1. Janeway's Immunobiology, Kenneth Murphy, Casey Weaver, Publisher: Garland Science, Taylor & Francis Group, Address: 711 Third Avenue, New York, NY 10017, USA
2. Essential Immunology, Author: Peter L. Roitt, Publisher: Wiley-Blackwell, Address: 111 River Street, Hoboken, NJ 07030, USA
3. Cellular and Molecular Immunology, Authors: Abul K. Abbas, Andrew H. Lichtman, Shiv Pillai, Publisher: Elsevier (Saunders), Address: 3251 Riverport Lane, Maryland Heights, MO 63043, USA
4. Immunology: A Short Course, Authors: Richard Coico, Geoffrey Sunshine, Publisher: Wiley-Blackwell, Address: 111 River Street, Hoboken, NJ 07030, USA
5. Molecular Cloning: A Laboratory Manual, Authors: Michael R. Green, Joseph Sambrook, Publisher: Cold Spring Harbor Laboratory Press, Address: 500 Sunnyside Blvd, Woodbury, NY 11797, USA
6. Molecular Biology Techniques: A Classroom Laboratory Manual, Authors: Heather Miller, D. Scott Witherow, Sue Carson, Publisher: Elsevier/Academic Press, Address: 125 London Wall, London EC2Y 5AS, UK
7. Experimental Techniques in Biochemistry and Molecular Biology, Author: S.K. Sawhney, Randhir Singh, Publisher: Narosa Publishing House, Address: 4746/23 Ansari Road, Daryaganj, New Delhi – 110002, India

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OR RESEARCH COURSES- RC 1: (In lieu of AMJ 1)

RESEARCH PLANNING & TECHNIQUES

Marks: 25 (5 Attd. + 20 SIE: 1Hr) + 75 (ESE: 3Hrs) = 100	**Pass Marks: Th (SIE + ESE) = 40**

(Credits: Theory-04) **60 Hours**

(Only for Hons with Research Degree)

Course Objectives:

1. To equip the students with the ability to understand the philosophy and ethics of research.
2. To Foster critical and analytical thinking aligned with NEP's emphasis on inquiry-based learning.
3. To frame the questions in research and structure the hypothesis to find the gap in any research matter.

Course Learning Outcomes:

1. They will be able to identify and define a research problem.
2. Able to conduct literature reviews using digital tools.
3. Form basic research questions and hypotheses.
4. Design research methodology along with given protocols.
5. Able to present research proposals.

Course Content:

UNIT I: Introduction to Research (08 Lectures)

1. What is research? Objectives and significance
2. Types of research: Basic, applied, qualitative, quantitative
3. Interdisciplinary and transdisciplinary research (NEP emphasis)
4. Ethics in research: Plagiarism, consent, and integrity

UNIT II: Research Planning and Design (08 Lectures)

1. Review of literature and its importance
2. Preparing a research proposal

UNIT III: Research Methods and Techniques (14 Lectures)

1. Data collection methods: Observation, survey, interviews, experiments if lab techniques are required
2. Sampling techniques
3. Introduction to data analysis: Quantitative and qualitative
4. Use of tools (questionnaires, spreadsheets, basic statistical software)

UNIT IV: Documentation and Communication (12 Lectures)

1. Structuring a Research Report
2. Referencing styles and citation tools (e.g., Zotero, Mendeley, Google Scholar, etc.)
3. Preparing posters and presentations

UNIT V: Project Work and Practical Application (18 Lectures)

1. Mini project on a chosen research topic
2. Preparing a report and delivering a presentation
3. Peer review and feedback

Reading Resources:

Text Books:

1. Kothari, C. R. – Research Methodology: Methods and Techniques

Reference Books:

1. NEP 2020 Document – Part II
2. Online resources: SWAYAM, NPTEL, and Google Scholar

SEMESTER VIII

I. MAJOR COURSE- MJ 19:
TOXICOLOGY, HISTOLOGY AND HISTOCHEMISTRY

Marks: 25 (5 Attd. + 20 SIE: 1Hr) + 75 (ESE: 3Hrs) = 100	**Pass Marks: Th (SIE + ESE) = 40**

(Credits: Theory-04) **60 Hours**

Course Objectives:

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

1. Theoretical and applied knowledge of the effects of chemical substances on human health.
2. The toxicological analysis and the signs and symptoms of important toxic syndromes.
3. The basic toxicokinetic principles and metabolic systems to elucidate mechanisms of toxicity induced by xenobiotic compounds.

Course Learning Outcomes:

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

1. Understand the principles and scope of toxicology.
2. Learn about different types of toxins and their effects on organisms
3. Study detoxification mechanisms and risk assessment
4. Provide hands-on experience in toxicity testing and analysis

Course Content:

UNIT I: TOXICOLOGY

1: Introduction to Toxicology **(04 Lectures)**

a. Definition, scope, and branches of toxicology
b. History and development of toxicology
c. Classification of toxicants: chemical, biological, and physical
d. Dose-response relationship, Factors affecting toxicity (age, sex, route, duration, etc.)

2: Absorption, Distribution, Metabolism and Excretion (ADME) of Toxicants **(07 Lectures)**

a. Routes of exposure: oral, dermal, inhalation
b. Toxicokinetics: absorption, distribution, biotransformation, excretion
c. Phase I and II metabolic reactions, Bioaccumulation, and biomagnification

3: Organ System Toxicity **(07 Lectures)**

a. Hepatotoxicity, nephrotoxicity, neurotoxicity
b. Hematotoxicity and reproductive toxicity

4: Environmental and Occupational Toxicology **(09 Lectures)**

a. Pesticide toxicity: organochlorines, organophosphates, carbamates
b. Heavy metals: arsenic, lead, mercury, cadmium
c. Industrial and household toxicants
d. Risk assessment and safety limits (LD50, LC50, NOAEL, etc.)

5: Toxicology in Public Health and Regulation **(03 Lectures)**

a. Food and drug toxicology, Forensic toxicology: poisoning and antidotes
b. Introduction to biosafety and toxicology regulations
c. National and international regulatory agencies (EPA, CPCB)

UNIT-II: HISTOLOGY AND HISTOCHEMISTRY

1. Definition, scope, and importance of histology in zoological studies **(01 Lectures)**
2. **Fixation and tissue processing:** Types of fixatives, Chemistry of fixation, and selection of fixatives, Dehydration, Clearing and embedding, Microtomy. **(08 Lectures)**
3. **Histological Staining of paraffin sections:** Types of staining, Dye chemistry, Principle and methods of staining of paraffin sections (Hematoxylin & Eosin, Trichrome stains), **(05 Lectures)**
4. **Histological stains, histochemical identification, and localization of the following:** **(16 Lectures)**
   A. **Carbohydrates -** Periodic Acid-Schiff (PAS) Reaction (for glycogen and glycoprotein)
   B. **Protein end groups -** Mercury Bromophenol Blue method (for general proteins), Ninhydrin/Schiff method (for α-amino acids), and Performic acid Alcian Blue method (for disulfide)
   C. **Lipid moieties -** Sudan Black B method (for phospholipids), Performic acid-Schiff (for unsaturated fatty acids), Perchloric acid nephthaoquinone Reaction (for cholesterol).
   D. **Nucleic acids –** Pyronin-Methyl green method (for nucleic acid) and Feulgen nuclear reaction (for DNA).

Suggested Readings:

1. Casarett and Doull's Toxicology – Curtis D. Klaassen
2. Principles of Toxicology – Karen Stine & Thomas M. Brown
3. Textbook of Toxicology – P.D. Sharma
4. Essentials of Toxicology – M.A. Subramanian
5. Environmental Toxicology – T.W. Clar

II. MAJOR COURSE- MJ 20: PRACTICAL-VI

Marks: Pr (ESE: 6Hrs) =100	**Pass Marks: Pr (ESE) = 40**

(Credits: Practical-04) **120 Hours**

Instruction to Question Setter for
End Semester Examination (ESE):
There will be one Practical Examination of 3 Lectures duration. Evaluation of Practical Examination will be as per the following guidelines:

Experiments based on Toxicology	*= 20 marks*
Experiments based on Histochemistry	*= 20 marks*
Spotting based on Histology	*= 20 marks*
Practical record	*= 15 marks*
Viva-voce	*= 25 marks*

Practicals:

1. Dose Determination of LC50 / LD50 using bioassay
2. Detection of heavy metals in water/soil using colorimetric methods
3. Study of pesticide residues in vegetables (demo/analytical kits)
4. Histological observation of toxin-induced changes in tissue (slides)
5. Case studies on toxic exposure and public health outcomes
6. Preparation of a toxicity profile for a common chemical.
7. Preparation and Staining of Permanent Slides
8. Histology of Epithelial Tissues
9. Histology of Connective and Muscular Tissues
10. Histochemistry of Carbohydrates- Periodic Acid–Schiff (PAS) reaction for glycogen and mucopolysaccharides.
11. Histochemistry of Proteins and Lipids- Protein – Mercury bromophenol blue method, Lipid – Sudan Black B staining

Reference Book:

1. Hodgson, A Textbook of Modern Toxicology
2. Gupta, Fundamentals of Toxicology
3. OECD Guidelines for Toxicity Testing
4. Lab safety manuals (institution-specific)
5. Bancroft, J. D., & Gamble, M. (2019). *Theory and Practice of Histological Techniques* (8th ed.). Elsevier.
6. Kiernan, J. A. (2015). *Histological and Histochemical Methods: Theory and Practice* (5th ed.). Scion Publishing.

III. ADVANCED MAJOR COURSE- AMJ 2:
ADVANCED CELL BIOLOGY & MOLECULAR GENETICS

Marks: 25 (5 Attd. + 20 SIE: 1Hr) + 75 (ESE: 3Hrs) = 100	**Pass Marks: Th (SIE + ESE) = 40**

(Credits: Theory-04) **60 Hours**

(Only for Hons. Degree)

Course Objectives:
After completion of the course, the learner will be able to learn:
1. Advanced molecular mechanisms governing cellular function.
2. The details of cellular compartments, genome organization, and gene regulation.
3. The modern tools in molecular biology and cellular imaging.
4. The analytical thinking through case studies and current research.

Course Learning Outcomes:
Students would be able to understand:
1. Cell architecture, membrane dynamics, and organelle-specific processes such as protein sorting, trafficking, and cellular compartmentalization.
2. the mechanisms of DNA replication, transcription, RNA processing, translation, and post-translational modifications in both prokaryotic and eukaryotic systems.
3. how cells regulate gene activity at transcriptional and post-transcriptional levels, and how chromatin remodeling and epigenetic modifications influence cellular behaviour.
4. how the cell cycle is controlled, how apoptosis is triggered, and how disruptions in these processes can lead to diseases such as cancer.
5. Techniques such as PCR, blotting, sequencing, gene editing (e.g., CRISPR), and microscopy to analyze molecular and cellular functions.

Course Content:

GROUP- A: ADVANCED CELL BIOLOGY

UNIT I: Advanced Cell Structure and Membrane Dynamics: (06 Lectures)
1. Membrane structure and function: Lipid rafts, membrane asymmetry, Transport mechanisms (passive, active, facilitated)
2. Membrane trafficking and vesicle transport: Endocytosis, exocytosis, clathrin, COPI, COPII, SNARE hypothesis

UNIT II: Organelle Biology and Protein Targeting: (04 Lectures)
1. Nucleus and nuclear pore complex,
2. Protein sorting and signal sequences of mitochondria, nucleus, and peroxisome.
3. Lysosomal storage disorders.

UNIT III: Cell Cycle, Apoptosis, and Cancer Biology: (06 Lectures)
1. Detailed cell cycle regulation: CDKs, cyclins, checkpoints,
2. Molecular basis of apoptosis and necroptosis, Caspase cascade, Bcl-2 family, apoptosome,
3. Cancer as a cell cycle disease: oncogenes, tumor suppressors (p53, Rb) genes.

UNIT IV: Signal Transduction Pathways: (09 Lectures)
1. MAPK/ERK, JAK/STAT, PI3K-Akt pathways,
2. Wnt, Hedgehog, TGF-beta families signal transduction pathways
3. Crosstalk between signaling pathways,
4. Cell adhesion molecules and extracellular matrix

GROUP-B: ADANCED MOLECULAR GENETICS

UNIT I: Genome Organization and Epigenetics: (05 Lectures)
1. Chromatin structure and remodelling, Histone code and post-translational modifications,
2. DNA methylation, imprinting, X-inactivation,
3. Non-coding RNAs in epigenetic regulation,
4. Epigenetic inheritance and diseases.

UNIT II: DNA Replication, Repair, and Recombination: (08 Lectures)
1. Prokaryotic vs. eukaryotic replication, DNA polymerases, and replication complexes,
2. DNA damage and repair methods.
3. Homologous and site-specific recombination, Transposons.

UNIT III: Gene Expression and Regulation: (08 Lectures)

1. Transcription regulation in prokaryotes and eukaryotes: Enhancers, silencers, promoters, transcription factors, RNA polymerases, and transcription initiation,
2. Post-transcriptional regulation,
3. RNA interference (RNAi), miRNA, siRNA, RNA transport, and mRNA stability.

UNIT IV: Translation and post-translational modifications (PTMs) (04 Lectures)

1. Chaperones, ubiquitin-proteasome system

UNIT V: Gene Regulations: (04 Lectures)

1. Lac operon regulations- inducible, non-inducible, and constitutive expressions of lactose, allolactose, glucose, cAMP, and artificial inducers.
2. Trp operon regulations – attenuation-based control of the operon.

UNIT VI: Molecular Techniques and Applications: (06 Lectures)

1. PCR, RT-PCR, qPCR
2. Blotting techniques
3. CRISPR-Cas9 and gene editing,
4. Single-cell and spatial transcriptomic

Suggested Readings

Text Books:

1. Molecular Biology of the Cell – Alberts et al. (Garland Science)
2. Lehninger Principles of Biochemistry, David L. Nelson and Michael M. Cox, 8th Edition (latest as of 2024), W. H. Freeman and Company (an imprint of Macmillan Learning), ISBN: 9781319381493, New York, USA

Reference Books:

3. Molecular Cell Biology – Lodish et al. (W.H. Freeman)
4. Lewin's Genes XII – Krebs, Goldstein & Kilpatrick (Jones and Bartlett)
5. Cell and Molecular Biology: Concepts and Experiments – Gerald Karp (Wiley)
6. Principles of Gene Manipulation and Genomics – Primrose & Twyman (Wiley-Blackwell)
7. Introduction to Genetic Analysis – Griffiths et al. (W.H. Freeman)
8. Molecular Biology of the Gene (Watson), James D. Watson, Tania A. Baker, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Losick, 7th Edition, Pearson Education, ISBN: 9780321762436, San Francisco, USA

IV. ADVANCED MAJOR COURSE- AMJ 3:
PRACTICAL-VII

Marks: Pr (ESE: 6Hrs) =100	**Pass Marks: Pr (ESE) = 40**

(Credits: Practical-04) **120 Hours**

(Only for Hons Degree)

Instruction to Question Setter for
End Semester Examination (ESE):
There will be one Practical Examination of 6Hrs duration. Evaluation of Practical Examination will be as per the following guidelines:

Preparation of buffers and determination of pH	*= 10 marks*
Preparation of permanent slides of metaphase chromosomes of the tip of the onion	*= 10 marks*
Extraction/Isolation of genomic DNA or RNA	*= 15 marks*
Separation of RNA or DNA by Gel electrophoresis	*= 15 marks*
Demonstration of PCR	*= 10 marks*
Practical Records	*= 15 marks*
Viva – voce	*= 25 marks*

Practical:

1. Buffers and determination of pH of the given sample.
2. Permanent slides of metaphase chromosomes of the tip of the onion
3. Karyotyping of a given sample
4. Study of tumor cell nuclei. (Virtual Mode)
5. Extraction/Isolation of genomic DNA and RNA from mammalian blood cells
6. Agarose Gel Electrophoretic analysis of DNA, or RNA.
7. Conduction of PCR.
8. Sub-cellular fractionation of mitochondria
    a. Isolation of mitochondria from mouse liver by differential centrifugation. (virtual mode)
    b. Identification of mitochondrial fraction by assay of marker enzyme. (virtual mode)

Reference Books:

1. A manual of cytogenetics by S.K. ROY
2. Practical manual in Genetics and Cytogenetics by J.S Arora
3. Cytogenetics laboratory manual by Marcelo L. Larramendy
4. Genes in Medicine: Rasko and Downes, Kluwer
5. Principles & Practice of Medical Genetics: Rimoin et al, Churchill
6. Clinical Genetics Handbook: Robinson and Linden, Blackwell
7. Molecular Biotechnology: Primrose, Panima
8. Molecular Cloning: Sambrook et al, CSHL
9. Gene Cloning and DNA Analysis - An Introduction: T.A. Brown, Blackwell
10. Biochemistry with clinical correlation- Thomas Devlin, 2nd ed, John Wiley and sons
11. Molecular Biology of the Cell –Bruce Albert Pub. By Garland Pub. Inc. New York & London.
12. Alberts B, Johnson A, Lewis J, et al. Molecular Biology of the Cell, Taylor & Francis Group, New York, USA.

OR RESEARCH COURSES- RC 2: (In lieu of AMJ 2 & AMJ 3)

RESEARCH/ PROJECT DISSERTATION/ RESEARCH INTERNSHIP/ FIELD WORK

Marks: 50 (SIE: 25 Synopsis + 25 Viva on Synopsis: 1Hr) + 100 (ESE Pr: 6Hrs) + 50 (Viva) = 200	**Pass Marks = 80**

(Only for Hons with Research Degree)

Guidelines to Examiners for Semester Internal Examination (SIE):

Evaluation of project dissertation work may be as per the following guidelines:

Project Synopsis = 25 marks

Project Synopsis presentation and viva-voce = 25 marks

Guidelines to Examiners for End Semester Examination (ESE):

Evaluation of project dissertation work may be as per the following guidelines:

Project model (if any) and the Project record notebook = 70 marks

Project presentation and viva-voce = 30 marks

The overall project dissertation may be evaluated under the following heads:

- *Motivation for the choice of topic*
- *Project dissertation design*
- *Methodology and Content depth*
- *Results and Discussion*
- *Future Scope & References*
- *Participation in an Internship programme with a reputed organization*
- *Application of the Research technique in Data collection*
- *Report Presentation*
- *Presentation style*
- *Viva-voce*

Research Project

Research project under a Supervisor of the Department/Institution may be allocated to the eligible and qualifying candidate.

Project Dissertation/ Research Internship/ Field Work

The students of Graduation must work Thirty-Six (36) days as Interns under Any Organisation having an MoU with the Radha Govind University, which may include Government Organizations/judiciary/ Health Care Sectors/ Educational Institutions/ NGOs etc.

- The nature and the place of working must be informed in writing, seeking permission from the head of the department or the institution before undertaking the Project dissertation.

Submission of the Project Work

Each student has to submit two copies of the dissertation work duly forwarded by the HOD of the Department concerned. The forwarded copies will be submitted to the Department/Institution for evaluation at least seven days before the seminar.

The Project Report will consist of:

a. Field work/Lab work related to the project.
b. Preparation of the dissertation based on the work undertaken.
c. Presentation of project work in the seminar on the assigned topic & open viva there on.
d. At least one Research paper must be presented at a conference or may be published in a reputed journal.

Topics

Project work related to the Industrial/socially relevant topics may be given.

NB: Students will select topics for the project work in consultation with a teacher of the department.

The seminar will be held in the respective University Department at RadhaGovind University, Ramgarh.

COURSES OF STUDY FOR FYUGP IN **"ZOOLOGY" MINOR**

ASSOCIATED CORE COURSE- MN A **Either may be opted in Sem-I or Sem-II**

I. ASSOCIATED CORE COURSE- MN A: INTRODUCTORY ZOOLOGY

Marks: 15 (15 SIE: 1Hr) + 60 (ESE: 3Hrs) = 75	**Pass Marks: Th (SIE + ESE) + Pr (ESE) = 40**

(Credits: Theory-03) **45 Hours**

Course Objectives:

After completion of the course, the learner shall be able:

1. To develop a foundational understanding of animal diversity, structural organization, basic biochemical principles, cellular architecture, genetic mechanisms, physiological processes, and evolutionary concepts.
2. To foster the ability to classify major animal groups, explain fundamental life processes, and relate evolutionary theories and behavioral patterns to adaptations in the animal kingdom.

Course Learning Outcomes:

On successful completion of this course:

1. Students will be able to classify major animal phyla and chordate groups.
2. Describe basic biochemical constituents, explain cellular structures and genetic principles, and outline key physiological processes.
3. Students will be able to interpret evolutionary theories, differentiate between micro- and macroevolution, and analyze examples of innate and learned animal behaviours in relation to adaptation and survival.

Course Content:

Unit I: Basics of the Animal Kingdom **(10 Lectures)**

Five Kingdoms pattern of classification

Classification of Protozoa, Coelenterata, Porifera, Helminthes, Annelida, Arthropoda, Mollusca, Echinodermata, and Chordates

Unit II: Basics of Biochemistry, Cell and Genetics **(12 Lectures)**

Introduction of Carbohydrates, Proteins, Lipids.

Prokaryotic and eukaryotic cells, Cell theory, Protoplasm, Plasma membrane, Mitochondria, Golgi Body, Endoplasmic Reticulum, Lysosome, and Nucleus.

DNA, RNA, Genetic Codes, Mendelian genetics, Crossing over

Unit III: Basics of Animal Physiology **(13 Lectures)**

Physiology of digestion, respiration, circulation, and excretion

Unit IV: Basics of Evolution and Behaviour **(10 Lectures)**

Darwinism, Lamarckism, and the Synthetic theory of evolution

Microevolution and Macroevolution

Innate and Learned behaviour

Reference Books:

1. Barnes, R. D. (2005). *Invertebrate zoology* (7th ed.). Belmont, CA: Brooks/Cole.
2. Alberts, B., Johnson, A., Lewis, J., Morgan, D., Raff, M., Roberts, K., & Walter, P. (2015). *Molecular biology of the cell* (6th ed.). New York, NY: Garland Science.
3. Nelson, D. L., & Cox, M. M. (2017). *Lehninger principles of biochemistry* (7th ed.). New York, NY: W. H. Freeman and Company.
4. Guyton, A. C., & Hall, J. E. (2020). *Guyton and Hall textbook of medical physiology* (14th ed.). Philadelphia, PA: Elsevier.
5. Futuyma, D. J., & Kirkpatrick, M. (2017). *Evolution* (4th ed.). Sunderland, MA: Sinauer Associates.

II. ASSOCIATED CORE COURSE- MN A PR: ZOOLOGY PRACTICAL-MN A PR

Marks: Pr (ESE: 6Hrs) = 25	**Pass Marks: Pr (ESE) = 10**

(Credits: Practical-01) **30 Hours**

Instruction to Question Setter for

End Semester Examination (ESE):

There will be one Practical Examination of 6Hrs duration. Evaluation of Practical Examination will be as per the following guidelines:

Experiment	*= 05 marks*
Spotting (4 x 2.5)	*= 10 marks*
Practical Record	*= 05 marks*
Viva-voce	*= 05 marks*

Practical:

Unit I: Basics of the Animal Kingdom **(08 Lectures)**

1. Study of museum specimens/charts / models of the following representative groups:
    a. Protozoa (*Amoeba, Paramecium*)
    b. Porifera (*Sycon)*
    c. Coelenterata (*Hydra*)
    d. Platyhelminthes (*Fasciola*)
    e. Annelida (*Earthworm*)
    f. Arthropoda (*Periplaneta, palaemon*)
    g. Mollusca (*Pila, Unio*)
    h. Echinodermata (*Asterias*)
    i. Chordata (*Scoliodon, Labeo, Catla, Hyla, Bufo,Calotes, Naja, Columba, Myna, Bat, Funambulus*)

Unit II: Basics of Biochemistry, Cell, and Genetics **(08 Lectures)**

1. Demonstration of qualitative tests for carbohydrates, proteins, and lipids.
2. Observation of prokaryotic and eukaryotic cells under a microscope (bacteria/onion peel/cheek cells).
3. Study of permanent slides: mitosis (onion root tip) and meiosis (testis/ovary section).

Unit III: Basics of Animal Physiology **(07 Lectures)**

1. Study of digestive system of human (chart/model).
2. Study of circulatory system using chart/model (human heart).

Unit IV: Basics of Evolution and Behaviour **(07 Lectures)**

1. Comparative study of homologous and analogous organs (charts/specimens).
2. Case studies of innate vs. learned behavior (ant trails, bird nesting, conditioning experiment shown via video/model).

Reference Book:

1. Verma, P. S., & Agarwal, V. K. (2018). *Cell Biology, Genetics, Molecular Biology, Evolution and Ecology* (S. Chand Publishing).
2. Kotpal, R. L. (2020). *Modern Text Book of Zoology: Invertebrates & Vertebrates* (Rastogi Publications).
3. Khurana, A. (2017). *Practical Zoology (Invertebrate & Chordate)* (S. Chand Publishing).

MINOR COURSE-B

I. MINOR COURSE- MN B:
FUNDAMENTALS OF ZOOLOGY

Marks: 15 (15 SIE: 1Hr) + 60 (ESE: 3Hrs) = 75	**Pass Marks: Th (SIE + ESE) + Pr (ESE) = 40**

(Credits: Theory-03) **45 Hours**

Course Objectives:
After completion of the course, the learner will be able to:

1. Understand the basics of cell biology, physiology, genetics, evolution, and ecology

Course Learning Outcomes:

1. A general concept of the animal world
2. Awareness of students regarding biological mechanisms of various processes, functions as well evolutionary significance
3. Students will acquire knowledge about the cell in detail, along with the different organelles
4. Will understand their own body processes
5. Will get an idea about the origin of life and evolution

Course Content:

UNIT I: **(07 Lectures)**

Hierarchy of Classification of Animals, Difference between Systematic and Taxonomy and their role in the evolution.

UNIT II: **(13 Lectures)**

1. Cell- Structure, Cell Theory. Difference between Prokaryotic and Eukaryotic cells
2. An overview of various cell organelles, including the detailed structure of Mitochondria, Golgi body, Endoplasmic Reticulum, Nucleus, Ribosome and Lysosome

UNIT III: **(05 Lectures)**

A general introduction to human physiology- Digestive, Respiratory, Circulatory and Excretory system.

UNIT IV: **(05 Lectures)**

Basic structure of DNA and RNA, Types of DNA and RNA, Functions of DNA and RNA.

UNIT V: **(05 Lectures)**

Mendel's laws of Inheritance and variation. Crossing over and Linkage.

UNIT VI: **(03 Lectures)**

Evolution: Lamarck's Inheritance theory, Darwin's natural selection theory, Mutation theory.

UNIT VII: **(07 Lectures)**

General concept of Ecology, Ecosystem, and its various components – Food chain, Food web, Energy flow and Ecological pyramids

Reference book:

1. Modern text book of Zoology, Invertebrate: R.L Kotpal
2. Modern text book of Zoology: R.L Kotpal
3. Cell Biology: H.C Nigam, Vishal publication
4. Animal physiology: H.C Nigam
5. Evolution and Environmental Biology: H.C Nigam
6. Zoology for degree students: V.K Agarawal, S. Chand
7. Fundamentals of Ecology: E. P. Odem

II. MINOR COURSE- MN B PR:
ZOOLOGY PRACTICAL-B PR

Marks: Pr (ESE: 6Hrs) = 25	**Pass Marks: Pr (ESE) = 10**

(Credits: Practical-01) **30 Hours**

Instructions to Question Setter for
End Semester Examination (ESE):
There will be one Practical Examination of 6Hrs duration. Evaluation of Practical Examination will be as per the following guidelines:
Experiment = 15 marks
Practical record = 05 marks
Viva-voce = 05 marks

Practical:

1. Study of Permanent Slides: T.S. Mammalian liver, Pancreas, Kidney, Ovary, Testis; *Amoeba, Paramecium,*
2. Museum Specimens: *Sycon, Ascaris, Asterias, Calotes, Hyla, Columba, Chiroptera*
3. Homologous and Analogous organs

Reference Books:

1. Practical Zoology Invertebrate (Vol. 1, 2, and 3): S. S. Lal, Rastogi Publication

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MINOR COURSE-C

I. MINOR COURSE- MN C:
ANIMAL DIVERSITY

Marks: 15 (15 SIE: 1Hr) + 60 (ESE: 3Hrs) = 75	**Pass Marks: Th (SIE + ESE) + Pr (ESE) = 40**

(Credits: Theory-03) **45 Hours**

Course Objectives:

After completion of the course, the learner shall be able to understand:

1. Taxonomy and classification of the animal kingdom up to classes.

Course Learning Outcomes:

1. Develop understanding of the diversity of life about protista, non-chordates, and chordates
2. Grouping of animals based on their diagonostic characteristics.
3. Will be able to examine the evolutionary history of a taxon.

Course Content:

UNIT I: Kingdom Protista **(03 Lectures)**
General characters and classification up to classes; *Paramecium*

UNIT II: Phylum Porifera **(03 Lectures)**
General characters and classification up to classes; *Sycon*

UNIT III: Phylum Coelenterata **(03 Lectures)**
General characters and classification up to classes; Hydra

UNIT IV: Phylum Platyhelminthes **(03 Lectures)**
General characters and classification up to classes; *Taenia solium*

UNIT V: Phylum Nemathelminthes **(03 Lectures)**
General characters and classification up to classes; *Ascaris lumbricoides*

UNIT VI: Phylum Annelida **(03 Lectures)**
General characters and classification up to classes; Earthworm

UNIT VII: Phylum Arthropoda **(03 Lectures)**
General characters and classification up to classes; Vision in insects

UNIT VIII: Phylum Mollusca **(02 Lectures)**
General characters and classification up to classes; *Pila*

UNIT IX: Phylum Echinodermata **(03 Lectures)**
General characters and classification up to classes; *Asterias*

UNIT X: Protochordates **(02 Lectures)**
General features

UNIT XI: Agnatha **(01 Lectures)**
General features

UNIT XII: Pisces **(02 Lectures)**
General features and Classification up to sub-classes

UNIT XIII: Amphibia **(04 Lectures)**
General features and Classification up to sub-classes; Parental care

UNIT XIV: Reptiles **(04 Lectures)**
General features and Classification up to sub-classes; Poisonous and non-poisonous snakes

UNIT XV: Aves **(03 Lectures)**
General features and Classification up to sub-classes; Flight adaptations in birds

UNIT XVI: Mammals **(03 Lectures)**
Classification up to sub-classes, Marsupials

Reference Books:

1. Vertebrates and Invertebrates of S. Chand and Rastogi Publications
2. Invertebrates: A New Synthesis, III Edition, Blackwell Science
3. Young, J. Z. (2004). The Life of Vertebrates. III Edition. Oxford university press.
4. Pough H. Vertebrate life, VIII Edition, Pearson International.
5. Hall B.K. and Hallgrimsson B. (2008). Strickberger's Evolution. IV Edition. Jones and Bartlett Publishers Inc.
6. Pechnek, J.A.2000. Biology of Invertebrates. Tata McGraw-Hill Publishing Company.

II. MINOR COURSE- MN C PR:
ZOOLOGY PRACTICAL-C PR

Marks: Pr (ESE: 6Hrs) = 25	**Pass Marks: Pr (ESE) = 10**

(Credits: Practical-01) **30 Hours**

Instructions to Question Setter for
End Semester Examination (ESE):
There will be one Practical Examination of 6Hrs duration. Evaluation of Practical Examination will be as per the following guidelines:
Experiment = 15 marks
Practical record = 05 marks
Viva-voce = 05 marks

Practical:

Study of the following specimens:

1. *Amoeba, Euglena, Plasmodium, Paramecium, Sycon, Hyalonema, Euplectella, Obelia, Physalia, Aurelia, Tubipora, Metridium, Taenia solium, Male and female Ascaris lumbricoides, Aphrodite, Nereis, Pheretima, Hirudinaria, Palaemon, Cancer, Limulus, Palamnaeus, Scolopendra, Julus, Periplaneta, Apis, Chiton, Dentalium, Pila, Unio, Loligo, Sepia, Octopus, Pentaceros, Ophiura, Echinus, Cucumaria and Antedon, Balanoglossus, Herdmania, Branchiostoma, Petromyzon, Sphyrna, Pristis, Torpedo, Labeo, Exocoetus, Anguilla, Ichthyophis/Ureotyphlus, Salamandra, Bufo, Hyla, Chelone, Hemidactylus, Chamaeleon, Draco, Vipera, Naja, Crocodylus, Chiroptera and Funambulus.*
2. Any six common birds.

Study of the following permanent slides:

1. T.S. and L.S. of *Sycon*
2. Larval stages of *Taenia and Fasciola*
3. T.S. of Male and female *Ascaris*

Reference Books:

1. Invertebrate Practical: S. Lal
2. Vertebrate Practical: S. Lal
3. A manual of practical Zoology Invertebrate: Dr. P.S. Verma
4. An advanced laboratory manual of Zoology – T. Poddar, S. Mukhopadhyay, S.K. Das

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MINOR COURSE-D

I. MINOR COURSE- MN D:
FOOD NUTRITION AND HEALTH

Marks: 15 (15 SIE: 1Hr) + 60 (ESE: 3Hrs) = 75	**Pass Marks: Th (SIE + ESE) + Pr (ESE) = 40**

(Credits: Theory-03) **45 Hours**

Course Objectives:

After completion of the course, the learner will be able to understand:

1. Importance on nutrients on human health
2. Different malnutrition disorders and their cure

Course Learning Outcomes:

1. Will understand the role of food and nutrition in health, and disease
2. Implement strategies for food access, procurement, preparation, and Strategy.

Course Content:

UNIT I: Nutrition and dietary nutrients (10 Lectures)

1. Basic concept of Food: Components and nutrients.
2. Concept of balanced diet, nutrient requirements and dietary pattern for different groups viz., adults, pregnant and nursing mothers, infants, school children, adolescents and elderly people.

UNIT II: Macro nutrients and micronutrients (10 Lectures)

1. Nutritional Biochemistry: Macronutrients. Carbohydrates, Lipids, Proteins- Definition, Classification, their dietary source and role.
2. Micronutrients.
3. Vitamins- Water-soluble and Fat- soluble vitamins- their sources and importance.
4. Important minerals viz., Iron, Calcium, Phosphorus, Iodine, Selenium and Zinc: their biological functions.

UNIT III: Health and Diseases (15 Lectures)

1. Definition and concept of health: Common nutritional deficiency diseases- Protein Malnutrition (e.g., Kwashiorkor and Marasmus), Vitamin A deficiency, Iron deficiency and Iodine deficiency disorders- their symptoms, treatment, prevention and government initiatives, if any.
2. Lifestyle-dependent diseases- hypertension, diabetes mellitus, and obesity-their causes and prevention.
3. Social health problems- smoking, alcoholism, narcotics.
4. Acquired Immune Deficiency Syndrome (AIDS): causes, treatment and prevention.

UNIT IV: Diseases caused by microorganisms (10 Lectures)

1. Food hygiene: Potable water- sources and methods of purification at domestic level.
2. Food and Water-borne infections: Bacterial diseases: cholera, dysentery; typhoid fever, viral diseases: Hepatitis, Poliomyelitis, etc., Protozoan diseases: amoebiasis, giardiasis, Parasitic diseases: taeniasis and ascariasis their transmission, causative agent, sources of infection, symptoms and prevention.
3. Causes of food spoilage and its prevention.

Reference Books:

1. Mudambi, S.R. and Rajagopal, M.V. (2007). Fundamentals of Foods, Nutrition and Diet Therapy; Fifth Ed;; New Age International Publishers
2. Srilakshmi, B. (2002). Nutrition Science; New Age International (P) Ltd.
3. Srilakshmi, B. (2007). Food Science; Fourth Ed; New Age International (P) Ltd.
4. Swaminathan, M. (1986). Handbook of Foods and Nutrition; Fifth Ed; BAPPCO.
5. Bamji, M.S.; Rao, N.P. and Reddy, V. (2009). Text Book of Human Nutrition; Oxford & IBH
6. Publishing Co. Pvt Ltd.
7. Wardlaw, G.M. and Hampl, J.S. (2007). Perspectives in Nutrition; Seventh Ed; McGraw Hill.
8. Lakra, P. and Singh M.D. (2008). Textbook of Nutrition and Health; First Ed; Academic Excellence.
9. Manay, M.S. and Shadakshara swamy, M. (1998). Food-Facts and Principles; New Age International (P) Ltd.
10. Gibney, M.J. et al. (2004). Public Health Nutrition; Blackwell Publishing.

II. MINOR COURSE- MN D PR:
ZOOLOGY PRACTICAL-D PR

Marks: Pr (ESE: 6Hrs) = 25	**Pass Marks: Pr (ESE) = 10**

(Credits: Practical-01) **30 Hours**

Instructions to Question Setter for
End Semester Examination (ESE):
There will be one Practical Examination of 6 Hrs. duration. Evaluation of Practical Examination will be as per the following guidelines:

Experiment	*= 10 marks*
Project	*= 05 marks*
Practical record	*= 05 marks*
Viva-voce	*= 05 marks*

Practical:

1. Detecting adulteration in a) Ghee b) Sugars c) Tea leaves and d) Turmeric.
2. Estimation of Lactose in milk.
3. Project on common diseases of society

Reference Books:

1. Experimental Biology – A Laboratory Manual: Abhijit Dutta
2. Experiment on the practical control of stored Grain Insects with a Revolving Drum – Type – Heater: Andre Andant
3. Stored grain pests and their management: B.P. Khare.
4. Pests of stored grains and their management: M.C. Bhargava
5. Pest management in stored grain: S. Mohan
6. Text Book of Nutrition and Dietetics: Kumud Khanna
7. Public Health, Nutrition in developing countries: Sheila Chandar Vir

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MINOR COURSE-E

I. MINOR COURSE- MN E:
ENVIRONMENT & PUBLIC HEALTH

Marks: 15 (15 SIE: 1Hr) + 60 (ESE: 3Hrs) = 75	**Pass Marks: Th (SIE + ESE) + Pr (ESE) = 40**

(Credits: Theory-03) **45 Hours**

Course Objectives:
After completion of the course, the learner will be able to understand:
1. Environmental and health awareness.

Course Learning Outcomes:
After completing this course, the students will be able to:
1. Understand the fundamental issues of the environment.
2. Analyze different sources of environmental problems and methods of measuring pollution.
3. Examine the microbiology of wastewater

Course Content:

UNIT I: Introduction **(05 Lectures)**
Sources of Environmental hazards, hazard identification and accounting toxic and persistent substances in the environment.

UNIT II: Climate Change **(10 Lectures)**
Greenhouse gases and global warming, Acid rain, Ozone layer destruction, Effect of climate change on public health

UNIT III: Pollution **(10 Lectures)**
Air, Water, Noise pollution sources and effects, Pollution control

UNIT IV: Waste Management Technologies **(10 Lectures)**
Sources of waste, types and characteristics, Sewage disposal and its management, Solid waste disposal, Biomedical waste handling and disposal, Nuclear waste handling and disposal, waste from thermal power plants, Case histories on Bhopal gas tragedy, Chernobyl disaster, Seveso disaster and three-mile island accident and their aftermath.

UNIT V: Diseases **(10 Lectures)**
Causes, Symptoms, and control of Tuberculosis, Asthma, Cholera, Dengue, Typhoid, COVID, Celiac disease, Silicosis

Reference Books:

1. Fundamentals of Ecology, B. Mukherjee, Silver Line Publication
2. An Introduction to Environment Management, Anand S. Bal, Himalaya Publishing House
3. Cutter, S.L., Environmental Risk and Hazards, Prentice-Hall of India Pvt. Ltd. New Delhi, 1999.
4. Kolluru Rao, Bartell Steven, Pitblado R and Stricoff "Risk Assessment and Management Handbook", McGraw Hill Inc., New York, 1996.
5. Kofi Asante Duah "Risk Assessment in Environmental Management", Jhon Wiley and sons, Singapore, 1998.
6. Kasperson, J.X. and Kasperson, R.E., and Kasperson, R.E., Global Environmental Risks, V.N. Univ. Press, New York, 2003.
7. Joshep F Louvar and B Diane Louver Health and Environmental Risk Analysis Fundamentals with applications, Prentice Hall, New Jersey 1997.

II. MINOR COURSE- MN E PR:
ZOOLOGY PRACTICAL-E PR

Marks: Pr (ESE: 6Hrs) = 25	**Pass Marks: Pr (ESE) = 10**

(Credits: Practical-01) **30 Hours**

Instructions to Question Setter for
End Semester Examination (ESE):
There will be one Practical Examination of 6Hrs duration. Evaluation of Practical Examination will be as per the following guidelines:
Experiment = 15 marks
Practical record notebook = 05 marks
Viva-voce = 05 marks

Practical:

1. Air quality index of your city/town/village.
2. Water quality index.
3. City solid waste management survey.
4. City garbage management survey.
5. E-Disposal survey.
6. Energy survey of a house having a minimum four individuals.

Reference Books:

1. Practical methods for water and Air pollution monitoring: S.K. Bhargav
2. Environmental Engineering – Water quality Test: Dr. Subhas Thanappan
3. Water Analysis: W. Fresenius
4. Integrated Solid Waste Management: George Tchobanoglous

MINOR COURSE-F

I. MINOR COURSE- MN F:
HUMAN ANATOMY AND HISTOLOGY

Marks: 15 (15 SIE: 1Hr) + 60 (ESE: 3Hrs) = 75	**Pass Marks: Th (SIE + ESE) + Pr (ESE) = 40**

(Credits: Theory-03) **45 Hours**

Course Objective:
After completion of the course, the learner will be able to understand:

1. Provide an understanding of human anatomical organization and major organ systems.
2. Develop skills in identifying and interpreting normal human tissues through histological techniques.

Course Learning Outcomes:
At the end of the course, the students will be able to know their visceral organs and the tissues composing them.

Course Content:

UNIT I: Introduction to Human Anatomy & Histology **(05 Lectures)**
Definition, scope, and importance of anatomy and histology.
Levels of organization in the human body.

UNIT II: Integumentary & Skeletal Systems **(06 Lectures)**
Anatomy and histology of skin layers, appendages, axial and appendicular skeleton overview.

UNIT III: Muscular & Nervous Systems **(07 Lectures)**
Anatomy and histology of types of muscles, major muscle groups, neuromuscular junction, CNS & PNS.

UNIT IV: Circulatory & Lymphatic Systems **(07 Lectures)**
Anatomy and histology of heart, major blood vessels, blood flow pathways, lymph nodes and vessels.

UNIT V: Respiratory & Digestive Systems **(07 Lectures)**
Anatomy and histology of organs of the respiratory tract, lungs, and alveoli; digestive tract and accessory glands.

UNIT VI: Urinary & Reproductive Systems **(07 Lectures)**
Anatomy and histology of kidney, urinary tract; male and female reproductive organs.

UNIT VII: Endocrine System & Special Senses **(06 Lectures)**
Anatomy and histology of endocrine glands (pituitary, thyroid, adrenal, pancreas); structure of eye and ear.

Reference Books:

1. Gray's Anatomy
2. Atlas of human anatomy- Frank H. Netter
3. Textbook of human anatomy- Inderveer Singh
4. Young's human anatomy

II. MINOR COURSE- MN F PR:
ZOOLOGY PRACTICAL-F PR

Marks: Pr (ESE: 6Hrs) = 25	**Pass Marks: Pr (ESE) = 10**

(Credits: Practical-01) **30 Hours**

Instructions to Question Setter for
End Semester Examination (ESE):
There will be one Practical Examination of 6Hrs duration. Evaluation of Practical Examination will be as per the following guidelines:
Experiment = 15 marks
Practical record notebook = 05 marks
Viva-voce = 05 marks

Practical:

1. Chart of anatomy of the alimentary canal, Heart, and kidney
2. Study of permanent slides of T.S. of Stomach, Duodenum, Large intestine, Liver, Pancreas, Spleen, Lung, kidney, Pituitary, Thyroid, Adrenal, Testes, and Ovary

Reference Books:

1. Practical human anatomy- B.K. Young
2. A manual of practical anatomy- D.J. Chourasia

MINOR COURSE-G

I. MINOR COURSE- MN G:
COMPARATIVE PHYSIOLOGY

Marks: 15 (15 SIE: 1Hr) + 60 (ESE: 3Hrs) = 75	**Pass Marks: Th (SIE + ESE) + Pr (ESE) = 40**

(Credits: Theory-03) **45 Hours**

Course Objective:
This course is designed to provide students with an understanding of physiological systems among different animal taxa emphasizing evolutionary adaptations and functional mechanisms.

Course Learning Outcomes:
At the end of the course, the students will be able to understand the mechanism of human physiological activities.

Course Content:

UNIT I: Mechanism of digestion in different vertebrate classes, viz. Frog, Pigeon, and Human **(12 Lectures)**

UNIT II: Mechanism of respiration along with gaseous exchange- Frog, Pigeon, and Human **(13 Lectures)**

UNIT III: Basic mechanism of excretion in different animals- Fish, Pigeon, and Human **(10 Lectures)**

UNIT IV: Reproduction and the process of spermatogenesis and oogenesis **(10 Lectures)**

Reference Books:

1. Animal physiology and Biochemistry – R Naga Bhushanam and M.S Podarkar
2. Animal physiology- A.K Berry
3. Comparative Animal physiology- P. S Verma, Tyagi and Agarwal

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II. MINOR COURSE- MN G PR:
ZOOLOGY PRACTICAL-G PR

Marks: Pr (ESE: 6Hrs) = 25	**Pass Marks: Pr (ESE) = 10**

(Credits: Practical-01) **30 Hours**

Instructions to Question Setter for
End Semester Examination (ESE):
There will be one Practical Examination of 6Hrs duration. Evaluation of Practical Examination will be as per the following guidelines:
Experiment = 15 marks
Practical record notebook = 05 marks
Viva-voce = 05 marks

Practical:

1. Types of kidney : Pro-, Meso- and Metanephric kidney (Chart/Model)
2. Air sacs of pigeon (Chart)
3. Permanent slides : TS of Liver, Kidney, Pancreas, Intestine, Ovary, Testes

Reference Books:

1. Animal anatomy and physiology laboratory manual- A.K Berry and R. S Bhatiya
2. Practical Zoology Manual- D. K. Belsare
3. Laboratory manual on Animal physiology and Biochemistry- P. Ramamurti and K Mani

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