KANNUR UNIVERSITY

BOARD OF STUDIES IN ZOOLOGY

FOUR-YEAR UNDER-GRADUATE PROGRAMME (KU-FYUGP)

ZOOLOGY - HONOURS/ RESEARCH

SYLLABUS FOR UNDER GRADUATE COURSES

Implemented from Academic Session 2024-2028

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11. Dr. Mumthaz T M V, Assistant Professor, Sir Syed College, Taliparamba

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Introduction

The Kerala Higher Education Reforms Commission has taken a significant step towards uplifting the standard of undergraduate education in the state. The introduction of 4-year undergraduate programs, with a flexible choice-based credit system and multidisciplinary approach, is a bold move to align Kerala's education system with renowned Universities worldwide. The three pathways of 3-year UG Degree, 4-year UG Degree (Honours), and 4-year UG Degree (Honours with Research) offer students multiple entry and exit options, providing them with a well-rounded learning experience. This curriculum is a result of the continuous efforts to improve the existing system and make it more relevant to the current global scenario, ensuring the students' competitiveness and employability. The incorporation of various courses, such as Discipline Specific, Multidisciplinary, Value enhancement, and Skill Enhancement, truly showcases the Commission's determination to provide a comprehensive and impactful education to the students of Kerala.

Contemporary animal science represents a synergistic blend of classical zoology with cutting-edge fields like biochemistry, molecular biology, biotechnology, and bioinformatics. This interdisciplinary approach has propelled zoology into an era of unprecedented growth, both in knowledge and practical application, powered by intensive research. Field biologists' dedication to conservation has unveiled new perspectives on animal diversity, further enriching zoological knowledge and efforts towards preservation.

In response to these evolutionary strides, Kannur University has crafted a revised undergraduate curriculum that adheres to the University Grants Commission's standards and embraces the Kerala State Undergraduate Curriculum Framework. This curriculum offers students a well-rounded education that encompasses the full gamut of animal science. Subjects such as animal diversity, physiology, biochemistry, molecular biology, genetics, anatomy, ecology, economic zoology, and wildlife biology are thoughtfully integrated, and the curriculum is constructed to reflect their importance equally across the eight semesters.

This comprehensive program not only equips students with theoretical knowledge but also emphasizes practical skills and techniques pertinent to the current and future landscape of zoological sciences. By incorporating applied courses tailored to foster hands-on experience and professional development, the curriculum also aims to enhance students' employability and entrepreneurial skills. Overall, the curriculum provides a robust foundation of information, complemented by a suite of enriching educational resources, setting the stage for graduates to navigate and contribute effectively to the evolving field of zoology.

Graduate Attributes

Kannur University is fundamentally dedicated to nurturing well-rounded individuals with a comprehensive set of graduate attributes. Graduates from Kannur University emerge equipped with a multidisciplinary approach, allowing them to integrate knowledge across various domains for a holistic understanding of complex issues. With a strong emphasis on critical thinking and effective problem-solving skills, Kannur University's graduates demonstrate intellectual curiosity and the ability to tackle challenges creatively. Proficient in communication and social interaction, they engage adeptly in diverse settings, fostering Kannur University FYUGP – Regulations and Curriculum Framework - 2024 collaboration and effective interpersonal connections. Moreover, the graduates embody effective citizenship and leadership, showcasing a sense of responsibility, community engagement, and leadership qualities. With a global perspective, ethical grounding, and a commitment to environmental sustainability, our students are well-prepared for active participation in an interconnected world. Embracing self-directed and lifelong learning, they continually adapt to evolving challenges, embodying the university's commitment to producing resilient, knowledgeable, and socially responsible individuals.

Program Outcomes (POs):

Program Outcomes (POs) serve as a foundational framework defining the skills, knowledge, and attributes that students at Kannur University are expected to acquire upon completion of a specific academic program. Tailored to the unique goals of each program, POs articulate the overarching learning objectives that guide curriculum design and assessment. These outcomes encompass a diverse range of competencies, including critical thinking, problem-solving, effective communication, and discipline-specific expertise. POs play a crucial role in shaping educational experiences, ensuring alignment with academic standards and industry expectations. By articulating clear and measurable expectations, POs contribute to the continuous improvement of academic programs and provide a roadmap for students to develop into well-rounded, competent professionals within their chosen fields.

PO1: Critical Thinking and Problem-Solving-Apply critical thinking skills to analyze information and develop effective problem-solving strategies for tackling complex challenges.

PO2: Effective Communication and Social Interaction-Proficiently express ideas and engage in collaborative practices, fostering effective interpersonal connections.

PO3: Holistic Understanding-Demonstrate a multidisciplinary approach by integrating knowledge across various domains for a comprehensive understanding of complex issues.

PO4: Citizenship and Leadership-Exhibit a sense of responsibility, actively contribute to the community, and showcase leadership qualities to shape a just and inclusive society.

PO5: Global Perspective-Develop a broad awareness of global issues and an understanding of diverse perspectives, preparing for active participation in a globalized world.

PO6: Ethics, Integrity and Environmental Sustainability-Uphold high ethical standards in academic and professional endeavors, demonstrating integrity and ethical decision-making. Also acquire an understanding of environmental issues and sustainable practices, promoting responsibility towards ecological well-being.

PO7: Lifelong Learning and Adaptability-Cultivate a commitment to continuous self-directed learning, adapting to evolving challenges, and acquiring knowledge throughout life.

Programme Specific Outcome (PSOs) of FYUGP Zoology:

PSO1: Appreciate animal diversity and contribute towards their conservation.

PSO2: Apply knowledge of animal morphology, systematics, and evolution to identify and classify species.

PSO3: Analyze and interpret different types of biological data.

PSO4: Understand biomolecular interactions and apply the knowledge to comprehend animal biology.

PSO5: Recommend measures for wellbeing of animals using available biological information

Highlights of Regulations of FYUGP

Programme Overview:

The proposed KU-FYUGP curriculum shall comprise Three Broad Parts:

a) Foundation Components, b) Discipline Specific Pathway components(Major/Minor), and c) Discipline Specific Capstone Components.

- The Foundation component of the KU-FYUGP shall consist of a set of general courses and a set of discipline-specific courses.
- General Foundation Courses shall be common for all students and shall be:
  Grouped into 4 major baskets as Ability Enhancement Courses(AEC), Skill Enhancement Courses(SEC), Value Addition Courses(VAC) and Multi-disciplinary Courses(MDC).

- Discipline-Specific Courses shall include Discipline-Specific Pathway Courses, both Major and Minor streams, enabling students to gain basic knowledge in the chosen discipline.
- FYUGP shall have three Broad Pathways, (a) 3-year UG Degree, (b) 4-year UG Degree (Honours) and (c) 4-year UG Degree (Honours with Research).
- The practice of lateral entry of students to various years exists, but an exit with a Degree shall be awarded only upon successful completion of the third year.
- Students who choose to exit after 3 years shall be awarded UG Degree in their respective Major Discipline after the successful completion of the required minimum of courses of 133 credits.
- A four-year UG Honours Degree with Research in the Major Discipline shall be awarded to those who complete the FYUGP with a specific number of Courses of 177 credits including 12 credits from a graduate project /dissertation in their major discipline. Students who aspire to pursue research as a career may opt for Honours with research stream in the fourth year.
- A 4-year UG Honours Degree in the Discipline/ Disciplines shall be awarded to those who complete the FYUGP with a specific number of Courses with 177 credits including an optional graduate project/ dissertation of 8 credits in their major discipline.
- The students at the end of second semester may be permitted to change their major programme of study. Based on the availability of seats and infrastructure facilities the students may be permitted to opt any discipline which he/she had studied during the first two semesters as discipline specific foundation course/multidisciplinary foundation course. If the student switches his/her major to a discipline in which an MDC has been done he/she will have to do additional DSC courses in new discipline to acquire the required minimum credits.

Credit Structure:

- One hour of lecture or tutorial or a minimum of two hours of lab work, practical work, or field work per week is given one credit.
- One credit in a semester should be designed for 15 hours of lectures or tutorials or 30 hours of practicum plus 30 hours of learner engagement in terms of course-related activities such as seminar preparation, submitting assignments, etc.

- A one-credit seminar or internship or studio activities or field practice/projects or Community engagement and service means two-hour engagements per week (30 hours of engagement per semester)
- All Discipline Specific Major/ Minor Courses shall be of 4 credits.
- For all Discipline Specific Major/ Minor Courses, there may be practical/ practicum of two or four hours per week.
- All Courses under the Multi-Disciplinary, Ability Enhancement, Value Addition and Skill Enhancement categories are of 3 credits.
- A student shall have the option of acquiring extra credits to a maximum of 240 credits for a 4-year (8-semester) UG program.
- A student shall have the option of acquiring extra credits to a maximum of 180 credits for a 6-semester UG program.

Course structure of the FYUG Degree Programmes:

- Major components consist of three types: Discipline Specific Core, Discipline Specific Elective Courses, and the research/laboratory/ fieldwork.
- All students shall undergo a Field Trip/Summer Internship/ Apprenticeship in a Firm, Industry or Organization; or Training in labs with faculty and researchers or other Higher Education Institutions (HEIs) or research institutions.
- Options shall be made available for students to earn credit by completing quality assured remote learning modes, including online programmes offered on the Study Webs of Active Learning for Young Aspiring Minds (SWAYAM) or other online educational platform approved by the board of studies from time to time.
- Students can earn a maximum of 12 credits through online courses.

Eligibility for Admission

- The eligibility for admissions and reservation of seats for various KU-FYUGP shall be by the norms /rules made by the Government/ University from time to time.
- No student shall be eligible for admission to KU-FYUGP in any of the disciplines unless he/she has completed the examination conducted by a Board/University at the +2 level of schooling or its equivalent.

Assessment and Evaluation

- There shall be Theory and Practical examinations at the end of each semester, ordinarily during October for odd semesters and during March for even semesters, as prescribed in the Scheme of Examinations.

Mark Distribution for Discipline Specific Pathway Courses and General Foundation Courses

Course	Credit		Mark		L		P		
	L	P	L	P	CCA (30%)	ESE (70%)	CCA (40%)	ESE (60%)	Total marks
4 Credit	4	0	100	0	30	70	0	0	100
	3	1	75	25	25	50	10	15	100
	2	2	50	50	15	35	20	30	100
	1	3	25	75	10	15	30	45	100
	0	4	0	100	0	0	40	60	100
	Credit		Mark		L		P		
	L	P	L	P	CCA (30%)	ESE (70%)	CCA (60%)	ESE (40%)	Total marks
3 Credit	3	0	75	0	25	50	0	0	75
	2	1	50	25	15	35	15	10	75
	1	2	25	50	10	15	30	20	75
	0	3	0	75	0	0	45	30	75

L – Lecture/Theory, P – Practical/Practicum components, CCA – Continuous Comprehensive Assessment, ESE – End Semester Evaluation

As per the regulation of Kannur University, one credit corresponds to 25 marks. Hence a 3-credit course must be evaluated for 75 marks and 4 credit courses for 100 marks. The ratio of continuous comprehensive assessment (CCA) to End semester examination (ESE) for theory/lecture courses is 30:70 and for the practical courses, it is 40:60. Therefore the mark distribution for various courses of different credits can be distributed as follows.

Evaluation of Internship

As per the KU -FYUGP regulation, a student shall do an internship of 2 credits by the end of the sixth semester. Since one credit corresponds to 25 marks, the internship shall be evaluated for 50 marks.

The evaluation of internship shall be done by a committee constituted by the Department Council. The scheme of CCA and ESE is given below:

Components of Evaluation of Internship	Weightage	Marks for Internship 2 Credit/50 Marks
Continuous Comprehensive Assessment (CCA)	30%	15
End Semester Evaluation	70%	35

Evaluation of Project

As per the KU -FYUGP regulation, a student pursuing UG Honours with research shall do a mandatory research project of 12 credits by the end of the eighth semester. For UG Honours students, the project is optional. Since one credit corresponds to 25 marks, the 12 credit project shall be evaluated for 300 marks. The scheme of evaluation of the Project is given below:

Project type	Maximum Marks	CCA (30%)	ESE (70%)
Research Project of 12 Credits (UG Honours with research, mandatory)	300	90	210
Research Project of 8 Credits (UG Honours, optional)	200	60	140

- The end-semester practical examination and viva-voce, and the evaluation of practical records shall be conducted by the course in-charge and an internal examiner appointed by the Department Council.

Grading

- Mark system is followed for evaluating each question. For each course in the semester letter grade and grade point are introduced in 10-point indirect grading system

Sl. No	Percentage of Marks (ESE and CCA put together)	Description	Letter Grade	Grade Point (P)	Range of Grade Points
1	95% and above	Outstanding	O	10	9.50 - 10
2	Above 85% and below 95 %	Excellent	A+	9	8.50 – 9.49
3	Above 75% to below 85%	Very Good	A	8	7.50 – 8.49
4	Above 65% to below 75%	Good	B+	7	6.50 – 7.49
5	Above 55% to below 65%	Above Average	B	6	5.50 – 6.49
6	Above 45% to below 55%	Average	C	5	4.50 – 5.49
7	Above 35% to below 45% (CCA and ESE put together) with a minimum of 30% in ESE.	Pass	P	4	3.50 – 4.49
8	Below an aggregate of 35% or below 30% in ESE	Fail	F	0	0 – 3.49
9	Not attending the examination	Absent	Ab	0	0

General Regulations for FYUGP Zoology Programme

- **Semester wise Credit distribution of General Foundation Courses**

Sl. No.	Name of the General Foundation Course	No. of Courses	Required Credits	Distribution among Semesters and Disciplines in KU-FYUGP	
1	Ability Enhancement Course (AEC)	4	12	Sem I	AEC1
					AEC2
				Sem II	AEC3
					AEC4
2	Multi-Disciplinary Course (MDC)	3	9	Sem I	MDC1
				Sem II	MDC2
				Sem III	MDC3 (KS)
3	Value-Added Course (VAC)	3	9	Sem III	VAC1
				Sem IV	VAC2, VAC 3
4	Skill Enhancement Course (SEC)	3	9	Sem IV	SEC1
				Sem V	SEC2
				Sem VI	SEC3
	Total in the first three years of KU-FYUGP	13	39		

- **Consolidated List of Courses and Credits in KU-FYUGP**

Sl. No.	Categorization of Courses for all programmes	3-year UG		4-year UG	
		Minimum number of Courses required	Minimum number of Credits required	Minimum numberof Courses required	Minimum number of Credits required
1.	Major	17	68	22	88
2.	Minor (for those with Minor pathway)	6	24	8	32
3.	Multi-disciplinary Courses (MDC)	3	9	3	9
4.	Skill Enhancement Courses (SEC)	3	9	3	9

5.	Ability Enhancement Courses (AEC)	4	12	4	12
6.	Value Added Courses (VAC)	3	9	3	9
7.	Internship	-	2	-	2
8.	Research Project	-	-	-	12
	or				
	Optional Project + One	-	-	(1)	(8 + 4)
	Major Course				
	or	-	-	3	(12)
	Three Major Courses				
	instead of Optional				
	Project				
9	An Additional Course in Major / Minor / any other discipline	-	-	1	4
	Total	36	133	47	177

- **Minimum Credit Requirements of the Different Pathways in Three-Year Programme in KU-FYUGP**

Sl. No.	Academic Pathway	Major (17 Courses)	Minor/ Other Disciplines (6 Courses)	Foundation Courses AEC: 4 MDC: 3 SEC: 3 VAC: 3	Internship	Total Credits
		Each course has 4 credits		Each course has 3 credits		
1	Single Major (A)	68	24	39	2	133
2	Major(A) with Multiple Disciplines (B, C)	68	12 + 12	39	2	133
3	Major (A) with Minor (B)	68	24	39	2	133
4	Major (A) withVocationalMinor (B)	68	24	39	2	133

5	Double Major (A1, A2)	A1: 48 A2: 44	-	12 + 18 + 9	2	133
			The 24 credits in the Minor stream are distributed between the two Majors. Overall, 40% of credits to be earned in the second major.			

- **Credit requirement for Discipline-Specific Coursesin the Fourth Year of KU-FYUGP**

Semester	**Nature of the Discipline-Specific Course**	**No. of Courses**	**Required Credits**
VII	Five PG level courses (level 400 & above) in the Major Discipline	5	20
VIII	• Three PG level courses (level 400 & above) in the Major discipline (for Honours); or • One Major course of level 400 & above + One 8-credit Project in the Major discipline (for Honours); or (iii) One 12-credit Research Project in the Major discipline (for Honours with Research) • In the case of Honours students who go to another Institution for doing the Project, the remaining Major course can be in the online mode or in the in-person mode from the institution where the Project is being done.	3	12
	• Three Minor Pathway Courses of level 300 & above / level 400 & above. or • Three courses in Major discipline of level 400 & above. or • Two courses in Minor discipline + One course in Major / any other discipline. or • Three courses in any other discipline of level 300 & above / level 400 & above. or • Two courses in Major / Minor / any other discipline + One course in research methodology • Two of these courses can be in the online mode. These online courses can be taken either in semester VII or in semester VIII, but their credits shall be added to the student's account only in semester VIII. • For those students who go to another institution for doing the Project, all these three courses can be in the	3	12

	online mode or in the in-person mode from the institution where the Project is being done.		
	Total in the fourth year of KU-FYUGP	11	44

- **Evaluation**

The evaluation of each course shall contain two parts:

(i) Internal Assessment

(ii) External Assessment

For 3 + 1 credit courses:

Evaluation Type		**Marks**	
		Theory	**Practical**
• End Semester Evaluation		50	15
• Continuous Evaluation		25	10
Continuous Evaluation			
Theory/Practical	Method of Assessment	Marks	
Theory			
a)	Test paper I	5	
b)	Test paper II	5	
c)	Viva-Voce/Seminar/ Discussion	10	
d)	Assignment	5	
		Total – 25 marks	
Practical			
a)	Regularity/Punctuality	5	
b)	Laboratory skill	5	
		Total – 10 marks	

For 4 credit courses:

Evaluation Type		Marks
• End Semester Evaluation		70
• Continuous Evaluation		30
Continuous Evaluation		
Theory	Method of Assessment	Marks
a)	Test paper I	6
b)	Test paper II	6
c)	Viva-Voce	6
d)	Assignment	6
e)	Seminar	6
	Total – 30 marks	

For 3 credit courses:

Evaluation Type		Marks
• End Semester Evaluation		50
• Continuous Evaluation		25
Continuous Evaluation		
Theory	Method of Assessment	Marks
a)	Test paper I	5
b)	Test paper II	5
c)	Viva-Voce	5
d)	Assignment	5
e)	Seminar	5
	Total – 25 marks	

The external theory examination of all odd semesters will be conducted by the college itself and the even semesters by the University at the end of each semester.

The end-semester practical examination, viva-voce and the evaluation of practical records shall be conducted by the course in-charge and an internal examiner appointed by the Department Council.

Scheme of Practical Examinations

Time: 2.5 Hours

Total Marks: 45

Major dissection with display/ Major experiment with principle and procedure: 20 marks

Minor dissection/Mounting (with or without sketch)/ Minor Experiment: 10 marks

Record: 5 marks

Viva-Voce: 10 marks

- **Field Trip/Summer Internship/Apprenticeship**

A field study trip of not less than 7 days is compulsory during the V or VI semester of the programme. During the study tour, students are expected to visit places of biological importance and research institutes. A detailed report certified by the teacher in charge of study trip and also by the Head of the Department, regarding the field trip specifying the places and institutions visited, date and time of visit, details of observations made etc. must be submitted by each student for evaluation at the end of VI semester.

Summer Internship/Apprenticeship can be done in a Firm, Industry or Organization; or Training in labs with faculty and researchers or other Higher Education Institutions (HEIs) or research institutions.

The undergraduate internships/apprenticeship would be classified into two types:

- for enhancing the employability
- for developing the research aptitude.

Internship/apprenticeship would involve a student from a HEI and he/she would be attached to an internship supervisor (IS), and mentor preferably from the same HEI for a specified duration and conduct a time-bound internship project. The HEI (parent Institute) and the Internship Providing Organization (IPO) would play important roles in facilitating the smooth conduct of the internship.

The internship/apprenticeship can be linked to the outcomes of value-added /skill development /ability enhancement courses.

For an internship/apprenticeship, two credit of Internship/apprenticeship means four-hour engagement per week. Accordingly, in a semester of 15 weeks' duration, two credit in this course is equivalent to 60 hours of engagement in a semester.

The student may undergo an internship/apprenticeship in the supervisor's lab/ working space at the host organization. During the period of internship/apprenticeship, the parent HEI through the internship/apprenticeship supervisor and mentor, will arrange to keep track of the activities and performance of students as interns at the host organization, based on periodic reports submitted by students.

On completion of Internship/apprenticeship, intern/apprentice will prepare a report and get it endorsed by mentor.

- **Records**

A record is compulsory for each practical course. The records are intended as observation records to be done in the lab itself. Artistic sketches are not expected, except where scientific diagrams are required as per the syllabi. The valuation of records, to be done internally, should be based on the effort and promptness of the student in lab work.

- **Capstone Project of 8 and 12 Credits for B.Sc. Zoology – Honours/Research**

A student pursuing UG Honours with research shall do a mandatory research project of 12 credits by the end of the eighth semester. For UG Honours students, the 8 credit project is optional. Upon completion of the project the student is supposed to submit a thesis demonstrating her/his findings. This thesis should essentially deliver a new body of knowledge to the field of study and should demonstrate the student's mastery on the subject. The thesis should clearly 1) define the problem and propose a hypothesis, 2) review the current state of knowledge related to the topic of study, 3) have a clear materials and methods section, 4) a results section and finally the student should 5) discuss her/his findings. The results sections should have tables and figures demonstrating the results (figures should be original ones and not copied from other sources, eg: images of animals from the internet). The thesis should also have an analysis part where the student analyses the results with standard statistical tools. Students should prepare a presentation of not less than 20 slides (not more than 20 minutes long) and demonstrate the findings in front of a public audience. The thesis should be devoid of plagiarism and should have a certificate from competent authorities of the University attached with it.

Sections of the thesis:

1) Introduction - a) introduce the work, b) define the problem and c) propose a hypothesis.

2) Review of literature - review the current state of knowledge related to the topic of study (International, National and local knowledge should be assessed).

3) Materials and methods - have a clear materials and methods section, so that a future researcher

can replicate the experiment.

4) Results - a results section (with tables, figures, graphs etc.)

5) Discussion - discuss her/his findings.

6) Reference - a reference section where all sources cited in the work are listed in alphabetical order (any convenient style of referencing could be used by the student).

A thesis without a certificate of "no plagiarism" will not be evaluated.

Students should preferably use open-source or free software for their thesis, in case this is not possible ensure that the license number of proprietary software (word processor, statistical package and image editor) should be provided in the thesis.

EVALUATION CRITERIA

PROJECT EVALUATION

Project with 12 Credits (300 marks)

1. Internal Evaluation (90 marks)		
i)	Initiative and Independence	15 Marks
ii)	Technical Skill	15 Marks
iii)	Communication Skills	15 Marks
Iv	Professionalism	15 Marks
v)	Presentation	30 Marks
If the student is doing the project in an external Institution, the internal marks may also be obtained from the Project Supervisor		
2. Final Evaluation (210 Marks)		
i)	Abstract	10 Marks
ii)	Novelty of the work	15 Marks
iii)	Experimental/Project Design	30 Marks
iv)	Literature Survey	20 Marks
v)	Results and Discussion	50 Marks
vi)	Presentation/Open Defence	60 Marks
vii)	Viva – voce	25 Marks

Project with 8 Credits (200 marks)

1. Internal Evaluation (60 marks)		
i)	Initiative and Independence	10 Marks
ii)	Technical Skill	10 Marks
iii)	Communication Skills	10 Marks
Iv	Professionalism	10 Marks
v)	Presentation	20 Marks
If the student is doing the project in an external Institution, the internal marks may also be obtained from the Project Supervisor		
2. Final Evaluation (140 Marks)		
i)	Abstract	5 Marks
ii)	Novelty of the work	5 Marks
iii)	Experimental/Project Design	25 Marks
iv)	Literature Survey	10 Marks
v)	Results and Discussion	40 Marks
vi)	Presentation/Open Defence	40 Marks
vii)	Viva – voce	15 Marks

Instruction to Question Setter

End Semester Examination for Theory

- **(ESE 70 marks): for 4 Credit Courses**

  There will be four group of questions. Questions in Section I is compulsory which will contain eight multiple choice questions, each with 0.5 mark. Questions in Section II will be very short answer type consisting of eleven questions of 2 mark each, out of which any nine to answer. Questions in Section III will be paragraph answer type of 4 marks. Out of ten questions, any eight are to answer. Questions in Section IV will contain three descriptive essay type questions of eight marks each, out of which any two are to answer.

- **(ESE 50 marks): for 3+1 and 3 Credit Courses**

  There will be four group of questions. Questions in Section I is compulsory which will contain eight multiple choice questions, each with 0.5 mark. Questions in Section II will be very short answer type consisting of nine questions of 2 mark each, out of which any seven to answer. Questions in section III will be paragraph answer type of 4 marks. Out of eight questions, any six are to answer. Questions in Section IV will contain descriptive essay type three questions of eight marks each, out of which any one to answer.

Format of Question Paper for End Semester Examination

Question format for **70 Marks**

Time: 2 Hours	Maximum Marks: 70
Section I **MCQ, answer all.** 1. .... 2. .... 3. .... 4. .... 5. .... 6. .... 7. .... 8.	(8x0.5=4)
Section II **Answer in a sentence or two, answer any nine.** 9. .... 10. .... 11. .... 12. .... 13. .... 14. .... 15. .... 16. .... 17. .... 18. .... 19.	(9x2=18)
Section III **Short answer type, answer any eight.** 20. .... 21. .... 22. .... 23. .... 24. .... 25. .... 26. .... 27. .... 28. .... 29.	(8x4=32)
Section IV **Short essay type, answer any two.** 30. .... 31. .... 32.	(2x8=16)

Format of Question Paper for End Semester Examination

Question format for **50 Marks**

Time: 1.5 Hours	**Maximum Marks: 50**
Section I **MCQ, answer all.** 1. .... 2. .... 3. .... 4. .... 5. .... 6. .... 7. .... 8.	(8x0.5=4)
Section II **Answer in a sentence or two, answer any seven.** 9. .... 10. .... 11. .... 12. .... 13. .... 14. .... 15. .... 16. .... 17.	(7x2=14)
Section III **Short answer type, answer any six.** 18. .... 19. .... 20. .... 21. .... 22. .... 23. .... 24. .... 25.	(6x4=24)
Section IV **Short essay type, answer any one.** 26. .... 27. .... 28.	(1x8=8)

Credit Framework for FYUGP - Zoology

SEMESTER I

No	Title	Hours/ week	Credit	CE	ESE	Total marks
1	AEC 1 (English)	3	3	25	50	75
2	AEC 2 (Additional Language)	3	3	25	50	75
3	MDC 1	3	3	25	50	75
4	DSC A1 (Major)	5	4	25	75	100
5	DSC B1 (Minor 1)	4	4	30	70	100
6	DSC C1 (Minor 2)	4	4	30	70	100
	Total credits		21			

SEMESTER II

No	Title	Hours/week	Credit	CE	ESE	Total marks
1	AEC 3 (English)	3	3	25	50	75
2	AEC 4 (Additional Language)	3	3	25	50	75
3	MDC 2	3	3	25	50	75
4	DSC A2 (Major)	5	4	25	75	100
5	DSC B2 (Minor 1)	4	4	30	70	100
6	DSC C2 (Minor 2)	4	4	30	70	100
	Total credits		21			

SEMESTER III

No	Title	Hours/week	Credit	CE	ESE	Total marks
1	MDC 3	3	3	25	50	75
2	VAC 1	3	3	25	50	75
3	DSC A 3 (Major)	5	4	25	75	100
4	DSC A 4 (Major)	4	4	30	70	100
5	DSC B 3 (Minor 1)	4	4	30	70	100
6	DSC C 3 (Minor 2)	4	4	30	70	100
	Total credits		22			

SEMESTER IV

No	Title	Hours/week	Credit	CE	ESE	Total marks
1	SEC 1	3	3	25	50	75
2	VAC 2	3	3	25	50	75
3	VAC 3	3	3	25	50	75
4	DSC A5 (Major)	5	4	25	75	100
5	DSC A6 (Major)	5	4	25	75	100
6	DSC A7 (Major)	5	4	25	75	100
	Total credits		21			

SEMESTER V

No	Title	Hours/ week	Credit	CE	ESE	Total marks
1	SEC 2	3	3	25	50	75
2	DSC A8 (Major)	5	4	25	75	100
3	DSC A9 (Major)	5	4	25	75	100
4	DSC A10 (Major)	4	4	30	70	100
5	DSE 11 (Elective)	4	4	30	70	100
6	DSE 12 (Elective)	4	4	30	70	100
	Total credits		23			

SEMESTER VI

No	Title	Hours/week	Credit	CE	ESE	Total marks
1	SEC 3	3	3	25	50	75
2	DSC A13 (Major)	5	4	25	75	100
3	DSC A14 (Major)	4	4	30	70	100
4	DSC A15 (Major)	5	4	25	75	100
5	DSE 16 (Elective)	4	4	30	70	100
6	DSE 17 (Elective)	4	4	30	70	100
7	INTERNSHIP	2	2			
	Total credits		25			
EXIT WITH UG DEGREE/PROCEED TO FOURTH YEAR WITH 133 CREDITS						

SEMESTER VII

No	Title	Hours/ week	Credit	CE	ESE	Total marks
1	DSC A18 (Major)	5	4	25	75	100
2	DSC A19 (Major)	5	4	25	75	100
3	DSC A20 (Major)	5	4	25	75	100
4	DSC A21 (Major)	5	4	25	75	100
5	DSC A22 (Major)	5	4	25	75	100
	Total credits		20			

SEMESTER VIII

No	Title	Hours/week	Credit	CE	ESE	Total marks
Honours with Research Pathway						
1	DSC A23 (Major)	4	4	30	70	100
2	DSC A24 (Major)	5	4	25	75	100
3	DSC A25 (Major)	4	4	30	70	100
	OR					
1	DSE (Elective)	4	4	30	70	100
2	DSE (Elective)	4	4	30	70	100
3	DSE (Elective)	4	4	30	70	100
	AND					
4	PROJECT		12	90	210	300
Honours Pathway						
1	DSC A23 (Major)	4	4	30	70	100
2	DSC A24(Major)	5	4	25	75	100
3	DSC A25 (Major)	4	4	30	70	100
4	DSE (Elective)	4	4	30	70	100
5	DSE (Elective)	4	4	30	70	100
6	DSE (Elective)	4	4	30	70	100
	OR					
1	DSC A23(Major)	4	4	30	70	100
2	DSC A24 (Major)	5	4	25	75	100
3	DSC A25(Major)	4	4	30	70	100
4	DSE (Elective)	4	4	30	70	100
	AND					
5	PROJECT		8	60	140	200
	Total credits		24			
EXIT WITH HONOURS/RESEARCH UG DEGREE WITH 177 CREDITS						

Course Structure for FYUGP, Zoology 'Honours / Research'

* Modified course code: XXSAAABBB000

where XX represent the Kannur University code (KU), S represent the semester number (Eg.1 for Sem1, 2 for Sem 2 etc.), AAA represents the course category (Eg. DSC represent Discipline Specific Core, AEC Ability Enhancement Course, VAC Value Added Course, INT Internship, RPH Research Project, CIP Capstone Internship Project, DSS Discipline Specific Signature Course etc.), BBB represents the discipline code (ZOO), 000 represent the course level (101 means level 100 course, 201 means level 200 etc.)

Foundation Courses offered by Zoology Departments						
Sl. No.	**Level**	**Course Category**	**Course Code**	**Semester**	**Name of Course**	**Credits**
1	100-199	MDC	KU1MDCZOO101	I	Insect Pest Management	3
2	100-199	MDC	KU2MDCZOO102	II	Nutrition, Nutraceuticals and Dietetics	3
3	100-199	MDC	KU3MDCZOO103	III	Genetic Counselling and Human Welfare	3
4	100-199	VAC	KU3VACZOO101	III	Wildlife Conservation Biology	3
5	100-199	SEC	KU4SECZOO101	IV	Apiculture	3
6	100-199	VAC	KU4VACZOO102	IV	Ethics in Biological Research	3
7	100-199	VAC	KU4VACZOO103	IV	Health, Wellbeing and Social Hygiene	3
8	100-199	SEC	KU5SECZOO102	V	Sericulture	3
9	100-199	SEC	KU6SECZOO103	VI	Ornamental Fish Farming and Aquarium Management	3

B.Sc. Zoology Pathway Courses (2024 admission onwards)						
Sl. No	**Level**	**Course Code**	**Semester**	**Name of course**	**Credits**	**Pathway Courses**
First Year						
Semester I						
1	100-199	KU1DSCZOO101	I	Introduction to Zoology	3+1	1
2	100-199	KU1DSCZOO102	I	Animals and Environment	3+1	
3	100-199	KU1DSCZOO103	I	General Laboratory Techniques	3+1	
4	100-199	KU1DSCZOO104	I	Introductory Animal Physiology	3+1	
Semester II						
5	100-199	KU2DSCZOO105	II	Fundamentals of Animal Biology	3+1	2
6	100-199	KU2DSCZOO106	II	Basics of Evolutionary Biology	3+1	
7	100-199	KU2DSCZOO107	II	Basics of Collection and Preservation of Biological Specimens	3+1	
8	100-199	KU2DSCZOO108	II	Cell Biology and Immunology	3+1	
Second Year						
Semester III						
9	200-299	KU3DSCZOO201	III	Animal Physiology	3+1	3
10	200-299	KU3DSCZOO202	III	Ethology and Evolution	4	4
11	200-299	KU3DSCZOO203	III	Diversity of Life	3+1	
12	200-299	KU3DSCZOO204	III	Advanced Biological Techniques	3+1	
13	200-299	KU3DSCZOO205	III	Human Physiology	3+1	
14	200-299	KU3DSCZOO206	III	Introductory Biochemistry	3+1	
Semester IV						
15	200-299	KU4DSCZOO207	IV	Cytogenetics	3+1	5
16	200-299	KU4DSCZOO208	IV	Biochemistry	3+1	6
17	200-299	KU4DSCZOO209	IV	Immunology	3+1	7
Third Year						
Semester V						
18	300-399	KU5DSCZOO301	V	Invertebrata - Systematics, Form and Function	3+1	8
19	300-399	KU5DSCZOO302	V	Environmental Science	3+1	9
20	300-399	KU5DSCZOO303	V	Developmental Biology	4	10
21	300-399	KU5DSEZOO304	V	General Parasitology (Elective)	4	11
22	300-399	KU5DSEZOO305	V	General Entomology (Elective)	4	12
23	300-399	KU5DSEZOO306	V	Marine Biology (Elective)	4	

24	300-399	KU5DSEZOO307	V	Wildlife Biology (Elective)	4	
25	300-399	KU5DSEZOO308	V	Economic Zoology (Elective)	4	
Semester VI						
26	300-399	KU6DSCZOO309	VI	Chordata - Systematics and Comparative Anatomy	3+1	13
27	300-399	KU6DSCZOO310	VI	Molecular Biology, Bioinformatics and Biotechnology	4	14
28	300-399	KU6DSCZOO311	VI	Biological Instrumentation and Methodology	3+1	15
29		KU6INTZOO312	VI	Internship/Apprenticeship/Field Trip	2	
30	300-399	KU6DSEZOO313	VI	Medical Parasitology (Elective)	4	16
31	300-399	KU6DSEZOO314	VI	Aquaculture (Elective)	4	17
32	300-399	KU6DSEZOO315	VI	Wildlife Conservation andManagement (Elective)	4	
33	300-399	KU6DSEZOO316	VI	Agricultural Entomology (Elective)	4	
34	300-399	KU6DSEZOO317	VI	Medical Entomology and Vector Biology (Elective)	4	
35	300-399	KU6DSEZOO318	VI	Industrial Fisheries (Elective)	4	
Courses For B.Sc. Zoology Honours/Research Programme						
Semester VII						
36	400-499	KU7DSCZOO401	VII	Developmental Genetics	3+1	18
37	400-499	KU7DSCZOO402	VII	Animal Systematics and Evolution	3+1	19
38	400-499	KU7DSCZOO403	VII	Advanced Cell and Molecular Biology	3+1	20
39	400-499	KU7DSCZOO404	VII	Advanced Physiology and Endocrinology	3+1	21
40	400-499	KU7DSCZOO405	VII	Methodology for ZoologicalResearch	3+1	22
Semester VIII						
41	400-499	KU8DSEZOO406	VIII	Cellular Metabolism	4	23
42	400-499	KU8DSEZOO407	VIII	Computational Biology	3+1	24
43	400-499	KU8DSCZOO408	VIII	Immunology and Microbiology	4	25
44	400-499	KU8DSCZOO409	VIII	Environmental Impact Assessment and Toxicology	4	
45	400-499	KU8DSCZOO410	VIII	Human Genetics (Elective)		
46	400-499	KU8DSEZOO411	VIII	Basics of Programming for Bioinformatics (Elective)	3+1	
47	400-499	KU8DSEZOO412	VIII	Nutrition and Dietitics (Elective)	3+1	
48	400-499	KU8DSEZOO413	VIII	Animal Behaviour (Elective)	4	
49	400-499	KU8DSEZOO414	VIII	Chordate Comparative Anatomy and Phylogeny (Elective)	4	
50				MOOC-Online course I		
51				MOOC-Online course II		

52				MOOC-Online course III		
53		KU8CIPZOO400	VIII	Capstone Internship Project in Honours Programme in Zoology	8	
54		KU8RPHZOO400	VIII	Project in Honours with Research Programme in Zoology	12	

- The BSc Honours/Research Programme in Zoology provides an extensive array of Elective Courses across diverse focal points within the field of Zoology. Department Coordinators for FYUGP can offer guidance to students, recommending relevant elective courses each semester based on the expertise of faculty members. This strategic selection will empower students to specialize in a particular Zoology domain, significantly enhancing their employability skills.

FOUNDATION COURSES OFFERED BY ZOOLOGY DEPARTMENTS

KU1MDCZOO101: INSECT PEST MANAGEMENT

<table>
<tr><td>Semester</td><td>Course Type</td><td>Course Level</td><td colspan="2">Course Code</td><td>Credits</td><td>Total Hours</td></tr>
<tr><td>I</td><td>MDC</td><td>100</td><td colspan="2">KU1MDCZOO101</td><td>3</td><td>45</td></tr>
<tr><td colspan="3">Learning Approach (Hours/ Week)</td><td colspan="3">Marks Distribution</td><td rowspan="2">Duration of ESE (Hours)</td></tr>
<tr><td>Lecture/Tutorial</td><td colspan="2">Practical</td><td>CE</td><td>ESE</td><td>Total</td></tr>
<tr><td>3</td><td colspan="2">-</td><td>25</td><td>50</td><td>75</td><td>1.5</td></tr>
</table>

Course Description

Insect pests are ubiquitous and are often a matter of concern to humankind. This course aims to introduce students to different types of insect pests and also equip them with the idea of pest control. Different methods of pest control and the pros and cons of each methods are dealt with. The course also aims at introducing an important concept in pest management – “integrated pest management”. The judicious use of pesticides and the concept of “ecological backlash” is also introduced here.

Course Prerequisite:

Course Outcomes:

	Expected Outcome	**Learning Domains**
CO1	Define an insect pest and learn about different types	U
CO2	Learn about different insect pest control methods	An
CO3	Evaluate the benefits and problems of different pest control methods	E
CO4	Idea about integrated pest management	U
CO5	Identify the challenges related to insect pest management	E

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO4	PSO 5
CO1	2	3	1	1	1
CO2	1	1	2	1	2
CO3	1	1	3	2	3
CO4	2	0	1	2	2
CO5	1	0	3	2	3

COURSE CONTENTS

Module I: Definition, classification and Examples of Insect Pests **(9 hours)**

Unit I:

1.1 Definition of insect pests

1.2 Classification of insect pests

Unit II: Common insect pests of crops

1.3 Pest of Coconut (*Oryctes rhinoceros*)

1.4 Pest of Paddy (*Leptocorisa acuta*)

1.5 Common insect pest of vegetable (*Dacus cucurbitae*, *Leucinodes orbonalis*)

Unit III:

1.6 Identification, nature of damage and control of *Sitophilus oryzae*.

Module II: Biological control of Insect Pest **(9 hours)**

Unit I:

2.1 Prophylactic method of insect control

2.2 Cultural methods of Insect control

2.3 Mechanical and Physical methods of Insect control

Unit II:

2.4 Biological method of Insect control

Unit III:

2.5 Insect growth regulators

Module III: Chemical Control of Insect Pests **(9 hours)**

Unit I:

3.1 Classification of insecticides

3.1.1 Mention Insecticide resistance.

Unit II:

3.2 Insect attractants and Insect repellents. **Unit III:** 3.3 Insect antifeedants
Module IV: Integrated Pest Management (9 hours) **Unit I** 4.1 Principles of Integrated Pest Management (IPM) **Unit I** 4.2. Advantages and Disadvantages of IPM **Unit III** 4.3. Biological control measures of insect pest by using *Bacillus thuringiensis*

Teacher Specific Module	**9 hours**
Directions: **20 percent of the content can be modified by the course teacher** *Suggestions:* 1. Guidelines for developing IPM 2. Challenges related to insect pest management 3. Concept of ecological backlash	

Core Compulsory Readings (Books, Journals, E-sources Websites/ weblinks)

1. Prasad T V., 2015. Handbook of Entomology, New Vishal Publishers.

2. David, BV and Ananthakrishnan TN, 2004. General and Applied Entomology, McGraw Hill Education.

Core Suggested Readings (Books, Journals, E-sources Websites/ weblinks)

1. https://www.epa.gov/ipm/introduction-integrated-pest-management
2. https://agritech.tnau.ac.in/crop_protection/crop_prot_pestisides.html (for pesticides)
3. https://agritech.tnau.ac.in/crop_protection/crop_prot_biological_control.html (for biological control)
4. https://agritech.tnau.ac.in/crop_protection/crop_prot_ipm.html (for IPM)
5. https://agritech.tnau.ac.in/crop_protection/crop_prot_crop_insect_pest.html (for insect pests)

Assessment Rubrics:

Evaluation Type		Marks
• End Semester Evaluation		50
• Continuous Evaluation		25
Continuous Evaluation		
Theory	Method of Assessment	Marks
a)	Test paper I	5
b)	Test paper II	5
c)	Viva-Voce	5
d)	Assignment	5
e)	Seminar	5
	Total – 25 marks	

Employability for the Course / Programme

- Employment as Insect pest control technicians.
- Consultancy regarding insect pest and pesticides.

KU2MDCZOO102: NUTRITION, NUTRACEUTICALS AND DIETITICS

Semester	Course Type	Course Level	Course Code			Credits	Total Hours
II	MDC	100	KU2MDCZOO102			3	45
Learning Approach (Hours/ Week)			Marks Distribution				Duration of ESE (Hours)
Lecture/Tutorial	Practical		CE	ESE	Total		
3	-		25	50	75		1.5

Course Description

Nutrition and dietetics is an emerging healthcare topic. This course aims to introduce various concepts related to nutrients, diet and diet management. Daily requirement of various nutrients, and the need to maintain nutrient adequate intake is introduced. Various metrics like Basal Metabolic Rate, Daily Energy Expenditure, Body Mass Index, Diet plan etc. will be introduced. Students taking this course can plan their diet for a healthy and hale body.

Course Prerequisite:

Course Outcomes:

	Expected Outcome	Learning Domains
CO1	Learn about different nutrient types	U
CO2	Acquaint about diet related indices	A
CO3	Assess and plan diet for different conditions	An
CO4	Idea about food safety regulations in India	U
CO5	Learn about daily requirement of different nutrients	U

**Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)*

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO4	PSO 5
CO1	1	1	1	2	1
CO2	0	0	3	2	1
CO3	1	0	3	2	3
CO4	0	0	0	0	3
CO5	1	1	1	3	3

COURSE CONTENTS

Module I: Nutrients and supplements **(9 hours)**

Unit I:

1.1 Food, Nutrition and Health

1.2 Classification of nutrients

1.3 Macronutrients: Carbohydrates, Proteins and Lipids

1.4 Micronutrients: Vitamins and Minerals

Unit II:

1.5 Pre and Probiotics

1.6 Organic Foods

1.7 Phytochemicals and Antioxidants.

Unit III:

1.8 Introduction to Nutraceuticals, Classification, Uses and Roles

1.9 Nutritional Dietary and health Supplements

1.10 Supplements Labelling.

Module II: Diet requirement and calculations **(9 hours)**

Unit I:

2.1 Basal Metabolic Rate (BMR) and Resting Metabolic Rate (RMR)

2.2 Factors affecting BMR Daily Energy Expenditure

2.3 Fuel requirements, calculation of energy requirements.

Unit II:

2.4 Recommended dietary allowances of carbohydrates, essential fatty acids, essential amino acids, vitamins and minerals

2.5 Dietary guidelines

2.6 Xenobiotics in diet and recommendations.

Unit III:

2.7 Body Mass Index (BMI) calculation, Mention obesity.

Module III: Diet Planning **(9 hours)**

Unit I:

3.1 Nutritional planning for following conditions:

3.1.1 Gastrointestinal Disorders

3.1.2 Nutritional Management in Diabetes mellitus

3.1.3 Nutritional Management of Coronary Heart Disease

3.1.4 Nutrition Care in Weight Management. **Unit II:** 3.2 Introduction to Clinical Nutrition 3.3 Introduction to Hospital diets, Soft, liquid and Normal Diet. **Unit III:** 3.4 Infancy, Adolescent Dietary Needs and Complications 3.5 Elderly Dietary Needs and its Complications
Module IV: Quality assurance **(9 hours)** **Unit I:** 4.1 Good manufacturing practices **Unit II:** 4.2 United States Food and Drug Administration **Unit III:** 4.3 Food Safety and Standards Authority of India 4.4 FSSAI regulations (general idea to be provided)

Teacher Specific Module	**9 hours**
Directions: **20 percent of the content can be modified by the course teacher** *Suggestions:* 1. Food Safety and Standards (Health Supplements, Nutraceuticals, Food for Special Dietary Use, Food for Special Medical Purpose, Functional Food and Novel Food) Regulations, 2016 2. Food Safety and Standards (Packaging) Regulation, 2018 3. Food Safety and Standards (Safe food and balanced diets for children in school) Regulations, 2020 4. Food Safety and Standards (Labelling and Display) Regulations, 2020 5. Food Safety and Standards (Vegan Foods) Regulations, 2022	

Core Compulsory Readings (Books, Journals, E-sources Websites/ weblinks)

1. Khanna, K., Gupta, S., Passi, S. J., Seth, R., Mahna, R., & Puri, S. (1997). Textbook of Nutrition and dietetics.
2. Clinical Dietetics Manual, Published by Indian dietetic association, Elite Publishing House.

Core Suggested Readings (Books, Journals, E-sources Websites/ weblinks)

1. https://www.fssai.gov.in/cms/food-safety-and-standards-regulations.php

Assessment Rubrics:

Evaluation Type		Marks
• End Semester Evaluation		50
• Continuous Evaluation		25
Continuous Evaluation		
Theory	Method of Assessment	Marks
a)	Test paper I	5
b)	Test paper II	5
c)	Viva-Voce	5
d)	Assignment	5
e)	Seminar	5
		Total – 25 marks

Employability for the Course / Programme

- Employment as diet planners.
- Consultancy regarding diet management and healthy diet.

KU3MDCZOO103: GENETIC COUNSELLING AND HUMAN WELFARE

Semester	Course Type	Course Level	Course Code		Credits	Total Hours
III	MDC	100	KU3MDCZOO103		3	45
Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture/Tutorial	Practical		CE	ESE	Total	
3	-		25	50	75	1.5

Course Description

Do you ever wonder how traits are passed from one generation to the next? This course offers an exploration into the fascinating world of genetics, delving into the core principles of inheritance, cutting-edge diagnostic techniques, and the ethical considerations surrounding genetic information.

Course Prerequisite:

Course Outcomes:

	Expected Outcome	Learning Domains
CO1	Explain the principles behind Mendel's laws and their application in predicting inheritance patterns.	An
CO2	Apply knowledge of chromosomal anomalies to identify potential genetic disorders in humans.	E
CO3	Describe the principles and applications of different cytogenetic tools	U
CO4	Analyze the advantages and limitations of various prenatal testing options.	E
CO5	Explain the importance of accurate diagnosis and risk calculation in genetic counselling.	E

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

Mapping of Course Outcomes to PSOs

	PSO1	PSO2	PS3	PSO4	PSO5
CO1	1	1	3	3	1
CO2	1	1	3	3	1
CO3	0	0	1	1	0
CO4	1	0	3	1	3
CO5	0	1	3	3	4

COURSE CONTENTS

Module I: Basics of inheritance **(9 hours)**

Unit I:

1.1 Structure and organization of DNA.

Unit II:

1.2 Patterns of inheritance

1.3 Mendel's laws and inheritance patterns

Unit III:

1.4 Autosomal Dominant inheritance

1.5 Autosomal Recessive inheritance

1.6 Sex linked inheritance

1.7 Co-dominance

Module II: Human Karyotype and Inheritance **(9 hours)**

Unit I:

2.1 Banding techniques,

2.2 Human karyotype

Unit II:

2.3 Chromosomal anomalies in humans

2.3.1 Down's syndrome

2.3.2 Turner's syndrome

2.3.3 Klinefelter s syndrome

Unit III:

2.4 Pedigree Analysis and Map construction

Module III: Molecular Cytogenetics	**(9 hours)**
Unit I: 3.1 In-situ Hybridization technique, 3.1.1 Fluorescent in situ hybridization 3.2 Comparative genomic hybridization.	
Module IV: Prenatal Diagnosis	**(9 hours)**
Unit I: 4.1 Prenatal diagnosis 4.2 Different methods of prenatal diagnosis **Unit II:** 4.3 Identification of pregnancies at risk 4.4 Maternal age 4.5 Population screening 4.6 Maternal serum biochemistry (for neural tube defects, downs syndrome) 4.7 Ultra sonograph 4.8 Previous child with Mendelian disorder & family history of Mendelian disorders	

Teacher Specific Module	**9 hours**
Directions: **20 percent of the content can be modified by the course teacher** *Suggestions:* • What is genetic counselling? • Principles related to genetic counselling • Establishing the diagnosis, details on problems of establishing the diagnosis • Calculating risk • Genetic testing, predictive testing • Genetic information and insurance	

Core Compulsory Readings (Books, Journals, E-sources Websites/ weblinks)

1. Gardner, A, Howell, RT and Davies T., 2008. Viva Books, New Delhi

2. Mange JE and Mange AP, 1994. Basic Human Genetics. Sinauer Associates, Sunderland.

Core Suggested Readings (Books, Journals, E-sources Websites/ weblinks)

1. https://www.genome.gov/ **National Human Genome Research Institute (NHGRI):** A comprehensive website with educational resources, news, and research updates on all aspects of genetics.

Assessment Rubrics:

Evaluation Type		**Marks**
• End Semester Evaluation		50
• Continuous Evaluation		25
Continuous Evaluation		
Theory	Method of Assessment	Marks
a)	Test paper I	5
b)	Test paper II	5
c)	Viva-Voce	5
d)	Assignment	5
e)	Seminar	5
	Total – 25 marks	

KU3VACZOO101: WILDLIFE CONSERVATION BIOLOGY

<table>
<tr><td>Semester</td><td>Course Type</td><td>Course Level</td><td colspan="2">Course Code</td><td>Credits</td><td>Total Hours</td></tr>
<tr><td>III</td><td>VAC</td><td>100</td><td colspan="2">KU3VACZOO101</td><td>3</td><td>45</td></tr>
<tr><td colspan="3">Learning Approach (Hours/ Week)</td><td colspan="3">Marks Distribution</td><td rowspan="2">Duration of ESE (Hours)</td></tr>
<tr><td>Lecture/Tutorial</td><td colspan="2">Practical</td><td>CE</td><td>ESE</td><td>Total</td></tr>
<tr><td>3</td><td colspan="2">-</td><td>25</td><td>50</td><td>75</td><td>1.5</td></tr>
</table>

Course Description

Conservation biology is a developing and complex field. This course will give students an overview to recognize and articulate the key aspects of biodiversity, the causes of biodiversity loss, and the role of conservation biology in preserving biodiversity. This discipline includes the scientific methods employed, the biological principles behind conservation techniques and strategies as well as the complexities involved in attempts to influence and implement conservation-oriented policies.

Course Prerequisite:

Course Outcomes:

	Expected Outcome	**Learning Domains**
CO1	Identify and explain important threats to biological diversity as well as the variety of approaches to protecting biodiversity	An
CO2	Form and articulate opinions on complex issues in conservation biology.	An
CO3	To apply knowledge in solving problems human wildlife conflicts and wildlife monitoring	E
CO4	Evaluate different conservation methods to find suitable one for a particular habitat.	E
CO5	Differentiate between different IUCN categories	An

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

Mapping of Course Outcomes to PSOs

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	2	1	3
CO2	2	2	3	1	3
CO3	2	2	3	2	3
CO4	1	2	3	2	3
CO5	1	1	2	1	3

COURSE CONTENTS

Module I: Biodiversity- Significance and Challenges **(9 hours)**

Unit I:

1.1 Types of biodiversity

1.1.1Genetic diversity

1.1.2 Species diversity

1.1.3 Ecosystem diversity.

1.2 Values of biodiversity-Intrinsic, consumptive, productive use, social, ethical, aesthetic and option values. Utilitarian values of biodiversity.

Unit II:

1.2 Threats to Biodiversity- habitat loss and fragmentation, extinction, pollution, global climate change, overexploitation, poaching of wildlife, invasive species.

Unit III:

1.4 Human and wildlife conflicts

1.4.1 Human-wildlife Coexistence

1.4.2 Wildlife Crimes

1.5 Eco-tourism

1.6 Sustainable Utilization of Biodiversity Resources.

Module II: Biodiversity Conservation **(9 hours)**

Unit I:

2.1 Conservation movements

2.1.1 International

2.1.2 National.

Unit II:

2.2 Reproductive parameters in conservation (breeding habitats, mating systems, inbreeding depression, genetic bottlenecks, genetic constraints), Captive breeding.

Unit III:

2.3 IUCN categories of species

2.4 Red Data Book and related documentation

2.5 Threatened plants and animals of India.

Module III: Conservation Strategies (9 hours)

Unit I:

3.1 Strategies for conservation

3.1.1 In situ Conservation -Wildlife Sanctuaries, National parks, Biosphere Reserves, Biodiversity hotspot in India

3.1.2 Ex-situ conservation –Botanical gardens, bio-parks, Aquaria and Gene banks

Unit II:

3.2 Demonstration and applicability of basic equipment needed for wildlife studies (Compass, Range finder, GPS, Camera Traps).

3.3 Animal Footprints (Pugmark & hoof mark), Animal Droppings (Scat, Dung, Pellet), Other animal signs, Antlers, Nests of birds;

Unit III:

3.4 Animal trail survey or trail monitoring.

Module IV: Conservation Policies, Organizations and Institutions (9 hours)

Unit I:

4.1Wildlife Protection Act 1972

4.2 IUCN, CMFRI

Unit II:

4.3 Chipko movement and Silent Valley movement,

4.4 Wetland conventions, Ramsar sites.

Unit III:

4.5 Role of NGOs in conservation.

Teacher Specific Module	9 hours
Directions: **20 percent of the content can be modified by the course teacher** *Suggestions:* **Wildlife Photography** 1. Basic Principles; Fundamentals of camera lenses and accessories 2. DSLR camera functions and features. 3. Focusing & its different methods. 4. Techniques for photographing mammals, birds, insects, reptiles, and amphibians.	

Compulsory Readings

1. Caughley, G., and Sinclair, A.R.E. (1994). Wildlife Ecology and Management. Blackwell Science.
2. Shekhar, S. Kolipaka, (2014). A Field Guide to Tracks & Signs of Indian Wildlife. 1-385pp.
3. Sinclair, A.R. E., John M. Frysell, and Graeme Caughley (2006). Wildlife Ecology, Conservation, and Management, Blackwell Publishing, 1-463, pp.
4. Berwick S. H. and Saharia, V. B. (1995). Development of International principles of Wildlife Research and Management (Asian and American approaches). Oxford University Press, Delhi, Bombay, Madras. 1-481. pp.
5. Vivek Menon, (2014). Indian mammals, A Field Guide; Hachetta Book Publishing India Pvt. Ltd.4th and 5th Floor Corporate centre, Plot No. 94, Sector 44, Gurgoan, 122001, India.
6. Hunter M. L., Gibbs, J. B. and Sterling, E. J. (2008). Problem-Solving Conservation Biology and Wildlife Management: Exercise for class, Field and laboratory, Blackwell Publishing.
7. Southerland, W. J. (2000). The conservation handbook: Research management and Policy. Blackwell Sciences.
8. Bookhout, T. A. (1996). Research and management techniques for wildlife and habitats, 5th edition. The Wildlife Society, Allen Press.
9. Woodroffe, R., Thirgood, S. and Rabinowitz, A. (2005). People and Wildlife, Conflict or Coexistence? Cambridge University.

Suggested Readings

1. Dhruva Narayana VV 1993. Soil and water conservation research in India, ICAR, New Delhi.
2. Kathiresan, 1986. Essentials of Forest Management, Natraj Publishers, Dehra Dun.
3. Pushpangathan et al. 1997. Conservation and Ecological Economics of biodiversity. Longman.
4. Rajesh, G. 1989. Fundamentals of Wildlife Management. Justice Home, Allahabad.
5. Honey M. 1998. Ecotourism and Sustainable Development. Iceland Press.
6. Luck M and Kirstges T. 2002. Global Ecotourism Policies and Case Studies. Channel View Publ.
7. Claussen E, Cochran VA and Davis DP. 2001. Climate Change: Science, Strategies and Solutions. Pew Centre on Global Climate Change, USA.

Assessment Rubrics:

<table>
<tr><th colspan="2">Evaluation Type</th><th>Marks</th></tr>
<tr><td colspan="2">• End Semester Evaluation</td><td>50</td></tr>
<tr><td colspan="2">• Continuous Evaluation</td><td>25</td></tr>
<tr><td colspan="3">Continuous Evaluation</td></tr>
<tr><td>Theory</td><td>Method of Assessment</td><td>Marks</td></tr>
<tr><td>a)</td><td>Test paper I</td><td>5</td></tr>
<tr><td>b)</td><td>Test paper II</td><td>5</td></tr>
<tr><td>c)</td><td>Viva-Voce</td><td>5</td></tr>
<tr><td>d)</td><td>Assignment</td><td>5</td></tr>
<tr><td>e)</td><td>Seminar</td><td>5</td></tr>
<tr><td></td><td colspan="2">Total – 25 marks</td></tr>
</table>

KU4SECZOO101: APICULTURE

Semester	Course Type	Course Level	Course Code			Credits	Total Hours
IV	SEC	100	KU4SECZOO101			3	45
Learning Approach (Hours/ Week)			Marks Distribution				Duration of ESE (Hours)
Lecture/Tutorial	Practical		CE	ESE	Total		
3	-		25	50	75		1.5

Course Description:

The goal of this course is to teach basic beekeeping of honey bees. Participants will gain a general knowledge of honey bee biology as well as how to care for honey bees throughout the year. Students will be taught how to recognize common honey bee ailments and pests, as well as the methods for treating them. This course also covers the history of bees, and scope of apiculture. After completion students will know how to manage honey bee colonies for maximum bee health and honey production.

Course Prerequisite:

Course Outcomes:

	Expected Outcome	**Learning Domains**
CO1	Understand principles of apiculture	U
CO2	Observe the behavior of honey bees and realize their significance in maintaining the biodiversity.	An
CO3	Understand the artificial bee hive construction and maintenance.	U
CO4	Gain knowledge in economic importance and economics prospects of honey, bee wax and venom.	U

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

Mapping of Course Outcomes to PSOs

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	0	0	0	0	0
CO2	3	0	0	1	2
CO3	0	0	0	1	0
CO4	0	0	0	0	0

COURSE CONTENTS

Module I: Introduction to Bee Keeping **(9hours)**

Unit I:

1.1 History of bee keeping

1.2 Scope of Apiculture

1.3 Life cycle of Honey bee

1.4 Classification of honey bee (Rock bee, Little Bee, Dammer bee)

Unit II:

1.5 Social organization of Honey bee

1.6 Functions of Queen, drones and worker bee in a colony.

Unit III:

1.7 Food of the bee- Honey and pollen-royal jelly

1.8 Feeding methods- Artificial feeding.

Module II: Principles of Apiculture **(9 hours)**

Unit I:

2.1 Bee keeping methods: Primitive bee keeping- Wall hive, Pot hive, log hive, bamboo hive

2.2 Modern bee keeping-Langstroth hive, Newton hive.

Unit II:

2.3 Swarming, Types of swarming, Prevention and control.

Unit III:

2.4 Queen rearing, Principles and procedure

Module III: Honey, Bee Wax and Bee Venom	**(9 hours)**
Unit I: 3.1 Honey: Collection and Extraction, Preservation and Storage 3.2 Chemical composition 3.3 Nutritive value, Medicinal values, Honey as daily food. **Unit II:** 3.3 Bee wax 3.4 Bee wax production 3.5 Extraction of Bees Wax 3.6 Characteristics and uses of Wax **Unit III:** 3.7 Bee Venom, Collection method, Composition of bee venom, Uses of Bee venom.	
Module IV: Enemies of Bees	**(9hours)**
Unit I: 4.1 Enemies of bees: Mites, Greater wax moth, lesser wax moth, ants, wasps, beetles, birds and their management. **Unit II:** 4.2 Diseases of bees: adult and brood diseases- Bacterial, Fungal, Viral & Protozoan **Unit III:** 4.3 Prevention and control of diseases of Bees.	

Teacher Specific Module	**9 Hours**
Directions: **20 percent of the content can be modified by the course teacher** *Suggestions:* • Behaviour of bee - Dances. • Appliances of apiaries- comb frames, comb foundation sheet, dummy division board, drone excluder, queen excluder, swarm trap, smoker, uncapping knife, bee veils, honey extractor, bee brush, feeders.	

Core Compulsory Readings

1. Arumugam, N., Murugan, T., Johnson Rajeshwar, J. and Ram Prabhu, R. (2011). Applied Zoology. Nagercoil: Saras Publications.
2. Sardar Singh (1962)., Bee Keeping in India, KAR Delhi.

Core Suggested Readings

1. Johnson, J. and Jeya Chandra, I. (2005). Apiculture. Marthandam: Olympic Grafix.
2. Sharma, P. and Singh L (1987) Hand book of bee Keeping, Controller Printing and Stationery, Chandigarh.
3. Stephen, R (1998) Introduction to Bee Keeping, Vikas publishing house, New Delhi.
4. Nagaraja, N and Rajagopal, D. 2009. Honey bee diseases, Parasites, Pest, Predators and their Management. MJP publishers, Chennai.

Assessment Rubrics:

Evaluation Type		**Marks**
• End Semester Evaluation		50
• Continuous Evaluation		25
Continuous Evaluation		
Theory	Method of Assessment	Marks
a)	Test paper I	5
b)	Test paper II	5
c)	Viva-Voce	5
d)	Assignment	5
e)	Seminar	5
		Total – 25 marks

Employability for the Course / Programme

- Entrepreneurship in the level bee keeping and trade.
- Marketing of honey and bee products.
- Formation of skill laborers in Apiculture.
- Develop as small-scale industry with less capital investment

KU4VACZOO102: ETHICS IN BIOLOGICAL RESEARCH

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
IV	VAC	100	KU3VACZOO102	3	45

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/Tutorial	Practical	CE	ESE	Total	
3	-	25	50	75	1.5

Course Description

The course will provide the fundamentals of ethical issues in Biology research and provide updates on research ethics guidelines. It will explore ethical issues that arise in the conduct of research and the results of research. Specifically, the course is made up of units on: Good practices and misconduct in science; research with human subjects, research with animals and emerging biotechnologies. As an applied ethics course, the emphases within these topics will include describing common practices in biological research, exploring ethical principles, professional norms, and laws that shape responsible conduct of research, and developing of ethical problem-solving skills.

Course Pre requisite:

Course Outcomes:

	Expected Outcome	**Learning Domains**
CO1	Understand ethical issues in animal and human experimentation	U
CO2	Understand about regulations and ethics of research and Publications	U
CO3	To Explore the possible alternatives like simulation, informatics, organs on chips	An
CO4	Evaluate the pros and cons of animal and human experimentation, genome and stem cell research.	An
CO5	To develop skills debating, in animation, video making and editing for biology research.	A

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

Mapping of Course Outcomes to PSOs

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	1	0	0	0	1
CO2	0	0	0	0	0
CO3	1	0	1	0	1
CO4	1	0	0	0	1
CO5	0	0	1	0	1
CO6	1	0	0	0	1

COURSE CONTENTS

Module I: Introduction **(9 hours)**

Unit I:

1.1 Importance of ethics in Biological Research

1.2 Conflicts of interest.

Unit II:

1.3 Scientific misconduct: fabrication, falsification, plagiarism.

Unit III:

1.4 Ethical Issues associated with Gender-Bias: Forms of gender discrimination

1.5 Value of a gender approach.

Module II: Publication Ethics **(9 hours)**

Unit I:

2.1 Publication Ethics: Selective reporting, misinterpretation of data.

2.2 Redundant publications: Duplicate and overlapping publications, salami slicing.

Unit II:

2.3 Best practices- COPE, WAME

2.4 Open access publishing; SHERPA, RoMEO

2.5 Journal finder tools- JANE, Elsevier Journal finder, Springer Journal suggester

2.6 Plagiarism software- Turnitin, Urkund and open source software tools

2.7 Predatory publications and journals.

Unit III:

2.8 Databases and Research Metrices: Indexing databases

2.9 Web of Science; Scopus, PubMed, Google scholar;

2.10 Journal citation report, Impact factor;

2.11 Metrices- h index, G index, i10 index.

Module III: Research Involving Animals (9 hours)

Unit I:

3.1 The use of animals in basic biological research,

3.2 Study of human disease; genetically modified animals in the study of human diseases and disorders, 3.3 Role of ethics committee.

3.4 Safe disposal of animal wastes.

3.5 Pros and cons of animal experimentation-

3.6 Impact of experimentations on animals.

Unit II:

3.7 Ethics, Principles and legislation in animal experimentation- Principle of the 4 R's- Reduction, Refinement, Replacement and Responsibility;

3.8 Legislation, regulation and policy relating to scientific procedures on animals;

3.9 Choice of the animal model; Housing and environmental enrichment

Unit III:

3.10 Relevance of animal experimentations and possible alternatives-

Module IV: Ethics of Research Involving Humans (9 hours)

Unit I:

4.1 Human participants in research; Publishing images from human research participants.

4.2 Research on human populations; ethnicity and racism;

4.3 Studies involving vulnerable groups.

Unit II:

4.4 Ethical issues in Human Genomic Research; Existing guidelines recommendations.

Unit III:

4.5 Solutions to ethical dilemmas in genomic research- informed consent, Withdrawal from research.

Teacher Specific Module	9 hours
Directions: **20 percent of the content can be modified by the course teacher** *Suggestions:* 1.Ethical issues in stem cell research: Informed consent; Waiver of consent; Confidentiality of donor information; Medical risks of oocyte retrieval and stem cell clinical trials; Protecting the reproductive interests of women in infertility treatment; Payment to donors. 2.Intellectual property rights.	

Suggested Readings:

1. Muralidhar K, Ghosh A, Singhvi AK (Ed.) 2019. Ethics in Science Education, Research and Governance. Indian National Science Academy, New Delhi. 137 pp.
2. CSIR Guidelines for Ethics in Research and in Governance 2019. Resnik DB 1998. The Ethics in Science - an introduction. Routledge, New York, 1998.

References

1. Mathaiyan J, Chandrasekaran A, Davis S 2013. Ethics of genomic research. Perspect Clin Res. 4(1):100-4. doi: 10.4103/2229-3485.106405. PMID: 23533991; PMCID: PMC3601693.
2. Gupta JA 2013. Ethical issues and challenges in bioethics education from a gender perspective. UNESCO : International Conference on Gender and Bioethics, Kazan, Russian Federation.
3. Kiani AK, Pheby D, Henehan G, Brown R, Sieving P, 2022. Ethical considerations regarding animal experimentation. J Prev Med Hyg; 63(suppl.3): E255-E266. https://doi.org/10.15167/2421-4248/jpmh2022.63.2S3.2768.
4. Denzin, NK 1994. Hand Book of Qualitative Research. New Delhi: Sage Publications.
5. Mathur. R., ICMR. 2017. Ed. National ethical guidelines for biomedical and health research involving human participants: Eds.

Assessment Rubrics:

Evaluation Type		Marks
• End Semester Evaluation		50
• Continuous Evaluation		25
Continuous Evaluation		
Theory	Method of Assessment	Marks
a)	Test paper I	5
b)	Test paper II	5
c)	Viva-Voce	5
d)	Assignment	5
e)	Seminar	5
	Total – 25 marks	

Employability:

- Work with research labs, Libraries, central and state natural resource agencies, conservation groups, Ethics committee, animal and wildlife research institutes and with private consulting companies.
- Animations and video making, *In silico* simulations and Informatics, 3D cell culture models and organ on chips.

KU4VACZOO103: HEALTH, WELLBEING AND SOCIAL HYGIENE

Semester	Course Type	Course Level	Course Code		Credits	Total Hours
IV	VAC	100	KU4VACZOO103		3	45
Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture/Tutorial	Practical		CE	ESE	Total	
3	-		25	50	75	1.5

Course Description

The course will provide the fundamentals of health, and hygiene and provide updates on different testing and imaging methods. It will explore the impacts of globalization on health. Specifically, the course is made up of units on: communicable and non-communicable diseases, importance of vaccination, diet and deficiency diseases, modern technologies etc, community health and wellbeing and diagnostic methods. As an applied Zoology course, it these topics will include describing common personal and social health issues and their prevention and methods for improving community health and wellbeing.

Course Pre-requisite:

Course Outcomes:

	Expected Outcome	**Learning Domains**
CO1	Acquire knowledge about different types of diseases and drug addiction	U
CO2	Understand importance of care of elderly people	U
CO3	Apply knowledge to explore the possible methods of diagnosis and prevention of diseases	An
CO4	Analyze measures for waste management and community health.	An
CO5	Evaluate the pros and cons of globalization and modern technologies on health.	An

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

Mapping of Course Outcomes to PSOs

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	1	0	0	1	2
CO2	1	0	0	0	2
CO3	0	0	1	1	3
CO4	0	0	1	1	3
CO5	0	0	0	0	3

COURSE CONTENTS

Module I: Introduction **(9 hours)**

Unit I:

1.1 History of Public Health

1.2 Prevention of diseases

1.3 Globalisation and its Impact on Health.

Unit II:

1.4 Personal hygiene

1.5 Mental health.

Unit III:

1.6 Community Hygiene and Health

1.7 Alcoholism, smoking and drug abuse.

Module II: Major Diseases **(9 hours)**

Unit I:

2.1 Communicable Diseases – Polio, Rabies, Hepatitis, H1N1, Dengue, SARS outbreak, Nipah outbreak, COVID–19, HIV-AIDS, TB, Typhoid, Amoebiasis, Malaria, Taeniasis, Filariasis – their transmission, causative agent, symptoms, treatment and prevention.

Unit II:

2.2 Non communicable diseases- Cancer, Diabetes, Stroke and Paralysis, Parkinson's disease- Causes, symptoms, treatment and prevention,

Unit III:

2.3 Deficiency diseases- Kwashiorkor, Marasmus, Scurvy, Rickets, Goitre symptoms, prevention and treatment

Module III:	**(9 hours)**
Unit I:	
3.1 Pollution and Waste management- biowastes, e- wastes.	
Unit II:	
3.2 National health programmes- for children- ICDS, women, elderly, NRHM, PMSSY.	
Unit III:	
3.3 Gerontology- Biological and psychological aspects of aging	
3.4 Old age ailments- Arthritis, Alzheimer's disease, depression, dementia, suicide- types and stages. Prevention of late life suicide.	
Module IV:	**(9 hours)**
Unit I:	
4.1 Vaccination- Polio, DPT, BCG, HPV, Rabies	
4.2 Antiserum for snakebites	
Unit II:	
4.3 Diagnostic Instruments - ECG, EEG, Stethoscope, Sphygmomanometer, Clinical Thermometer, Glucometer, Hemocytometer, Mammogram, Endoscopy, Ultrasound scanning, X-ray, CT, MRI	
Unit III:	
4.4 Diagnostic tests- Lipid profile; ELISA; RTPCR; examination of blood, feces, urine	
4.5 Impact of modern technologies like mobile phones and computers on health.	
Teacher Specific Module	**9 hours**
Directions: **20 percent of the content can be modified by the course teacher** *Suggestions:* 1.Nutritional requirements- Carbohydrates, lipids, proteins, vitamins, minerals, water- their role in maintaining health. 2.Balanced diet, Malnutrition, Obesity, BMI 3. Yoga and exercises/ first aid.	

References:

1. Angus, J., and Reeve, P. (2006). Ageism: A threat to "aging well" in the 21st century. The Journal of Applied Gerontology, 25(2), 137-152.
2. Gibney, M.J. et al. (2004). Public Health Nutrition; Blackwell Publishing.

3. Lakra, P. and Singh M.D. (20()8). Textbook of Nutrition and Health; First Ed; Academic Excellence.
4. Mudambi, S.R. and Rajagopal, M.V. (2007). Fundamentals of Foods, Nutrition and Diet Therapy; Fifth Ed; New Age International Publishers.
5. Oxford textbook of Public Health Ed. Roger Detels, James Mcewen, Robert Beaglehole, and Heizo Tanaka Oxford University Press (OUP) 4th Edition: 2002.
6. Preventive and Social Medicine, K Park, Bansaridas Bhanot Publishing House.
7. Epidemiology and Management for Health Care: Sathe, *et al.* Popular Prakashan, Mumbai.
8. Mann, J. and Truswell, S. eds., 2017. Essentials of human nutrition. Oxford University Press.
9. *Prescott's Microbiology* by Joanne Willey, Linda Sherwood, and Christopher J. Woolverton; Brock Biology of Microorganisms by Michael T. Madigan, John M Published by McGraw-Hill Education, 2 Penn Plaza, New York, NY 10121. Copyright © 2020 by McGraw-Hill
10. Pelczar, M., Reid, R. and Chan, E. (1957) Microbiology. T.M.H. Edition, Tata McGraw-Hill Publishing Company Ltd., Noida.
11. Vir S.C., (2015), Public health nutrition in developing countries (Part I and II), Woodhead Publishing India Pvt, Ltd.

Assessment Rubrics:

Evaluation Type		**Marks**
• End Semester Evaluation		50
• Continuous Evaluation		25
Continuous Evaluation		
Theory	Method of Assessment	Marks
a)	Test paper I	5
b)	Test paper II	5
c)	Viva-Voce	5
d)	Assignment	5
e)	Seminar	5
	Total – 25 marks	

Employability: Public health workers, waste management, field of epidemic surveillance and control.

KU5SECZOO102: SERICULTURE

<table>
<tr><td>Semester</td><td>Course Type</td><td>Course Level</td><td colspan="2">Course Code</td><td>Credits</td><td>Total Hours</td></tr>
<tr><td>V</td><td>SEC</td><td>100</td><td colspan="2">KU5SECZOO102</td><td>3</td><td>45</td></tr>
<tr><td colspan="3"></td><td colspan="3"></td><td></td></tr>
<tr><td colspan="3">Learning Approach (Hours/ Week)</td><td colspan="3">Marks Distribution</td><td rowspan="2">Duration of ESE (Hours)</td></tr>
<tr><td>Lecture/Tutorial</td><td colspan="2">Practical</td><td>CE</td><td>ESE</td><td>Total</td></tr>
<tr><td>3</td><td colspan="2">-</td><td>25</td><td>50</td><td>75</td><td>1.5</td></tr>
</table>

Course Description

The course that deals with the rearing of silkworms and the production of raw silk is called Sericulture. The course covers topics related to various processes of Sericulture and Silk Farming. Through this course, students study techniques related to the rearing of silkworms to produce raw silk which is further used to manufacture silk clothes and products. The implementation of Sericulture is found in the development of the rural economy of the nation. A person with a knowledge in Sericulture can work in cottage industry and hence the scope of employment for people from rural areas is high.

Course Prerequisite:

Course Outcomes:

	Expected Outcome	**Learning Domains**
CO1	Develop self-employment capabilities related to sericulture	U
CO2	Acquires scientific knowledge of sericulture	U

****Remember I, Understand (U), Apply (A), Analyse (An), Evaluate I, Create (C)***

Mapping of Course Outcomes to PSOs

	PSO1	PS2	PSO3	PSO4	PSO5
CO1	0	0	0	0	0
CO2	1	1	0	0	0

COURSE CONTENTS

Module I: Introduction **(9 hours)**

Unit I:

1.1 Sericulture industry in India, Sericulture as cottage industry, role of Central Silk Board.

Unit II:

1.2 Moriculture, Mulberry varieties.

Unit III:

1.3 Diseases of mulberry

1.4 Fungal diseases

1.5 Bacterial diseases

1.6 Viral disease –Nematode disease – one example each, Pests of mulberry – leaf eating insect pests and borer pests – one example each.

Module II: Biology of Silkworm **(9 hours)**

Unit I:

2.1 Life history of *Bombyx mori*, Morphology of larva.

Unit II:

2.2 Silk glands, spinnerets, silk proteins,

2.3 Uni, bi and multivoltine breeds.

Unit III:

2.4 Economic importance of sericulture, Non mulberry silk worms.

Module III: Rearing of Silkworm **(9 hours)**

Unit I:

3.1 Rearing house

3.1.1 Rearing appliances

3.1.2 Rearing operation

3.1.3 Disinfection

3.1.4 Brushing – Maintenance of optimum conditions **Unit II:** 3.2 Feeding 3.2.1 Bed cleaning 3.2.3 Spacing. 3.3 Rearing of young ages 3.3.1 Chawki rearing 3.3.3 Rearing of late age larva 3.3.4 Shelf rearing 3.3.5 Floor rearing 3.4 Application of Sampoorna. **Unit III:** 3.5 Mounting: Methods – precautions. 3.5.1 Harvesting and sorting of cocoons.
Module IV: Silk Reeling **(9 hours)** **Unit I:** 4.1 Cocoon stifling – types 4.1.1 Sorting 4.1.2 Boiling 4.1.3 Deflossing 4.1.4 Brushing **Unit II:** 4.2 Process of reeling: Different methods 4.2.1 Silk waste and byproducts of silk reeling. **Unit III:** 4.3 Raw silk and marketing 4.4 Uses of silk.

Teacher Specific Module	9 Hours
Directions: **20 percent of the content can be modified by the course teacher** *Suggestions:* 1**.** Diseases of silkworm: Muscardine, Pebrine, Flacherie. Prevention and control. 2. Pests of silkworm. Uzi fly, ants and rodents. Control measures.	

Core Compulsory Readings

1. Ganga, G. and I. Sulochana Chetty, An introduction to Sericulture. Oxford& IBH Publishing Company Private Limited, S -155, Panchshila Park, New Delhi.
2. Ganga, G. Comprehensive Sericulture, Volume – 2 Silkworm Rearing and Silk Realing. Oxford & IBH Publishing Company Private Limited, S -155, Panchshila Park, New Delhi.
3. Dandin, S.B, Jayant Jayaswal and K. Giridhas, Hand Book of Sericultural Technologies, Central Silk Board, Madivala, Bangalore –68.
4. Kamile Afifa. S and Masoodi M. Amin, Principles of Temperate Sericulture, Kalyani Publishers, B – 1/1292, Rajinder Nagar, Ludhiana.
5. Kesary, M and M. Johnson, Sericulture, Department of Zoology, N.M. Christian College, Marthandam.

Assessment Rubrics:

Evaluation Type		**Marks**
• End Semester Evaluation		50
• Continuous Evaluation		25
Continuous Evaluation		
Theory	Method of Assessment	Marks
a)	Test paper I	5
b)	Test paper II	5
c)	Viva-Voce	5
d)	Assignment	5
e)	Seminar	5
	Total – 25 marks	

KU6SECZOO103: ORNAMENTAL FISH FARMING AND AQUARIUM MANAGEMENT

Semester	Course Type	Course Level	Course Code		Credits	Total Hours
VI	SEC	100	KU6SECZOO103		3	45
Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture/Tutorial	Practical		CE	ESE	Total	
3	-		25	50	75	1.5

Course Description

This course aims to introduce students to the wonderful world of ornamental fishes and fish keeping. Ornamental fish farming can also be a source of income and thus an alternate method of livelihood for rural populace. This course will provide the required training to keep fishes in an aquarium and teach to maintain aquaria properly. The course also aims to provide students with knowledge about different types of fish feed and will provide details about ornamental fish diseases and treatment

Course Pre-requisite:

Course Outcomes:

	Expected Outcome	Learning Domains
CO1	Understand different ornamental fish culture methods	U
CO2	Learn about aquarium management and apply the knowledge to keep fishes	An
CO3	Learn about different fish feed types	U
CO4	Evaluate the challenges related to ornamental fish related business	An
CO5	Prepare a proposal for ornamental fish related business and become adept in funding avenues.	A

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

Mapping of Course Outcomes to PSOs

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	1	0	0	1	2
CO2	1	1	1	1	2
CO3	0	1	0	1	0
CO4	1	0	1	0	2
CO5	1	0	0	0	0

COURSE CONTENTS

Module I: Ornamental Fish Culture **(9 hours)**

Unit I:

1.1 Introduction to Ornamental fish culture.

1.2 Status of ornamental fish culture (Indian scenario and International scenario).

1.3 Prospects of ornamental fish culture.

Unit II:

1.4 Ornamental fish keeping systems.

1.5 Differences between freshwater and marine aquaria.

Unit III:

1.6 Ornamental fish culture as a hobby.

Module II: Ornamental Fish and plant species diversity **(9 hours)**

Unit I:

2.1 Ornamental fish characteristics.

2.2 Indigenous and Exotic ornamental fishes

2.3 Freshwater and marine ornamental fishes.

Unit II:

2.4 Classification of ornamental fishes.

2.5 Live bearers (with any two suitable examples).

2.6 Egg layers (with any two suitable examples).

2.7 Classification of egg layer fishes.

Unit III: 2.8 Commercially important ornamental fishes.	
Module III: Aquarium Management	**(9 hours**
Unit I: 3.1 Different types of aquaria 3.2 Water quality management 3.3 Stock management 3.4 Design and construction of aquarium tanks. 3.5 Decoration of aquarium. 3.6 Aeration and Heating. 3.7 Types of filtration systems. **Unit II:** 3.8 Feed types and feed management. 3.9 Live feed development. 3.10 Feed preparation. **Unit III:** 3.11 Common aquarium fish diseases and management	
Module IV: Ornamental fish trade	**(9 hours)**
Unit I: 4.1 International and Indian Scenario. 4.2 Ornamental fish trade in Kerala. 4.3 Economic analysis of ornamental fish breeding and rearing. 4.4 Economics of ornamental fish retail outlets. **Unit II:** 4.5 Governmental agencies supporting ornamental fish trade/business. **Unit III:** 4.6 Government assisted financial schemes for starting ornamental fish business	

Teacher Specific Module	**9 hours**
Directions: **20 percent of the content can be modified by the course teacher** *Suggestions:* 1.Ornamental fish culture and trade as a profession. 2.Common aquarium plant species.	

Core Compulsory Readings

1. Sinha, A., & Pandey, P. K. (2023). *Breeding and Culture of Freshwater Ornamental Fish*. CRC Press.

Core Suggested Readings

1. Jayasree, Tharadevi and Arumugam, 2015. Home aquarium and ornamental fish culture.
2. Anikuttan, K. K., Nazar, A. K. A., Jayakumar, R., Johnson, B., Tamilmani, G., Sakthivel, M., Ramesh Kumar P & Sankar, M. (2019). Handbook on Marine Ornamental Fish Seed Production.

Assessment Rubrics:

Evaluation Type		**Marks**
• End Semester Evaluation		50
• Continuous Evaluation		25
Continuous Evaluation		
Theory	Method of Assessment	Marks
a)	Test paper I	5
b)	Test paper II	5
c)	Viva-Voce	5
d)	Assignment	5
e)	Seminar	5
	Total – 25 marks	

Employability for the Course / Programme

- Entrepreneurship in the field of ornamental fish farming and trade.
- Aquarium fish shops.
- Technicians in aquaculture farms.
- Indigenous ornamental fish breeding, rearing technology development and technology transfer.

LEVEL 100 DSC COURSES

KU1DSCZOO101: INTRODUCTION TO ZOOLOGY

Semester	Course Type	Course Level	Course Code		Credits	Total Hours
I	DSC	100	KU1DSCZOO101		3+1	60
Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture/Tutorial	Practical		CE	ESE	Total	
3	2		25	75	100	1.5

Course Description

Introduction to Zoology, participants will delve into the definition of animals and Zoology, explore various scope of Zoology and different animal phyla, and trace the evolutionary tree that connects the myriad forms of life within this kingdom. Subsequent modules will spotlight specific groups, starting with Basal Animals like sponges, corals, and jellyfish, then progressing to the intricate world of bilaterians, including the wondrous worms of Lophotrochozoa and the fascinating insects and nematodes of Ecdysozoa. Delving further, participants will explore the evolution of deuterostomes, examining starfish, sea squirts, and amphioxus, and tracing the rise of vertebrates both in aquatic environments and their subsequent adaptation to land. The final module will captivate participants with a showcase of fascinating, enigmatic animals.

Course Pre requisite: Any student with a +2 or equivalent degree

Course Outcomes:

	Expected Outcome	Learning Domains
CO1	Demonstrate a deep understanding of the definition of animals, distinguishing their characteristics from other organisms.	An
CO2	Comprehend the architectural patterns and body plans of animals	U
CO3	Utilize the scientific method (hypothetico-deductive method) to test hypotheses related to biological phenomena	A
CO4	Prepare taxonomic keys using derived characteristics of organisms based on cladistic principles	An
CO5	Evaluate different strategies to collect animals and choose the right one to obtain and preserve their target species	E

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	3	3	1	1	1
CO2	3	3	1	0	0
CO3	1	2	3	2	2
CO4	3	3	3	0	0
CO5	2	2	2	0	3

COURSE CONTENTS

Module I **11 hours**

Unit I

1.1 Definition of life (General properties of living systems)

1.2. The cell theory (classical and definition by Virchow)

1.2.1 Cell Theory vs Spontaneous Generation and Pasteur's experiments.

1.3. The theory of evolution by natural selection

1.3.1 Populations: variation and inheritance; Fitness: traits, adaptation and survival

1.4. The tree of life Taxonomy, Domains of life, Hierarchical classification of organisms, scientific nomenclature of animals (brief account only).

Unit II

1.5. Principles of Science

1.5.1 Five essential characteristics of science.

1.5.2 The scientific method (hypothetico-deductive method)

1.5.2.1 Any two suitable case studies related to hypothesis testing in biology (e.g. Why do giraffes have long necks? How do ants navigate?)

1.5.2.2 Paradigm and scientific revolutions

1.5.2.3 Proximate causes and experimental sciences

1.5.2.4 Ultimate causes and evolutionary sciences.

Unit III

1.6. The geological time scale

Module II **11 hours**

Unit I

2.1 What is an animal?

2.1.1 Features shared by all animals: multicellularity, heterotrophy, locomotion and specialized cells

2.1.2 Animals as a natural group in the evolutionary tree of life

2.2 Origin of animals

2.2.1 Brief idea on why multicellularity evolved. Proposal on the division of labour by Lynn Margulis, self-cannibalism by Kerszberg and Wolpert.

2.2.2 Cambrian explosion

2.2.3 Animal phyla (A list of 33 animal phyla to be introduced).

Unit II

2.3 Architectural pattern of an animal

2.3.1 Hierarchical organization of animal complexity

2.3.1.1 Body size and evolution of animals

2.3.1.2 Surface area: Volume ratio

2.3.1.3 Mention energy requirements related to body size (e.g.: Metabolic rate in mm^3 O_2/g body mass per hour of mouse and elephant)

2.3.2 Extracellular components of metazoan bodies

2.3.3 Types of Tissues

Unit III

2.4 Animal body plans

2.4.1 Symmetry (Radiata and Bilateria)

2.4.2 Bilaterian classification based on body cavities – The Coelomata Hypothesis

2.4.3. Metamerism

2.4.4. Cephalization

Module III **12 hours**

Unit I

3.1 The Evolutionary Tree of Animals

Unit II

3.2 Protostomia (List of phyla belonging to this group to be mentioned)

3.2.1 What is a protostome?

3.2.2 Characteristics of a lophotrochozoan (Key lineages)

3.2.3 Introduction to Mollusca

3.2.4 Characteristics of an ecdysozoan (Key lineages)

3.2.5 Introduction to Arthropoda

Unit III

3.3 Deuterostomia (List of phyla belonging to this group to be mentioned)

3.3.1 Definition of deuterostomia

3.3.2 What is an echinoderm? The echinoderm body plan and key features

3.3.3 Chordata: Chordate body plan and salient features

Module IV **11 hours**

Unit I

4.1 What is a Species?

4.1.1 Typological species concept

4.1.2 Biological species concept

4.1.3 Evolutionary species concept

4.1.4 Phylogenetic species concept

4.1.5 Dynamism of species concept

4.2 Taxonomic characters and phylogeny reconstruction

4.2.1 Ancestral characters, derived characters, polarity, outgroup

4.2.3 Sources of phylogenetic information

Unit II

4.3 Theories of Taxonomy

4.3.1 Traditional evolutionary taxonomy

4.3.2 Phylogenetic systematics or cladistics

4.3.3 Mention classification of anthropoid primates and reptiles in light of evolutionary taxonomy and cladistics.

Unit III 4.4 Collection and preservation of animals 4.4.1 Collection of soil fauna, aquatic fauna 4.4.2 Quadrat method and transect methods of biodiversity survey 4.4.3 Camera traps for mammalian observation 4.4.4 Preservation of specimen - wet and dry preservation.
Module V: Practicals **30 Hours** 5.1 Preparation of taxonomic keys (of any 5 animals displayed) 5.1.1. Intended dichotomous keys 5.1.2. Bracketed dichotomous keys. 5.2 Study of microscope 5.3.1 Dissection/stereoscopic 5.3.2. Compound microscope, 5.3.2.1. Use of 10x, 45x, 100x (Any 3) 5.3.3 Camera lucida (Draw any simple biological specimen) 5.3 General features of an animal cell – demonstration. 5.4 Animal cells and tissues – four types of animal tissues viz., epithelial, connective, muscle and nervous tissue to be demonstrated 5.5 Prepare a temporary mount of cheek epithelial cells 5.6 Prepare a blood smear slide and identify different types of cells 5.7 Study of cell division – using permanent slides (mitosis and meiosis) or preparation of a temporary slide of onion root tip.

Teacher Specific Module	**9 hours**
Directions: **20 percent of the experiments can be modified by the course teacher** *Suggestion:*	

Core Compulsory Readings

1. Holland, P., (2011). The Animal Kingdom, A Very Short Introduction. Oxford University Press, New York.
2. Hickman, C. P., Roberts, L. S., Larson, A., Anson, H. I., & Eisenhour, D. J.

(2006). *Integrated principles of zoology* 12th Ed. New York: McGraw-Hill. (Chapter 1 [Module 1]; Chapter 9 [Module 2 and 3], Chapter 10 [Module 4])

3. Freeman, S., Quillin, K., & Allison, L., (2016). Biological Science. 5th Ed. Pearson Education India (Pages 1-55, Module 1; Pages 803-861 Module 2 and 3)

Core Suggested Readings (Books, Journals, E-sources Websites/ weblinks) List

1. https://www.edgeofexistence.org/species/purple-frog/
2. https://animaldiversity.org/accounts/Macaca_silenus/
3. https://www.ifoundbutterflies.org/papilio-buddha
4. https://bigcatsindia.com/royal-bengal-tiger-information-and-facts/
5. https://www.worldwildlife.org/species/indian-elephant

Assessment Rubrics:

Evaluation Type		**Marks**	
		Theory	**Practical**
• End Semester Evaluation		50	15
• Continuous Evaluation		25	10
Continuous Evaluation			
Theory/Practical	Method of Assessment	Marks	
Theory			
a)	Test paper I	5	
b)	Test paper II	5	
c)	Viva-Voce/Seminar/ Discussion	10	
d)	Assignment	5	
		Total – 25 marks	
Practical			
a)	Regularity/Punctuality	5	
b)	Laboratory skill	5	
		Total – 10 marks	

KU1DSCZOO102: ANIMALS AND ENVIRONMENT

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
I	DSC	100	KU1DSCZOO102	3+1	60

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/Tutorial	Practical	CE	ESE	Total	
3	2	25	75	100	1.5

Course Description:

Explore the fundamental principles of Ecology. Dwelve into ecological organization, interactions, and energy flow. Investigate biodiversity, community dynamics, and human impacts on ecosystems. Gain essential knowledge for understanding and contributing to a sustainable world. This course also equips students with essential knowledge and skills for further studies in environmental science, biology, and related fields, fostering an understanding of ecological systems and the importance of environmental stewardship.

Course Prerequisite: Any student with a +2 or equivalent degree

Course Outcomes:

	Expected Outcome	**Learning Domains**
CO1	Understanding of the core principles of ecology	U
CO2	Identify and describe the main components of ecosystems, such as producers, consumers, decomposers, and the abiotic factors influencing these environments	A
CO3	Evaluate the impact of human activities on ecosystems, considering factors like pollution, habitat destruction, and climate change	E
CO4	Propose measures for biodiversity conservation and mitigation of climate change	An

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO4	PSO 5
CO1	1	0	0	0	0
CO2	2	2	2	0	0
CO3	1	0	3	2	3
CO4	3	0	3	1	3

COURSE CONTENTS

Module I: Distribution of Life on Earth (11 hours)

Unit I

1.1 Biosphere and its subdivisions

1.2 Terrestrial environments: Biomes

1.2.1 Principal terrestrial biomes: Temperate, Deciduous forests, Coniferous forests, Tropical forests, Grasslands, Tundra, Desert,

1.2.2 Aquatic environments: Inland waters (lotic and lentic), Oceans (benthic, pelagic, photic, littoral, intertidal, estuary, neritic zones)

Unit II.

1.3 Animal Distribution (Zoogeography)

1.3.1 Disjunct distribution

1.3.2 Distribution by dispersal

1.3.3 Distribution by vicariance

1.3.4 Continental drift theory

Unit III: Animal Ecology

1.4 Hierarchy of ecology: Organisms, populations and communities

1.5 Environment and niche

1.5.1 Habitat

1.6 Population ecology: density, natality, mortality, age structure, carrying capacity(K)

1.7 Population interactions

1.7.1 Types of interaction:

1.7.1.1 Positive interactions (mutualism, commensalism)

1.7.1.2 Negative interactions (predation, competition, parasitism)

1.8 Ecological warfare by Predator and parasites

1.9 Mimicry

1.10 Keystone species

1.11 Social insects

Module II: Ecosystem: Basic concepts, components of ecosystem. (12 hours)

Unit I

2.1 Components of Ecosystems: Trophic levels: Producers, consumers, and decomposers

Unit II

2.2 Food chains and Food webs

2.3 Energy flow in ecosystems

2.4 Ecological pyramids

Unit III

2.5 Nutrient Cycling

2.5.1 Carbon cycle

2.5.2 Nitrogen cycle

2.5.3 Phosphorus cycle

Module III: Biodiversity and Community Ecology (11 hours)

Unit I

3.1 What is biodiversity?

3.2 Levels of Biodiversity: alpha, beta and gamma

3.3 Types of diversity: Genetic Diversity, Species diversity, Ecosystem diversity

Unit II

3.4 Species Richness and Endemism

3.5 Biodiversity Hotspots

Unit III

3.6 Threats to Biodiversity

3.6.1 Habitat destruction, habitat degradation, overexploitation, invasive species, climate change

Module IV: Human Impact and Conservation (11 hours)

Unit I

4.1 Values of biodiversity

4.2 Ethical dimension of biodiversity

Unit II 4.3 Conservation of genetic diversity of populations and species 4.3.1 Management plans for invasive species, 4.3.2 In situ conservation & ex-situ conservation and reintroduction, 4.3.3 Genetic restoration, 4.3.4 Wildlife corridors 4.3.5 Ecosystem restoration **Unit III** 4.5 Climate change: Acid rain, Greenhouse effect, Global warming
Module V: Practicals **(30 hours)** 5.1 Study of ecological relationships: 5.1.1 Mutualism 5.1.2 Commensalism 5.1.3 Parasitism 5.1.4 Predation 5.2 Measurement of pH of different water samples 5.3 Differentiate different castes of honey bees and study their morphological peculiarities 5.4 Study of indicator species 5.5 Measuring dissolved oxygen of given water samples 5.6 Mapping of biodiversity in college campus/ park/sacred groves

Teacher Specific Module	**9 Hours**
Directions: **20 percent of the experiments can be modified by the course teacher** *Suggestion:* Conduct biodiversity surveys in local ecosystems such as parks, forests, or wetlands, identifying and documenting plant and animal species.	

Essential Readings:

1. Muller-Dombols, D. and Ellenberg, H. (1974). Aims and Methods of Vegetation Ecology, Wiley, New York.
2. Odum, E.P. (1983), Basic Ecology, Sanders, Philadelphia.
3. Robert Ricklefs (2001). The Ecology of Nature. Fifth Edition. W.H. Freeman and Company.
4. Singh K.P. and J.S. Singh (1992). Tropical Ecosystems: Ecology and Management. Wiley Eastern Limited, Lucknow, India.
5. Singh, J.S. (ed.) (1993). Restoration of Degraded Land: Concepts and Strategies. Rastogi Publications, Meerut.
6. Smith, R.L. (1996). Ecology and Field Biology, Harper Collins, New York.
7. Botkin, D.B. and Keller, E.A. (2000). Environment Science: Earth as a living planet. Third Edition. John Wiley and Sons Inc.

Core Suggested Readings

1. https://www.biologysimulations.com/ecology
2. https://www.labster.com/course-packages/ecology
3. https://biomanbio.com/HTML5GamesandLabs/EcoGames/ecology.html
4. https://www.pbslearningmedia.org/subjects/science/life-science/ecology/?rank_by=recency
5. https://simbio.com/

Assessment Rubrics:

Evaluation Type		**Marks**	
		Theory	**Practical**
• End Semester Evaluation		50	15
• Continuous Evaluation		25	10
Continuous Evaluation			
Theory/Practical	Method of Assessment	Marks	
Theory			
a)	Test paper I	5	
b)	Test paper II	5	
c)	Viva-Voce/Seminar/ Discussion	10	
d)	Assignment	5	
		Total – 25 marks	
Practical			
a)	Regularity/Punctuality	5	
b)	Laboratory skill	5	
		Total – 10 marks	

KU1DSCZOO103: GENERAL LABORATORY TECHNIQUES

Semester	Course Type	Course Level	Course Code		Credits	Total Hours
I	DSC	100	KU1DSCZOO103		3+1	60
Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture/Tutorial	Practical		CE	ESE	Total	
3	2		25	75	100	1.5

Course Description

This course provides a foundational understanding and practical skills in general laboratory techniques essential for scientific inquiry. Students will gain hands-on experience in basic laboratory operations, safety protocols, and commonly used laboratory instruments. Topics covered include laboratory safety, equipment usage, measurements, sample preparation, and experimental procedures. Through a combination of theoretical knowledge and practical exercises, participants will develop proficiency in laboratory techniques applicable across various scientific disciplines. The course aims to prepare students for success in laboratory settings, fostering competence in conducting experiments, analyzing data, and adhering to ethical and safety standards.

Course Pre-requisite: Any student with a +2 or equivalent degree

Course Outcomes

	Expected Outcome	**Learning Domains**
CO1	Gain a comprehensive understanding of safety protocols in Laboratory	U
CO2	Acquire deep knowledge of microscopes	A
CO3	Develop skills in using temperature sensing devices, centrifuges, and balances	A
CO4	Introduce essential concepts of separation techniques, colorimetry, and spectrophotometry	U

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO4	PSO 5
CO1	0	0	2	1	3
CO2	0	0	2	1	0
CO3	0	0	2	1	2
CO4	0	0	2	2	1

COURSE CONTENTS

Module I Laboratory safety and protocols **(12 hours)**

Unit I Safety training

1.1 General Lab Safety

1.2 Emergency Management

1.3 Waste Management

1.4 Chemical Safety

1.5 Biosafety

1.6 Fire & Safety

Unit II Personal protective equipment

1.7 Eye and Face Protection

1.8 Head Protection

1.9 Hand Protection

1.10 Protective clothing

1.11 Respiratory protection

1.12 Foot Protection

Unit III Good Lab Practice

1.13 Standard operating Procedures

1.14 Safety Signs

1.15 Housekeeping

1.16 Personal Hygiene

1.17 Working alone

1.18 Phones in lab

1.19 Energy Conservation in Lab

1.20 Ordering new equipments & Chemicals

1.21 Emergency equipments & Standard operating Procedures

1.22 Emergency Action Plan

Module II Microscope **(11 Hours)**

Unit I History of Microscopes

2.1Working Principles of optical Microscopes

2.1.1Optical Microscope

2.1.2 Scanning Electron Microscopy

2.1.3Transmission Electron Microscopy

Unit II Micrometry

2.2 Introduction to Micrometry

2.3 Micrometers and Scales

2.4 Calibration

2.5 Measurement Techniques

Unit III: Line Drawing and Image Systems in Microscopy

2.6 Camera Lucida

2.7 Drawing tube

2.8 Digital Tools

2.9 Image Systems in Microscopy

Module III Temperature sensing devices, centrifuges & Balances **(11 hours)**

Unit I Types of thermometers

3.1 Liquid in glass thermometers

3.2 Deformation type thermometers

3.3 Electrical thermometers

Unit II Laboratory Heating Equipment

3.4 Thermocouple

3.5 Thermostat

3.6 Incubator

3.7 Hot air oven

3.8 Water bath

3.9 Magnetic stirrer

Unit III Balances

3.10 Two pan balances

3.11 Single pan balance

3.12 Errors in weighing- lever arm error and scale deflection error

Module IV Analytical Techniques in Biological Sciences (11 hours)

Unit I Introduction to Analytical Techniques

4.1 Overview of analytical methods in biological science

4.2 Importance and applications in research and diagnostics

Unit II: Separation Techniques (Centrifuges, Chromatography & Electrophoresis)

4.3 Centrifuge: Principle and uses; brief accounts on types of centrifuges

4.4 Principles and types of chromatography (e.g., paper, thin-layer, gas, liquid chromatography)

4.5 Fundamentals of electrophoresis

4.6 Types of electrophoresis (agarose gel electrophoresis, SDS-PAGE)

4.7 Applications in DNA, RNA, and protein analysis

Unit III Colorimeter and Spectrophotometer

4.8 Basic principles of colorimetry

4.9 Instruments and measurement techniques

4.10 Principles of spectrophotometry

4.11 Types of spectrophotometry (e.g., UV-Vis spectrophotometry, IR spectrophotometry)

4.12 Instrumentation and techniques

4.13 Applications in quantitative analysis of biomolecules

Module V Practical: (30 hours)

I Operation of the following equipments

- 5.1 Compound microscope
- 5.2 Colorimeter
- 5.3 Spectrophotometer
- 5.4 Hot air oven
- 5.5 Incubator
- 5.6 Autoclave
- 5.7 Electrical balance (monopan)

II. Experiments

- 5.8 Micrometry- Measure dimensions of microscopic objects. (Minor)
- 5.9 Scientific drawing – To draw specimens using camera lucida. (Minor)
- 5.10 Colorimetry- To find the concentration of a given sample solution using standard graph (major)

Teacher Specific Module	**9 hours**
Directions: **20 percent of the experiments can be modified by the course teacher**	

Core Compulsory Readings

1. Mukherjee K L,1998. Medical Laboratory Techniques -Vol. I, II & III. Tata McGraw Hill
2. Sharma V K, 1991. Techniques in Microscopy & Cell Biology. Tata Mc Graw Hill. Pub.
3. Cotterill R, 2012. Biophysics-An Introduction. John Wiley & Sons Ltd. Pub.

Core Suggested Readings

1. Roy K N. A Text Book of Biophysics. New Central Book Agency Pub.
2. De Robertis E D P & E M F De Robertis, 1990. Cell and Molecular Biology. Wavelry Int. Book Distributors, Dehradun.

Assessment Rubrics:

Evaluation Type		**Marks**	
		Theory	**Practical**
• End Semester Evaluation		50	15
• Continuous Evaluation		25	10
Continuous Evaluation			
Theory/Practical	Method of Assessment	Marks	
Theory			
a)	Test paper I	5	
b)	Test paper II	5	
c)	Viva-Voce/Seminar/ Discussion	10	
d)	Assignment	5	
		Total – 25 marks	
Practical			
a)	Regularity/Punctuality	5	
b)	Laboratory skill	5	
		Total – 10 marks	

KU1DSCZOO104: INTRODUCTORY ANIMAL PHYSIOLOGY

<table>
<tr><td>Semester</td><td>Course Type</td><td>Course Level</td><td colspan="2">Course Code</td><td>Credits</td><td>Total Hours</td></tr>
<tr><td>II</td><td>DSC</td><td>100</td><td colspan="2">KU1DSCZOO104</td><td>3+1</td><td>60</td></tr>
<tr><td colspan="3">Learning Approach (Hours/ Week)</td><td colspan="3">Marks Distribution</td><td rowspan="2">Duration of ESE (Hours)</td></tr>
<tr><td>Lecture/Tutorial</td><td colspan="2">Practical</td><td>CE</td><td>ESE</td><td>Total</td></tr>
<tr><td>3</td><td colspan="2">2</td><td>25</td><td>75</td><td>100</td><td>1.5</td></tr>
</table>

Course Description

This course is aimed as a preliminary course of animal biology, emphasizing key topics such as animal size, homeostasis, osmoregulation, sensory systems and locomotion. The course covers topics on tissues, organs and organ systems. The student is introduced to homeostasis and heat exchange in animals. Animal osmoregulation and locomotory structures like muscles and skeleton are discussed. Another important aspect of animal colouration and integument is introduced here. The final section focuses on nerve impulse transduction, memory and sensory organs.

Course Pre requisite: Any student with a +2 or equivalent degree

Course Outcomes:

	Expected Outcome	**Learning Domains**
CO1	Understand the structure and functioning of different systems in animals	U
CO2	Evaluate different physiological parameters and assess the wellbeing of organisms	E
CO3	Observe morphological structures and analyse their reel in adaptation of organisms to the environment	An
CO4	Understand the mechanism behind memory	U
CO5	Make observations on physiological samples and predict the wellbeing of the animal	An

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

Mapping of Course Outcomes to PSOs

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	1	1	2	2	0
CO2	1	1	3	3	1
CO3	2	2	3	3	1
CO4	0	0	2	2	2
CO5	1	2	3	3	3

COURSE CONTENTS

Module I Animal form and function: (12 hours)

Unit I

1.1 The role of Fitness trade-offs

1.1.1 Case study of spermatophore deposition in crickets

1.1.2 Adaptation and acclimatization

1.2 Correlation of structure and function

1.2.1 case study of Galapagos finch beak

Unit II

1.3 Tissues and organs

1.3.1 Connective tissue

1.3.2 Nervous tissue

1.3.3 Muscle tissues

1.3.4 Epithelial tissue

1.3.5 Organs and organ systems

Unit III

1.4 Body size and animal physiology

1.5 Homeostasis

1.5.1 Confirmation and regulation

1.6 Body temperature regulation

1.6.1 Mechanism of heat exchange

1.6.2 Variation in thermoregulation

1.6.3 Endothermy and Ectothermy; temperature homeostasis in endotherms

1.6.4 Counter current heat exchange

Module II Animal Integument and Skeleton (11 hours)

Unit I

2.1 Invertebrate integument

2.2 Vertebrate integument and derivatives 2.2.1 Animal colouration 2.3 Hydrostatic skeletons 2.4 Rigid skeletons 2.5 notochord and cartilage **Unit II** 2.7 Animal movement 2.8 Ameboid movement 2.9 Ciliary and flagellar movement **Unit III** 2.10 Muscular movement 2.10.1 Types of vertebrate muscles 2.10.2 Types of invertebrate muscles 2.10.3 Sliding Filament Hypothesis
Module III Osmoregulation and Excretion (11 hours) **Unit I** 3.1 Diffusion, osmosis, osmotic stress 3.2 How do electrolytes and water move across cell membranes? 3.2.1 Types of Nitrogenous wastes **Unit II** 3.3 Water and Electrolyte balance in Marine fishes 3.4 Water and Electrolyte balance in freshwater fishes **Unit III** 3.5 Water and electrolyte balance in terrestrial insects 3.6 Water and Electrolyte balance in terrestrial vertebrates
Module IV Nervous and Sensory systems (11 hours) **Unit I** 4.1 Principles of Electrical signaling

4.2 Membrane potentials

4.2.3 Maintenance of resting potential

4.2.4 Action potential

4.2.4.1 Working of voltage gated channels, propagation of potentials

4.3 Neurotransmitters

Unit II

4.4 The vertebrate nervous systems: Peripheral and Central nervous systems

4.5 How does memory work?

4.6 How does sensory organs convey information to brain

4.7 Sensory transduction

Unit III

(Brief details on)

4.8 Mechanoreception

4.8.1 Hair cells, signal transduction in hair cells, Mammalian ear, echolocation in bats, lateral line system in fishes

4.9 Photoreception

4.9.1 Insect eye, Vertebrate eye, rods and cones,

4.10 Chemoreception

4.10.1 Taste detection, olfaction,

4.11 Thermoreception, Electroreception, and Magnetoreception.

Module V: Practicals **30 hours**

5.1 Measuring osmosis and hemolysis in RBCs

5.2 Observing the effects of exercise on the human body

5.3 Test for uric acid: phosphotungstic acid test and Benedict's test

5.4 Test for ammonia in urine solution

5.5 Test for urea in urine solution

5.6 Estimation of hemoglobin content using Hemoglobinometer

5.7 Hemocytometer – demonstration.

5.8 Differential WBC count

Teacher Specific Module	9 hours
Directions: **20 percent of the experiments can be modified by the course teacher** *Suggestion:* 1.Study of model and identification of parts (Heart and Kidney) 2.Classification of animals based on nitrogenous wastes	

Core Compulsory Readings

1. Freeman, S., Quillin, K., & Allison, L., (2016). Biological Science. 5th Ed. Pearson Education India (Pages 1031-1151).

Core Suggested Readings

1. Biology: A Global Approach" by Neil A. Campbell, Jane B. Reece, et al.
2. Biology: How Life Works" by James Morris, Daniel L. Hartl, et al.
3. Human Physiology: An Integrated Approach" by Dee Unglaub Silverthorn
4. Life: The Science of Biology by David Sadava et al.
5. Biology by Raven et al.
6. Mosby's Handbook of Anatomy and Physiology by Kevin T. Patton; Gary A. Thibodeau
7. Anatomy & Physiology Animations (https://bialive.com/animations/anatomy.htm)
8. Anatomy Corner (https://anatomycorner.com/main/)
9. Get Body Smart(https://www.getbodysmart.com/)
10. Gray's Anatomy of the Human Body (https://www.bartleby.com/lit-hub/anatomy-of-the human-body/)
11. Human Anatomy and Physiology (Khan Academy) (https://www.khanacademy.org/science/health-and-medicine/human-anatomy-and-physiology)
12. Inner Body(https://www.innerbody.com/htm/body.html)
13. Visible Human Project (National Library of Medicine) (https://www.nlm.nih.gov/research/visible/visible_human.html)

Assessment Rubrics:

Evaluation Type		Marks	
		Theory	**Practical**
• End Semester Evaluation		50	15
• Continuous Evaluation		25	10
Continuous Evaluation			
Theory/Practical	Method of Assessment	Marks	
Theory			
a)	Test paper I	5	
b)	Test paper II	5	
c)	Viva-Voce/Seminar/ Discussion	10	
d)	Assignment	5	
	Total – 25 marks		
Practical			
a)	Regularity/Punctuality	5	
b)	Laboratory skill	5	
	Total – 10 marks		

KU2DSCZOO105: FUNDAMENTALS OF ANIMAL BIOLOGY

Semester	Course Type	Course Level	Course Code		Credits	Total Hours
II	DSC	100	KU2DSCZOO105		3+1	60
Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture/Tutorial	Practical		CE	ESE	Total	
3	2		25	75	100	1.5

Course Description

This course is aimed as a preliminary course of animal biology, emphasizing key topics such as animal size, homeostasis, osmoregulation, sensory systems and locomotion. The course covers topics on tissues, organs and organ systems. The student is introduced to homeostasis and heat exchange in animals. Animal osmoregulation and locomotory structures like muscles and skeleton are discussed. Another important aspect of animal colouration and integument is introduced here. The final section focuses on nerve impulse transduction, memory and sensory organs.

Course Pre requisite: Any student with a +2 or equivalent degree

Course Outcomes:

	Expected Outcome	**Learning Domains**
CO1	Understand the structure and functioning of different systems in animals	U
CO2	Evaluate different physiological parameters and assess the wellbeing of organisms	E
CO3	Observe morphological structures and analyse their reel in adaptation of organisms to the environment	An
CO4	Understand the mechanism behind memory	U
CO5	Make observations on physiological samples and predict the wellbeing of the animal	An

**Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)*

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO4	PSO 5
CO1	1	1	2	2	0
CO2	1	1	3	3	1
CO3	2	2	3	3	1
CO4	0	0	2	2	2
CO5	1	2	3	3	3

COURSE CONTENTS

Module I Animal form and function: (12 hours)

Unit I

1.1 The role of Fitness trade-offs

1.1.1 Case study of spermatophore deposition in crickets

1.1.2 Adaptation and acclimatization

1.2 Correlation of structure and function

1.2.1 case study of Galapagos finch beak

Unit II

1.3 Tissues and organs

1.3.1 Connective tissue

1.3.2 Nervous tissue

1.3.3 Muscle tissues

1.3.4 Epithelial tissue

1.3.5 Organs and organ systems

Unit III

1.4 Body size and animal physiology

1.4.1 The surface area/volume relationships

1.4.2 Case study comparing surface area/volume relationship

1.5 Adaptations that increase surface area

1.6 Homeostasis

1.6.1 Confirmation and regulation

1.7 Body temperature regulation

1.7.1 Mechanism of heat exchange

1.7.2 Variation in thermoregulation

1.7.3 Endothermy and Ectothermy; temperature homeostasis in endotherms

1.7.4 Counter current heat exchange

Module II Animal Integument and Skeleton **(11 hours)**

Unit I

2.1 Invertebrate integument

2.2 Vertebrate integument and derivatives

2.2.1 Animal colouration

2.3 Hydrostatic skeletons

2.4 Rigid skeletons

2.5 notochord and cartilage

2.6 General plan of vertebrate skeleton

Unit II

2.7 Animal movement

2.8 Ameboid movement

2.9 Ciliary and flagellar movement

Unit III

2.10 Muscular movement

2.10.1 Types of vertebrate muscles

2.10.2 Types of invertebrate muscles

2.10.3 Sliding Filament Hypothesis

Module III Osmoregulation and Excretion **(11 hours)**

Unit I

3.1 Diffusion, osmosis, osmotic stress

3.2 How do electrolytes and water move across cell membranes?

3.2.1 Types of Nitrogenous wastes

Unit II

3.3 Water and Electrolyte balance in Marine fishes

3.4 Water and Electrolyte balance in freshwater fishes

Unit III

3.5 Water and electrolyte balance in terrestrial insects

3.6 Water and Electrolyte balance in terrestrial vertebrates

Module IV Nervous and Sensory systems (11 hours)

Unit I

4.1 Principles of Electrical signaling

4.2 Membrane potentials

4.2.3 Maintenance of resting potential

4.2.4 Action potential

4.2.4.1 Working of voltage gated channels, propagation of potentials

4.3 Neurotransmitters

Unit II

4.4 The vertebrate nervous systems: Peripheral and Central nervous systems

4.5 How does memory work?

4.6 How does sensory organs convey information to brain

4.7 Sensory transduction

Unit III

(Brief details on)

4.8 Mechanoreception

4.8.1 Hair cells, signal transduction in hair cells, Mammalian ear, echolocation in bats, lateral line system in fishes

4.9 Photoreception

4.9.1 Insect eye, Vertebrate eye, rods and cones,

4.10 Chemoreception

4.10.1 Taste detection, olfaction,

4.11 Thermoreception, Electroreception, and Magnetoreception.

Module V Practicals 30 hours

5.1 Measuring osmosis and hemolysis in RBCs

5.2 Observing the effects of exercise on the human body

5.3 Test for uric acid: phosphotungstic acid test and Benedict’s test

5.4 Test for ammonia in urine solution

5.5 Test for urea in urine solution

5.6 Estimation of hemoglobin content using Hemoglobinometer

5.7 Hemocytometer – demonstration.

5.8 Differential WBC count

Teacher Specific Module	9 hours
Directions: **20 percent of the experiments can be modified by the course teacher** *Suggestion:* 1.Study of model and identification of parts (Heart and Kidney) 2.Classification of animals based on nitrogenous wastes	

Core Compulsory Readings

1. Freeman, S., Quillin, K., & Allison, L., (2016). Biological Science. 5th Ed. Pearson Education India (Pages 1031-1151).

Core Suggested Readings

1. Biology: A Global Approach" by Neil A. Campbell, Jane B. Reece, et al.
2. Biology: How Life Works" by James Morris, Daniel L. Hartl, et al.
3. Human Physiology: An Integrated Approach" by Dee Unglaub Silverthorn
4. Life: The Science of Biology by David Sadava et al.
5. Biology by Raven et al.
6. Mosby's Handbook of Anatomy and Physiology by Kevin T. Patton; Gary A. Thibodeau
7. Anatomy & Physiology Animations (https://bialive.com/animations/anatomy.htm)
8. Anatomy Corner (https://anatomycorner.com/main/)
9. Get Body Smart(https://www.getbodysmart.com/)
10. Gray's Anatomy of the Human Body (https://www.bartleby.com/lit-hub/anatomy-of-the human-body/)
11. Human Anatomy and Physiology (Khan Academy) (https://www.khanacademy.org/science/health-and-medicine/human-anatomy-and-physiology)
12. Inner Body(https://www.innerbody.com/htm/body.html)
13. Visible Human Project (National Library of Medicine) (https://www.nlm.nih.gov/research/visible/visible_human.html)

Assessment Rubrics:

Evaluation Type		Marks	
		Theory	**Practical**
• End Semester Evaluation		50	15
• Continuous Evaluation		25	10
Continuous Evaluation			
Theory/Practical	Method of Assessment	Marks	
Theory			
a)	Test paper I	5	
b)	Test paper II	5	
c)	Viva-Voce/Seminar/ Discussion	10	
d)	Assignment	5	
		Total – 25 marks	
Practical			
a)	Regularity/Punctuality	5	
b)	Laboratory skill	5	
		Total – 10 marks	

KU2DSCZOO106: BASICS OF EVOLUTIONARY BIOLOGY

Semester	Course Type	Course Level	Course Code		Credits	Total Hours
II	DSC	100	KU2DSCZOO106		3+1	60
Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)	
Lecture/Tutorial	Practical	CE	ESE	Total		
3	2	25	75	100	1.5	

Course Description

This course covers the core concepts, theories, and evidence that underpin the fascinating process of how life on Earth has transformed over time. From understanding the concept of evolution and exploring the historical theories proposed by key figures like Darwin, to examining compelling evidence such as fossils and genetic variations, participants will gain a comprehensive insight into the forces shaping the diversity of living organisms. This course not only equips learners with a solid foundation in evolutionary biology but also fosters a deeper appreciation for the interconnectedness of all living beings and the dynamic tapestry of life on our planet.

Course Pre-requisite: Any student with a +2 or equivalent degree

Course Outcomes:

	Expected Outcome	Learning Domains
CO1	Students will acquire a thorough understanding of the concept of evolution	U
CO2	Analyse data on homologous characters and prepare a simple phylogeny	An
CO3	Using genetic data on allele frequencies calculate genetic equilibrium	An
CO4	Understand the concept of evolutionary population variation and apply the knowledge to comprehend pressing issues like antibiotic resistance, viral transmissions etc.	An
CO5	Understand the sources of genetic variation and their consequences	U

**Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)*

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO4	PSO 5
CO1	2	2	2	1	1
CO2	3	3	3	1	0
CO3	1	1	3	1	0
CO4	1	1	3	3	3
CO5	1	1	3	1	0

COURSE CONTENTS

Module I **(11 hours)**

Unit I

1.1 What is Evolution?

1.2 Organic Evolution, descent of populations with modifications

1.2.1 Case study: evolution of antibiotic resistance, transmission of HIV, evolution of insecticide resistance (any one)

Unit II

1.3 Origin of Life

1.4 Abiogenesis vs. Biogenesis

Unit III

1.5 Early Earth Conditions

1.6 Miller-Urey Experiment and the Origin of Organic Molecules

Module II **(11 hours)**

Unit I

2.1 Evolutionary theories before Darwin

2.1.1 Ideas of Plato, Linnaeus, Charles Lyell and Lamarck

Unit II

2.2 Darwin’s theory of Evolution

2.2.1 Darwin's Explanatory Model of Evolution by Natural Selection

2.2.2 Change over time, common descent, gradualism, population change and natural selection

Unit III

2.3 Modern Synthesis

2.3.1 Microevolution and macroevolution

2.3.2 Principal claims of Evolutionary synthesis

2.4 Concept of tree of life

Module III **(11 hours)**

Unit I

3.1 Evidences of evolution from Fossil record: Types of Fossils

3.1.1 Hominin fossil records

3.1.2 Punctuated equilibria

Unit II

3.2 Time scale of origin of life

3.2.1 Major features of:

3.2.1.1 Precambrian Life

3.2.1.2 Paleozoic life: Cambrian explosion, ordovician and silurian, carboniferous and permian

3.2.1.3 Mesozoic life

3.2.1.4 Coenozoic era

Unit III

3.3 Evidences of evolution from Comparative Anatomy:

3.3.1 Homologous Structures

3.3.2 Analogous Structures

3.3.3 Vestigial Organs

Module IV **(12 hours)**

Unit I

4.1 Geological time scale and Evolutionary trend: Example of evolution of Horse.

4.2 Concept of homology: importance in phylogenetic reconstruction

4.3 Ontogeny, Phylogeny and recapitulation

4.3.1 Heterochrony, pedomorphosis

Unit II

4.4 Multiplication of species

4.4.1 Allopatric speciation, sympatric speciation, vicariant speciation, Adaptive radiation

4.5 Gradualism 4.6 Adaptation **Unit III** 4.7 Role of mutation and recombination in maintaining genetic variation in populations 4.8 Microevolution: Allele frequency and Genetic Equilibrium 4.8.1 Disruption of Genetic Equilibrium: Genetic Drift. Non-random mating, migration, Natural selection 4.8.2 Methods for measurement of Genetic variation within populations 4.9 Macroevolution
Module V: Practicals **(30 hours)** • Study of homologous organs and divergent evolution. • Study of analogous structures and convergent evolution. • Study of vestigial organs in animals. • Preparation of a phylogeny of a group of animals using homologous characters • Study of Hardy-Weinberg equilibrium using coloured beads • Simulation of genetic drift using online resources • Study of adaptive radiation

Teacher Specific Module	**9 hours**
Directions: **20 percent of the experiments can be modified by the course teacher** *Suggestion:* • Adaptations of fishes. • Study of phylogeny of horse using pictures.	

Core Compulsory Readings

1. Futuyma, Douglas J. (1998). Evolutionary Biology (3rd ed.). Sunderland, MA: Sinauer Associates.
2. Hickman, C. P., Roberts, L. S., Larson, A., Anson, H. I., & Eisenhour, D. J. (2006). *Integrated principles of zoology* 12th Ed. New York: McGraw-Hill.

Core Suggested Readings

1. Evolution - Douglas J Futuyma. by: Doug J Futuyma
2. Strickberger's Evolution, Brian Keith Hall, Benedikt Hallgrímsson, Monroe W. Strickberger
3. Campbell Biology

4. Life: The Science of Biology by David Sadava et al.
5. Biology by Raven et al.
6. http://www.coursesource.org/
7. http://www.evo-ed.org/
8. https://evolution-outreach.springeropen.com/
9. https://www.hhmi.org/biointeractive/evolution-collection
10. https://ncse.com/
11. https://ncse.com/signup-ncseteach
12. https://ncse.com/scientistinclassroom
13. https://ncse.com/dealingwithdenial
14. https://ncse.com/classroom-resources
15. https://www.pbs.org/wgbh/evolution/educators/course/index.html
16. http://www.sensoryecology.com/games/
17. http://humanorigins.si.edu/education/teaching-evolution-through-human-examples
18. http://evolution.berkeley.edu/
19. http://undsci.berkeley.edu/

Assessment Rubrics:

Evaluation Type		**Marks**	
		Theory	**Practical**
• End Semester Evaluation		50	15
• Continuous Evaluation		25	10
Continuous Evaluation			
Theory/Practical	Method of Assessment	Marks	
Theory			
a)	Test paper I	5	
b)	Test paper II	5	
c)	Viva-Voce/Seminar/ Discussion	10	
d)	Assignment	5	
		Total – 25 marks	
Practical			
a)	Regularity/Punctuality	5	
b)	Laboratory skill	5	
		Total – 10 marks	

KU2DSCZOO107: BASCIS OF COLLECTION AND PRESERVATION OF BIOLOGICAL SPECIMEN

<table>
<tr><td>Semester</td><td>Course Type</td><td>Course Level</td><td colspan="2">Course Code</td><td>Credits</td><td>Total Hours</td></tr>
<tr><td>II</td><td>DSC</td><td>100</td><td colspan="2">KU2DSCZOO107</td><td>3+1</td><td>60</td></tr>
<tr><td colspan="3">Learning Approach (Hours/ Week)</td><td colspan="3">Marks Distribution</td><td rowspan="2">Duration of ESE (Hours)</td></tr>
<tr><td>Lecture/Tutorial</td><td colspan="2">Practical</td><td>CE</td><td>ESE</td><td>Total</td></tr>
<tr><td>3</td><td colspan="2">2</td><td>25</td><td>75</td><td>100</td><td>1.5</td></tr>
</table>

Course Description

This course is designed to provide a comprehensive understanding of the fundamental principles and techniques involved in collecting, handling, and preserving biological specimens. Biological specimens, including plants, animals, and microorganisms, play a crucial role in scientific research, biodiversity studies, and environmental monitoring. The accuracy and reliability of biological data heavily depend on the meticulous collection and preservation of these specimens. Throughout this course, we will delve into the importance of ethical and sustainable practices, ensuring scientific endeavours contribute positively to the understanding and protection of our natural world.

Course Pre-requisite: Any student with a +2 or equivalent degree

Course Outcomes:

	Expected Outcome	**Learning Domains**
CO1	Understand the Importance of different biological specimen collection	E
CO2	Learn different field techniques for specimen collection, maintenance and transportation	A
CO3	Learn and apply diverse preservation methods for preservation	A
CO4	Demonstrate responsible stewardship of biological specimens for research and conservation, grounded in ethical principles and best practices.	E

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO4	PSO 5
CO1	2	3	1	1	2
CO2	2	3	1	1	2
CO3	3	3	1	1	2
CO4	2	2	0	0	3

COURSE CONTENTS

Module I Collection Techniques **(12 hours)**

Unit I Introduction to Collection Techniques

1.1 Introduction to Biological Collection: Importance of biological collection in research and conservation.

1.3 Types of Biological Collections

Unit II Herbarium techniques

1.3 Methods and equipments required

1.4 Preservation

1.5 Storage

Unit III Taxonomic collection from various ecological Zones

1.6 Major ecological Zones

1.7 Factors effecting zonation and distribution of Animals

1.8 Collection equipments and method of operation

Module II Preservation Techniques **(11 hours)**

Unit I Preservation Techniques

2.1Steps for the preservation for scientific study

2.2 Preserving Solutions

2.3 Preservation methods (any one method for each group)

2.4 Labels and Records

Unit II Preparation of museum specimens (animal)

2.5 Vertebrate skeletal techniques

2.6 Taxidermy: Methodology (of mammals and birds)

Unit III Slide preparations

2.7 Cell division in animal and plant cells

2.8 Preparation of blood smear

Module III Maintenance and transportation of Plants & Animals (11 hours)

Unit I Maintenance of living organisms

3.1 Aquarium

3.2 Terrarium

Unit II Transportation of Plants & Animals

3.3Transportation of plants

3.4 Transportation of Animals

Unit III Monitoring and Health Management

3.5 Regular monitoring schedules and procedures

3.6 Common diseases in plants and animals

3.7 Identifying and mitigating stress factors during maintenance and transportation

3.8 Best practices to minimize stress in plants and animals

Module IV Ethical Aspects When Using Biological Samples for Research (11 hours)

Unit I Ethical Considerations in Data Collection and use

4.1 Importance of maintaining anonymity Techniques for anonymizing data

4.2 Methods for preserving biological data Ensuring data integrity over time

4.3 Regulatory Bodies and Compliance

Unit II Ethical Approval and Animal Welfare

4.4 Ethical Guidelines for Animal Use

4.5 Euthanasia and Repatriation

Unit III Standards, Best Practices, and Conservation Ethics

4.6 Developing and implementing best practices for ethical research

4.7 Ensuring high standards in data collection, handling, and analysis

4.8 Conservation-Related Ethics

4.9 Sustainable Research Practices

Module V: Practical (30 hours)

1. Method of preparation of museum specimens
2. Animal specimens – any 5

3. Plant specimens – any 5
II. Record should carry sketches and notes on method of preparation.
III. Field Visit to Major Ecological Zones nearby & Taxonomic collection of specimens

Teacher Specific Module	**9 hours**
Directions: **20 percent of the experiments can be modified by the course teacher**	

Core Compulsory Readings

1. Singh H B and Subramaniam B. Field Manual on Herbarium Techniques. Published by National Institute of Science Common, New Delhi.
2. Vieria K S, Vieria WLS and Alves R, 2015. An introduction to Zoological Taxonomy and the Collection and Preservation of Zoological Specimens.
3. Jairajpuri M S, 1990. Collection and Preservation of Animals. Zoological Survey of India,Calcutta, Pub.
4. Proger, L W, 1951. Preparation of Museum Specimens: in Annals of Royal College of Surgeons of England, vol 8 (5): pages 388-391.
5. Frederick C H, 1975. Techniques for Skeletonizing Vertebrates in American Antiquity, vol 40(2): pages 215-219.
6. Maynard C J, 2002. Manual of Taxidermy. Botson S E, Cassino& Co. Pub.
7. Broekel R, 1982. Aquariums and Terrariums. Children Press Pub.

Core Suggested Readings

1. International Council of Museums (ICOM). (2017). "ICOM Code of Ethics for Museums." Available online: ICOM Code of Ethics
2. Schofield, J., Morris, M., & Mawdsley, N. (2009). "Fieldwork for Design: Theory and Practice." Springer.

Assessment Rubrics:

Evaluation Type		Marks	
		Theory	**Practical**
• End Semester Evaluation		50	15
• Continuous Evaluation		25	10
Continuous Evaluation			
Theory/Practical	Method of Assessment	Marks	
Theory			
a)	Test paper I	5	
b)	Test paper II	5	
c)	Viva-Voce/Seminar/ Discussion	10	
d)	Assignment	5	
		Total – 25 marks	
Practical			
a)	Regularity/Punctuality	5	
b)	Laboratory skill	5	
		Total – 10 marks	

Employability for the Course / Programme:

- Museum Curator or Collections Manager
- Field Biologist
- Laboratory Technician or Specialist
- Conservation Biologist
- Aquarium or Zoo Technician
- Ethics and Compliance Officer
- Environmental Consultant

KU2DSCZOO108: CELL BIOLOGY AND IMMUNOLOGY

<table>
<tr><td>Semester</td><td>Course Type</td><td>Course Level</td><td colspan="2">Course Code</td><td>Credits</td><td>Total Hours</td></tr>
<tr><td>IV</td><td>DSC</td><td>200</td><td colspan="2">KU2DSCZOO108</td><td>3+1</td><td>60</td></tr>
<tr><td colspan="3">Learning Approach (Hours/ Week)</td><td colspan="3">Marks Distribution</td><td rowspan="2">Duration of ESE (Hours)</td></tr>
<tr><td>Lecture/Tutorial</td><td colspan="2">Practical</td><td>CE</td><td>ESE</td><td>Total</td></tr>
<tr><td>3</td><td colspan="2">2</td><td>25</td><td>75</td><td>100</td><td>1.5</td></tr>
</table>

Course Description: This course helps the students to gather overall knowledge regarding the basic unit of life, the Cell. This course is designed to enable them to understand the functions of Cellular components in supporting all the life processes. Students also achieve a comprehensive & detailed understanding of the immune system and its role in animal biology.

Course Prerequisite:

Course Outcomes:

	Expected Outcome	**Learning Domains**
CO1	Learn the role of cell in supporting life activities & comprehend the activities of cellular organelles	U
CO2	Learn the fundamental principles of inheritance	U
CO3	Recognize abnormal cellular structures and functions associated with diseases, such as cancer, infections, and genetic disorders	An
CO4	Understand the immune system of animals and apply the knowledge for human wellbeing	U

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

Mapping of Course Outcomes to PSOs

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	0	0	3	3	0
CO2	1	0	3	2	1
CO3	2	0	3	3	2
CO4	0	0	3	3	1

COURSE CONTENTS

Module I: Overview of Cells and Structure & functions of Cell organelles (10 hours)

Unit I- Cell types

1.1 Prokaryotic & Eukaryotic cell

1.2 Virus & Mycoplasma

Unit II- Plasma Membrane & Cytoskeleton

1.3 Plasma membrane: Structure (Fluid mosaic model)

1.4 Plasma membrane: Functions (Transport & Cytosis)

1.5 Cytoskeleton: Microtubules, microfilaments, intermediate filaments

Unit III- Mitochondria& Microbodies

1.6 Mitochondria: Structure, oxidative phosphorylation, electron transport chain

1.6.1 Endosymbiotic hypothesis

1.7 Microbodies: Peroxisomes & Glyoxysomes: Functions

Module II: Nucleus & Cell Reproduction (11 hours)

Unit I: Nucleus – Structure & Functions

2.1 Nucleus- structure, nuclear envelop, nucleolus, nuclear pore complex

2.2 Nucleus- functions

Unit II: Chromosomes & its types

2.3 Types of Chromosomes

2.4 Chromatin-Euchromatin & heterochromatin

2.5 Nucleosome concept

Unit III: Cell Reproduction & Cancer

2.6 Cell cycle

2.7 Mitosis

2.8 Meiosis

2.9 Cancer-

2.9.1 Types

2.9.2 Characteristics

2. 9. 3 Cancer Therapy

Module III: Introduction to Immunology (12 hours)

Unit I: Definition & scope, Types of Immunity

3.1 Natural and Acquired immunity

3.2 Active and passive immunity

3.3 Cell mediated immunity, Humoral immunity

Unit II: Immune response

3.4 Primary immune response

3.5 Secondary immune response

Unit III: Organs of Immune System

3.6 Thymus

3.7 Spleen

3.8 Bursa of Fabricius

3.9 Lymph nodes

3.10 Mucosa Associated Lymph Tissue

Module IV: Cells of Immune system and Hypersensitivity (12 hours)

Unit I: Cells of Immune System and Antibodies

4.1 T cells

4.2 B Cells

4.3 Granulocytes

4.4 Mast Cells & Dendritic Cells

4.5 Structure of Antibody

4.6 Diversity of antibody

4.7 Genetic basis of antibody diversity - Somatic recombination theory (Brief Mention Only)

Unit II: Hypersensitivity

4.8 Types of hypersensitivity- I, II, III & IV.

4.9 Brief accounts of allergy and anaphylaxis

4.10 Autoimmunity

Unit III: Vaccination and Transplantation Immunology

4.11 Definition, principles
4.12Vaccines-types (Brief account)

4.13 National Immunization Programme

4.13.1 BCG

4.13.2 DPT

4.13.3 OPV

4.14 Types of grafts

4.15 Graft rejection

4.16 Prevention of Graft rejection

Module V: Practicals **(30 hours)**

1. Micrometry -Measurement of microscopic objects.

2. Study of mitotic stages – Onion root tip squash preparation.

3. Study of meiosis – Grasshopper testis squash.

4. Salivary gland Chromosome- Drosophila

5. Staining of buccal epithelial cells.

6. Chi-square analysis using beads

7. Study of human karyotype (normal & abnormal)

8. Buccal smear – Identification of Barr Body

9. Blood Grouping (ABO & Rh factor)

10. Histology Slides- Lymphocyte, Thymus, Tonsil, Spleen, MALT

11. Blood Smear and observation of different immune cells.

Teacher Specific Module	**9 Hours**
Directions: **20 percent of the experiments can be modified by the course teacher**	

Essential Readings:

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). Principles of Genetics. VIII Edition. Wiley India. ISBN No. 978-8126510436.
2. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc. ISBN No. 978-0470388259
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). Concepts of Genetics. X Edition. Benjamin Cummings. ISBN No. 978-0321724120.
4. Russell, P. J. (2009). Genetics- A Molecular Approach.III Edition. Pearson Education India. ISBN No. 978-0321569769.
5. Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. (2007) Introduction to Genetic Analysis. IX Edition. W. H. Freeman and Co. ISBN No. 978-0716768876
6. Fletcher H., Hickey I, Winter P (2006). BIOS Instant Notes in Genetics. III Edition. GS, Taylor and Francis Group, New York and London. ISBN No. 978-0415376198.

Assessment Rubrics:

Evaluation Type		**Marks**	
		Theory	**Practical**
1. End Semester Evaluation		50	15
2. Continuous Evaluation		25	10
Continuous Evaluation			
Theory/Practical	Method of Assessment	Marks	
Theory			
a)	Test paper I	5	
b)	Test paper II	5	
c)	Viva-Voce/Seminar/ Discussion	10	
d)	Assignment	5	
	Total – 25 marks		
Practical			
a)	Regularity/Punctuality	5	
b)	Laboratory skill	5	
	Total – 10 marks		

LEVEL 200 DSC COURSES

KU3DSCZOO201: ANIMAL PHYSIOLOGY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
III	DSC	200	KU3DSCZOO201	3+1	60

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/Tutorial	Practical	CE	ESE	Total	
3	2	25	75	100	1.5

Course Description:

This course explores the physiological processes of animals, including nutrition, respiration, circulation, excretion, nerve function, and muscle activity. Through theoretical study and practical application, students gain insight into how animals maintain homeostasis and adapt to diverse environments.

Course Prerequisite:

Course Outcomes:

	Expected Outcome	**Learning Domains**
CO1	Identify and explain the basic physiological processes that allow animals to survive in different habitats	U
CO2	Apply the scientific method to studies of animal physiology by conceiving and designing an experimental approach for studying specific physiological processes	A
CO3	Improve scientific literacy by critically evaluating scientific literature and articulating the key questions, hypotheses, methods, results, and conclusions	An
CO4	Evaluate and compare different approaches for applying physiological principles to practical applications in the lab and field to answer physiological questions	E
CO5	Connect physiological principles to other scientific disciplines (e.g., ecology, behaviour, morphology)	C

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO4	PSO 5
CO1	1	0	3	2	3
CO2	0	0	2	1	2
CO3	0	1	3	3	1
CO4	1	1	3	3	1
CO5	0	0	3	3	1

COURSE CONTENTS

Module I: Neurotransmission Physiology and Physiology of Motility (13 hours)

Unit I

Membrane physiology

1.1 Functional consequences of molecular composition and arrangement (Gibbs Donnan Equilibrium).

1.2 Transport across cell membrane- Diffusion, active transport, ionic pump (Na-K pump, Calcium channel); uniports, symports and antiport, co-transport by symporters and antiporters.

Unit II

Physiology of neuronal system

1.3 Membranes potential

1.4 Propagation of action potential across the myelinated and non-myelinated nerve fibres, All or none law, Summation. Synaptic transmission

1.5 Electrical transmission, Chemical transmission, Mixed transmission

1.6 Neurotransmitters (eg. Acetylcholine, Adrenaline, GABA, Dopamine, Serotonin, Glycine)

Unit III

1.7 Neuromuscular junction

1.8 Biochemistry of contractile proteins

1.9 Physiology of skeletal muscle

a) Actomyosin complex

b) Source of energy for muscle contraction - Cori Cycle

c) Sliding filament theory

d) Excitation- Contraction Coupling, Role of Calcium

e) Mechanism of relaxation

Module II: Physiology of Respiration and Circulation (12 hours)

Unit I

2.1 Physiological anatomy and histology of respiratory passage and lungs

2.2 Mechanism of pulmonary ventilation (inspiration & expiration)

2.3 Alveolar ventilation, dead space and its effect on alveolar ventilation

2.4 Role of surfactant in alveolar expansion

2.5 Pulmonary volumes and capacities

2.6 Transport of oxygen and carbon dioxide (Haldane Effect and Bohr Effect)

2.7 Oxygen dissociation curve

2.8 Neural and chemical regulation of respiration

Unit II

2.9 Structure of human heart

2.10 Pacemaker and specialized conducting fibres

2.11 Cardiac cycle

2.12 ECG – Principle and application

2.13 Neuro hormonal regulation of cardiac amplitude and frequency (Acetylcholine and Adrenaline)

Unit III

2.14 Blood clotting mechanism (Extrinsic and Intrinsic Pathway), Anticoagulants.

2.15 Lymph channels of the body

2.16 Composition and formation of lymph

2.17 Functions of lymph and lymphatic system

Module III: Nutritional Physiology (10 hours)

Unit I

3.1 Constituents of normal diet and their daily requirements, balanced diet: A human perspective; Malnutrition (PEM, Obesity)

3.2 Digestion of carbohydrate, protein & lipids– role of salivary glands, liver, pancreas and intestinal glands in digestion (Brief description of structure of glands expected).

Unit II

3.3 Absorption of carbohydrates, lipids, amino acids, water, electrolytes, vitamins and minerals in GIT

Unit III 3.4 Movements in GI tract (Brief description of histology is expected). 3.5 Bulk movement, peristalsis and defecation 3.6 The role of hormones (Gastrin, Enterogastrin, Cholecystokinin and Serotonin) and neurotransmitters (Acetylcholine and Adrenaline) in digestion and gastrointestinal motility
Module IV: Physiology of Excretion (10 hours) **Unit I** 4.1 Components (normal & abnormal) and characteristics of urine 4.2 Urine formation (glomerular filtration, tubular reabsorption and tubular secretion) **Unit II** 4.3 Mechanism of concentration of urine – Counter current system (counter current multiplier and counter current exchanger) 4.4 Ornithine Cycle **Unit III** 4.5 Hormonal control of urine formation 4.6 Renal regulation of acid base balance 4.7 Physiology of micturition
Module V: Practicals (30 hours) 1. Qualitative tests for identification of ammonia, urea and uric acid (nitrogenous excretory products) 2. Study of permanent histological sections of mammalian endocrine glands - pituitary, thyroid, pancreas, adrenal gland. 3. Estimation of haemoglobin using Sahlis Haemoglobinometer. 4. Differential count of WBC using Haemocytometer. 5. Total RBC Count using Haemocytometer 6. Human Blood Smear preparation

Teacher Specific Module	**9 Hours**
Directions: **20 percent of the experiments can be modified by the course teacher** *Suggestion:* 1. Effect of pH and Temperature on salivary amylase activity. 2. Estimation of total protein by Lowry’s method.	

Essential Reading:

1. Guyton, A.C. and Hall, J.E. (2011). Textbook of Medical Physiology, XII Edition, Harcourt Asia Pvt. Ltd/ W.B. Saunders Company

References:

1. Tortora, G.J. and Derrickson, B.H. (2009). Principles of Anatomy and Physiology, XII Edition, John Wiley & Sons, Inc.
2. Widmaier, E.P., Raff, H. and Strang, K.T. (2008) Vander's Human Physiology, XI Edition., McGraw Hill
3. Hoar, W.S. (1983). General and Comparative Physiology, Prentice Hall.
4. Prosser, C.L. (1978). Comparative Animal Physiology. W.B. Saunders co.
5. Schmidt Nielsen, K. (1994). Animal Physiology: Adaptation and Environment. Cambridge University Press

Suggested Readings:

1. Neuroscience: Exploring the Brain" by Mark F. Bear et al.
2. "Principles of Neural Science" by Eric R. Kandel et al

Assessment Rubrics:

Evaluation Type		**Marks**	
		Theory	**Practical**
• End Semester Evaluation		50	15
• Continuous Evaluation		25	10
Continuous Evaluation			
Theory/Practical	Method of Assessment	Marks	
Theory			
a)	Test paper I	5	
b)	Test paper II	5	
c)	Viva-Voce/Seminar/ Discussion	10	
d)	Assignment	5	
		Total – 25 marks	
Practical			
a)	Regularity/Punctuality	5	
b)	Laboratory skill	5	
		Total – 10 marks	

KU3DSCZOO202- ETHOLOGY AND EVOLUTION

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
3	DSC	200	KU3DSCZOO202	4	60

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/Tutorial	Practical	CE	ESE	Total	
4	-	30	70	100	2

Course Description:

Going through this course on Evolution & Ethology, students develop an understanding about the processes and patterns of biological evolution across different scales, from molecular changes within genes to the diversification of species over millions of years. And students also explore how organisms have adapted to their environments through natural selection, genetic drift, mutation, and other mechanisms, leading to the incredible diversity of life on Earth. The course also aims to give an elaborate account on the various types & patterns of animal behaviours in their natural environment. Several types of animal communications, along with most pioneering studies trigger curiosity among students.

Course Prerequisite:

Course Outcomes:

	Expected Outcome	**Learning Domains**
CO1	Recall key concepts and terminology related to evolution and ethology	U
CO2	Comprehend the theories and methodologies used in ethological research to study animal behaviour in natural and captive settings	U
CO3	Apply evolutionary principles to analyse and interpret specific behaviours observed in animals, considering how these behaviours contribute to their survival and reproductive success	A
CO4	Critically evaluate scientific literature and experimental data related to evolution and ethology, identifying strengths, weaknesses, and gaps in research methodologies and conclusions	E

**Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)*

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO4	PSO 5
CO1	1	1	0	0	0
CO2	1	1	2	0	1
CO3	2	1	3	1	3
CO4	1	0	2	0	0

COURSE CONTENTS

Module I: MODERN CONCEPTS OF EVOLUTIONARY FORCES (12 hours)

Unit I

1.1 Modern ideas on origin of life - naked gene hypothesis RNA world theory.

1.2 Research on Extra-terrestrial life

1.3 Post Darwin Biology – modern synthesis – beyond modern synthesis

Unit II

1.4 Genetics to Genomics and evolution

1.5 Genetic basis of evolution, genetic drift, Hardy-Weinberg equilibrium, punctuated Equilibrium.

1.6 Molecular evolution -Neutral theory of kimura, concept of molecular clock, mitochondrial eve and Y chromosomal Adam, molecular phylogeny, selfish genes, C value paradox.

Unit III

1.7 Long-term experimental evolution project with *E. coli*

1.8 Epigenetics

1.9 Evo-devo (Evolutionary development biology); Ancient DNA (aDNA); Horizontal gene transfer

1.10 Isolation and isolating mechanisms of speciation

1.11 Mimicry and evolution

1.12 Microevolution and macroevolution

1.13 Evolution of cooperation – kin selection and reciprocity

Module II: HUMAN EVOLUTION (12 hours)

Unit I

2.1 Introduction, development of our ideas on human evolution (2hrs)

2.2 Early primates - Dryopithecus and Ramapithecus

2.3 The fossil record of human evolution

Unit II

2.4 Bipedalism and adaptations for locomotion

2.5 Diet, dentition, and feeding strategies in human evolution

2.6 The emergence of Homo habilis and Homo erectus

2.7 The Neanderthals: Morphology, behaviour, and extinction theories

Unit III

2.8 Modern human origins (Homo sapiens) - "Out of Africa" theory; Behavioural modernity: Language, art, and culture in early Homo sapiens; Human evolution and climate change

2.9 Future of human evolution - ethical considerations and potential changes

Module III: ETHOLOGY (12 hours)

Unit I

3.1 Definition and History of ethology -1973 Nobel prize in Physiology)

3.2 Motivation and models of motivation.

3.3 Types of behaviours – innate and learnt. Types of learning with examples

Unit II

3.4 Patterns of behaviours – types of rhythms, navigation, homing instinct, hibernation, aestivation

3.5 Animal communication – types; Pheromones- types with examples; insect pheromones, mammalian pheromones; human pheromones.

3.6 Hormones and their action on behaviour (aggressive and parental behaviour).

Unit III

3.7 Sociobiology: advantages and specialties of animal societies. Social life in insects - (eg. honeybees, ants and termites-brief description with thrust on behavioural aspects of each caste); Social life in mammals (eg. monkey, elephant)

Module IV: POPULAR DISCUSSIONS AND DEBATES ON EVOLUTION

(12 hours)

1. Intelligent design and creation research
2. Teaching evolution - the Scopes trial, current global status
3. Social Darwinism debates; Biology of caste and gender
4. Popular Publications – brief accounts
    a) "The Origin of Species" by Charles Darwin
    b) "The Selfish Gene" by Richard Dawkins
    c) "The Greatest Show on Earth: The Evidence for Evolution" by Richard Dawkins
    d) "Why Evolution Is True" by Jerry A. Coyne
    e) "Your Inner Fish: A Journey into the 3.5-Billion-Year History of the Human Body" by Neil Shubin
    f) "The Ancestor's Tale: A Pilgrimage to the Dawn of Evolution" by Richard Dawkins
    g) Darwin's Dangerous Idea: Evolution and the Meanings of Life" by Daniel C. Dennett
    h) "Sapiens: A Brief History of Humankind" by Yuval Noah Harari
    i) **"**Homo Deus: A Brief History of Tomorrow" by Yuval Noah Harari

Teacher Specific Module	**12 hours**
Directions: **20 percent of the content can be modified by the course teacher**	

Essential Readings:

1. Organic Evolution- Veer Bala Rastogi. Med tech (A division of Scientific International)
2. Andrews. M.I and Joy, K.P. 2003. Environmental biology, evolution, Ethology and Zoogeography. St. Mary's press and book depot. Changanassery.
3. Aubrey Manning & Dawkins: An Introduction to Animal Behaviour; Cambridge.

4. Boulenger, E.G. Animal behaviour, 1994, Atlantic Pub.& distributors.
5. Darwin, C.: The Origin of Species, 6e. OUP.
6. Dobzhansky Th. (1964): Genetics and the Origin of Species. Columbia University Press

Assessment Rubrics:

Evaluation Type		**Marks**
1. End Semester Evaluation		70
2. Continuous Evaluation		30
Continuous Evaluation		
Theory	Method of Assessment	Marks
a)	Test paper I	6
b)	Test paper II	6
c)	Viva-Voce	6
d)	Assignment	6
e)	Seminar	6
	Total – 30 marks	

KU3DSCZOO203: DIVERSITY OF LIFE

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
III	DSC	100	KU3DSCZOO203	3+1	60

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/Tutorial	Practical	CE	ESE	Total	
3	2	25	75	100	1.5

Course Description

This course is a comprehensive journey through the vast diversity of animal life on Earth. This course delves into the fundamental principles of animal biology, covering topics such as body symmetry, germ layers, segmentation, and coelom formation. Participants will explore the characteristics of major animal phyla, from simple organisms like sponges and jellyfish to complex vertebrates like mammals and birds. Through four modules, students will examine the unique features and evolutionary adaptations of each phylum and class, gaining a deeper understanding of the remarkable diversity and interconnectedness of life within the animal kingdom. From the microscopic world of protozoans to the magnificent diversity of vertebrates, this course offers a fascinating exploration of animal form, function, and evolution.

Course Prerequisite:

Course Outcomes

	Expected Outcome	**Learning Domains**
CO1	Comprehensive understanding of the diverse range of animal life on Earth	U
CO2	Acquire a solid foundation in fundamental biological concepts such as body symmetry, germ layers, segmentation, and coelom formation etc.	An
CO3	Students will develop the ability to identify and classify various animal taxa, using key morphological and anatomical features.	A
CO4	Learners will appreciate the diverse array of evolutionary adaptations that have shaped animal form and function over millions of years	E
CO5	Students will recognize the importance of conservation efforts in preserving biodiversity within the animal kingdom	E

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO4	PSO 5
CO1	3	1	0	0	1
CO2	1	2	2	1	0
CO3	3	3	1	1	0
CO4	2	1	0	0	2
CO5	3	1	0	0	3

COURSE CONTENTS

Module I: Introduction to Animal Diversity: Invertebrata Part I (12 hours)

Unit I

1.1 Understanding the salient features of different Phyla

1.2. Grades of organization and body plan

1.3. Body symmetry

1.4. Germ layers (diploblastic & triploblastic organization)

1.5. Segmentation

1.6. Coelom (Self study topics - 1.2 to 1.6)

Unit II

1.7. Phylum Porifera

Examples: Sycon, Leucosolenia, Spongilla

1.8 Phylum Cnidaria

Examples: Hydra, Obelia, Physalia, Aurelia, Sea Anemone, Corals

1.9 Phylum Ctenophora

Examples: Pleurobrachia, Etenoplana

Unit III

1.10 Phylum Platyhelminthes

Examples: Taenia, Fasciola, Planaria

1.11 Phylum Aschelminthes

Examples: Ascaris, Rhabditis, Wuchereria, Ancylostoma

Module II: Invertebrata Part II (11 hours)

Unit I

2.1 Phylum Annelida

Examples: Nereis, Aphrodite, Pheretima, Hirudinaria

Unit II

2.2 Phylum Arthropoda

Examples: Honeybee, Silkworm, Lac insect, Anophelus, Locust, Limulus

Unit III

2.3 Phylum Mollusca

Examples: Pila, Pinctada, Sepia, Loligo, Octopus, Aplysia, Dentalium, Chaetopleura

2.4 Phylum Echinodermata

Examples: Asterias, Echinus, Antedon, Sea cucumber, Ophiura

2.5 Phylum Hemichordata

Examples: Balanoglossus, Saccoglossus

Module III: Chordata Part I **(11 hours)**

Unit I

3.1 Phylum Chordata

Salient features

Unit II

3.2 Subphylum Urochordata

Examples: Ascidia, Salpa, Doliolum

3.3 Subphylum Cephalochordata

Examples: Amphioxus

Unit III

3.4 Subphylum Vertebrata

Classification up to classes

3.5 Superclass I. Agnatha

3.6 Class – Cyclostomata

Examples: Petromyzon and Myxine

Module IV: Chordata Part II **(11 hours)**

Unit I

4.1 Superclass II. Gnathostomata

4.2 Class a – Chondrichthyes (Cartilaginous fishes)

Examples: Scoliodon, Pristis, Carcharodon, Trygon

4.3 Class b – Osteichthyes (Bony fishes)

Examples: Exocoetus, Hippocampus, Rohu, Catla, Clarius, Betta, Pterophyllum

Unit II

4.4 Class c – Amphibia

Examples: Bufo, Rana, Hyla, Salamander, Ichthyophis

4.5 Class d – Reptilia

Examples: Chelone, Chameleon, Testudo, Hemidactylus, Calotes, Naja, Krait, Viper, Crocodile, Alligator

4.6 Identification of poisonous and nonpoisonous snakes

Unit III

4.6 Class e – Aves

Examples: Corvus, Columba, Psittacula, Struthio, Pavo, Penguin, Vulture

4.7 Flight adaptations in birds

4.8 Class f – Mammalia

Examples: Platypus, Kangaroo, Whale, Macaca, Panthera, Elephant, Horse, Rat, Dolphin, Cat, Camel, Pteropus

4.9 Dentition in mammals

Module V: Practicals **(30 hours)**

1. Study of museum slides / specimens / models (Classification of animals upto orders)
2. Porifera: Sycon, Spongilla, Euspongia
3. Cnidaria: Physalia, Gorgonia
4. Platyhelminthes: Planaria, *Fasciola hepatica*
5. Nemathelminthes: Ascaris (Male & Female)
6. Annelida: Nereis, Hirudinaria
7. Arthropoda: Palaemon, Scorpion, Scolopendra, Limulus, Peripatus
8. Mollusca: Chiton, Pila, Unio, Pteredo, Murex, Sepia, Octopus
9. Echinodermata: Asterias, Echinus, Cucumaria
10. Hemichordata: Balanoglossus
11. Pisces- Scoliodon, Sardine, Hippocampus
12. Amphibia: Rhacophorus
13. Reptelia: Chameleon, Naja
14. Aves: Columba

15. Mammalia: Bat, Rat

Teacher Specific Module	**9 hours**
Directions: **20 percent of the experiments can be modified by the course teacher**	

Core Compulsory Readings

1. Anderson, D. T.: Invertebrate Zoology. 2e, 2001, Oxford Uty. Press (Indian Edn.2006)
2. Bhaskaran, K. K. & Biju Kumar, A.: Economic Zoology. Manjusha Pubs, Calicut
3. Dhami, P. S. & Dhami, J. K.: Invertebrate Zoology. R. Chand & Co, New Delhi
4. Ekambaranatha Ayyar, M. & Ananthakrishnan, T. N.: A Manual of Zoology Vol. I [Part I & II], S. Viswanathan, Madras
5. Jordan, E. L. & Verma, P. S.: Invertebrate Zoology. S. Chand & Co, New Delhi
6. Kotpal, R. L.: Modern TB of Zoology: Invertebrates. Rastogi
7. Pechenik, J. A. 4e 2002 Biology of the Invertebrates. TMH 2002
8. Ruppert, E. E. et al.: Invertebrate Zoology. 7 e, 2004, Thomson Brooks Cole
9. J.Z. Young (2004): The Life of Vertebrates
10. Jordan & Varma: Chordate Zoology, S. Chand Publications
11. Kotpal R.L: Modern Text Book of Zoology- Vertebrates
12. Kent GC and Cavr R.K (2000): Comparative Anatomy of the Vertebrates IX Edition, Mac Graw Hill.

Assessment Rubrics:

Evaluation Type		Marks	
		Theory	**Practical**
1. End Semester Evaluation		50	15
2. Continuous Evaluation		25	10
Continuous Evaluation			
Theory/Practical	Method of Assessment	Marks	
Theory			
a)	Test paper I	5	
b)	Test paper II	5	
c)	Viva-Voce/Seminar/ Discussion	10	
d)	Assignment	5	
		Total – 25 marks	
Practical			
a)	Regularity/Punctuality	5	
b)	Laboratory skill	5	
		Total – 10 marks	

KU3DSCZOO204: ADVANCED BIOLOGICAL TECHNIQUES

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
III	DSC	200	KU3DSCZOO204	3+1	60

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/Tutorial	Practical	CE	ESE	Total	
3	2	25	75	100	1.5

Course Description

This course is designed to equip students with a strong foundation in advanced biological techniques, fostering practical skills and theoretical knowledge essential for careers in biological research and related fields.

Course Prerequisite:

Course Outcomes

	Expected Outcome	Learning Domains
CO1	Demonstrate Proficiency in Laboratory Techniques	U
CO2	Perform Advanced Histological Procedures	A
CO3	Apply Molecular Biology Techniques	A
CO4	Utilize Advanced Biotechnological Tools in Research	An

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

Mapping of Course Outcomes to PSOs

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	0	0	3	3	0
CO2	0	0	3	3	3
CO3	0	0	3	3	3
CO4	0	0	3	3	2

COURSE CONTENTS

Module I: Fundamental aspects of laboratory practices (12 hours)

Unit I. Distilled Water and Ion-Exchangers

1.1 Types of Distilled Water

1.2 Principles and Uses of Ion-Exchangers

1.3 Brief Overview of Anion, Cation, and Amphoteric Exchangers

Unit II: Glassware Cleaning and Sterilization

1.4 Cleaning of Glassware: General and Special Procedures

1.5 Preparation of Cleaning Solutions (Any Two)

1.6 Sterilization of Glassware (brief account)

Unit III: Solutions

1.6 Definition of Solute and Solvent

1.7 Preparation of Molar, Molal, Normal, and Percentage Solutions

1.8 Understanding ppm, ppb, and ppt

1.9 Buffer Solutions

1.10 Organic solvents

1.11 Definition of pH

1.12 Methods for determining pH

1.13 Significance of pH Determination in Biological Laboratories

Module II: Histological Techniques and Staining in Biological Studies (11 Hours)

Unit I: Tissue Techniques

2.1 Histological and Histochemical Studies

2.2 Processes: Fixation, Washing, Dehydration, Clearing, Infiltration, Embedding (Paraffin Method)

Unit II: Microtomy

2.3 Microtome Overview: Rotary Microtome and Cryostat

2.4 Working Mechanism and Uses of Rotary Microtome

2.5 Problems Associated with Microtomy, Reasons, and Remedies

Unit III: Stains

2.6 General Introduction

2.7 Histochemical Stains: Preparation Methods and Staining Procedures for Proteins, Carbohydrates, Nucleic Acids, and Lipids

2.8 Special Stains in Animal Histological Studies

Module III: Molecular Biology and Bioinformatics Techniques (11 hours)

Unit I: Nucleic Acid Isolation and Molecular Techniques

3.1 Methodology for Isolation of Total RNA and DNA

3.2 Complementary DNA (cDNA) Synthesis and Cloning

3.3 Polymerase Chain Reaction

3.4 Real-Time PCR (RT-PCR)

3.5 Random Amplification of Polymorphic DNA (RAPD)

3.6 Restriction Fragment Length Polymorphism (RFLP)

3.7 Amplified Fragment Length Polymorphism (AFLP)

Unit II: DNA Barcoding

3.8 Definition and Concept

3.9 Methodology Overview and Applications

3.10 Genes Used for Barcoding in Plants and Animals

Unit III: Introduction to Bioinformatics

3.11 Fundamentals of Bioinformatics

3.12 Sequence Analysis and Tools

3.13 Applications of Bioinformatics

Module IV: Advanced Biological Techniques (11 hours)

Unit I: Hybridization Techniques

4.1 DNA-DNA Hybridization

4.2 Fluorescence In Situ Hybridization (FISH)

4.3 RNA Hybridization Techniques

Unit II: X-ray Crystallography and Tissue Culture

4.4 X-ray Crystallography

4.5 Applications of X-ray Crystallography

4.6 Tissue Culture Techniques

Unit III: Immunological Techniques and Stem Cells

4.7 Immunological Techniques; Enzyme-Linked Immunosorbent Assay,

Flow Cytometry, Western Blotting 4.8 Applications of Immunological Techniques 4.9 Stem Cells; Types of Stem Cells (Embryonic and Adult), Stem Cell Culture Techniques, Therapeutic Applications and Ethical Considerations
Module V: Practicals **(30 hours)** I. Preparation method of the following:- (Demonstration) 1. Standard buffer solution- Acetate and Phosphate 2. Fixatives – Bouin's, Carnoy's, Schaudinn's 3. Stains – Cytological, anatomical, histological and histochemical (one each) 4. Paraffin blocks of tissues for sectioning- fixing, washing, dehydration etc. Record should carry notes of the preparation methods. II. Operation of the following equipments 5. pH meter, 6. Distillation apparatus, 7. Microtome 8. Thermocycler Record should carry sketches and notes on the principle and uses. III. Experiments 9. Double staining- To stain the given slide of animal tissue using haematoxylin-eosine(minor) 10. Microtomy – To take serial sections of the given tissue and spread them on glass slide. (minor)

Teacher Specific Module	**9 hours**
Directions: **20 percent of the experiments can be modified by the course teacher**	

Core Compulsory Readings

1. Humason G L, 1972. Animal Tissue techniques. (3rd edition). W H Freeman &Co.
2. Gupta P K, 2010. Elements of Biotechnology. Rastogi Publications, New Delhi.
3. Wilson K & Walker J, 2010. Principles and Techniques of Biochemistry and Molecular Biology: Cambridge Univ. Press.

4. Watson J D et al., 2017. Molecular Biology of the Gene (7thedition). Pearson Pub.

Core Suggested Readings

1. Mukherjee K L, 1998. Medical Laboratory Technology-Vol. I, II & III: Tata Mc Graw Hills Int. Pub.
2. Lesk A M, 2002. Introduction to Bioinformatics, 4th edition. Oxford Pub.
3. Cotterill R, 2012. Biophysics-An Introduction. John Wiley & Sons Ltd. Pub.

Assessment Rubrics:

Evaluation Type		**Marks**	
		Theory	**Practical**
1. End Semester Evaluation		50	15
2. Continuous Evaluation		25	10
Continuous Evaluation			
Theory/Practical	Method of Assessment	Marks	
Theory			
a)	Test paper I	5	
b)	Test paper II	5	
c)	Viva-Voce/Seminar/ Discussion	10	
d)	Assignment	5	
		Total – 25 marks	
Practical			
a)	Regularity/Punctuality	5	
b)	Laboratory skill	5	
		Total – 10 marks	

Employability for the Course / Programme:

- Biomedical Research Assistant
- Clinical Laboratory Technologist
- Histotechnologist
- Quality Control Analyst

KU3DSCZOO205: HUMAN PHYSIOLOGY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
III	DSC	200	KU3DSCZOO205	3+1	60

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/Tutorial	Practical	CE	ESE	Total	
3	2	25	75	100	1.5

Course Description:

This course explores the physiological processes of animals, including nutrition, respiration, circulation, excretion, nerve function, and muscle activity. Through theoretical study and practical application, students gain insight into how animals maintain homeostasis and adapt to diverse environments.

Course Prerequisite:

Course Outcomes:

	Expected Outcome	Learning Domains
CO1	Identify and explain the basic physiological processes that allow animals to survive in different habitats	U
CO2	Apply the scientific method to studies of animal physiology by conceiving and designing an experimental approach for studying specific physiological processes	A
CO3	Improve scientific literacy by critically evaluating scientific literature and articulating the key questions, hypotheses, methods, results, and conclusions	An
CO4	Evaluate and compare different approaches for applying physiological principles to practical applications in the lab and field to answer physiological questions	E
CO5	Connect physiological principles to other scientific disciplines (e.g., ecology, behaviour, morphology)	C

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO4	PSO 5
CO1	1	0	3	2	3
CO2	0	0	2	1	2
CO3	0	1	3	3	1
CO4	1	1	3	3	1
CO5	0	0	3	3	1

COURSE CONTENTS

Module I: Neurotransmission Physiology and Physiology of Motility (13 hours)

Unit I

Membrane physiology

1.1 Functional consequences of molecular composition and arrangement (Gibbs Donnan Equilibrium).

1.2 Transport across cell membrane- Diffusion, active transport, ionic pump (Na-K pump, Calcium channel); uniports, symports and antiport, co-transport by symporters and antiporters.

Unit II

Physiology of neuronal system

1.3 Membranes potential

1.4 Propagation of action potential across the myelinated and non-myelinated nerve fibres, Synaptic transmission

1.5 Nerve Impulse Transmission

1.6 Neurotransmitters

Unit III

1.7 Neuromuscular junction

1.8 Biochemistry of contractile proteins

1.9 Physiology of skeletal muscle

a) Actomyosin complex

b) Source of energy for muscle contraction - Cori Cycle

c) Sliding filament theory

d) Excitation- Contraction Coupling, Role of Calcium

e) Mechanism of relaxation

Module II: Physiology of Respiration and Circulation (12 hours)

Unit I

2.1 Physiological anatomy and histology of respiratory passage and lungs

2.2 Mechanism of pulmonary ventilation (inspiration & expiration)

2.3 Alveolar ventilation, dead space and its effect on alveolar ventilation

2.4 Role of surfactant in alveolar expansion

2.5 Pulmonary volumes and capacities

2.6 Transport of oxygen and carbon dioxide (Haldane Effect and Bohr Effect)

2.7 Oxygen dissociation curve

Unit II

2.9 Structure of human heart

2.10 Pacemaker and specialized conducting fibres

2.11 Cardiac cycle

2.12 ECG – Principle and application

Unit III

2.14 Blood clotting mechanism (Extrinsic and Intrinsic Pathway), Anticoagulants.

2.15 Lymph channels of the body

2.16 Composition and formation of lymph

2.17 Functions of lymph and lymphatic system

Module III: Nutritional Physiology (10 hours)

Unit I

3.1 Constituents of normal diet and their daily requirements, balanced diet: A human perspective; Malnutrition (PEM, Obesity)

3.2 Digestion of carbohydrate, protein & lipids– role of salivary glands, liver, pancreas and intestinal glands in digestion.

Unit II

3.3 Absorption of carbohydrates, lipids, amino acids, water, electrolytes, vitamins and minerals in GIT

Unit III

3.4 Movements in GI tract (Brief description of histology is expected).

3.5 Bulk movement, peristalsis and defecation

3.6 The role of hormones (Gastrin, Enterogastrin, Cholecystokinin and Serotonin) and neurotransmitters (Acetylcholine and Adrenaline) in digestion and gastrointestinal motility

Module IV: Physiology of Excretion **(10 hours)**

Unit I

4.1 Components (normal & abnormal) and characteristics of urine

4.2 Urine formation (glomerular filtration, tubular reabsorption and tubular secretion)

Unit II

4.3 Mechanism of concentration of urine – Counter current system (counter current multiplier and counter current exchanger)

4.4 Ornithine Cycle

Unit III

4.5 Hormonal control of urine formation

4.6 Renal regulation of acid base balance

4.7 Physiology of micturition

Module V: Practicals **(30 hours)**

1. Qualitative tests for identification of ammonia, urea and uric acid (nitrogenous excretory products)
2. Study of permanent histological sections of mammalian endocrine glands - pituitary, thyroid, pancreas, adrenal gland.
3. Estimation of haemoglobin using Sahlis Haemoglobinometer.
4. Differential count of WBC using Haemocytometer.
5. Total RBC Count using Haemocytometer
6. Human Blood Smear preparation

Teacher Specific Module	**9 Hours**
Directions: **20 percent of the experiments can be modified by the course teacher** *Suggestion:* 1. Effect of pH and Temperature on salivary amylase activity. 2. Estimation of total protein by Lowry’s method.	

Essential Reading:

1. Guyton, A.C. and Hall, J.E. (2011). Textbook of Medical Physiology, XII Edition, Harcourt Asia Pvt. Ltd/ W.B. Saunders Company

References:

1. Tortora, G.J. and Derrickson, B.H. (2009). Principles of Anatomy and Physiology, XII Edition, John Wiley & Sons, Inc.
2. Widmaier, E.P., Raff, H. and Strang, K.T. (2008) Vander's Human Physiology, XI Edition., McGraw Hill
3. Hoar, W.S. (1983). General and Comparative Physiology, Prentice Hall.
4. Prosser, C.L. (1978). Comparative Animal Physiology. W.B. Saunders co.
5. Schmidt Nielsen, K. (1994). Animal Physiology: Adaptation and Environment. Cambridge University Press

Suggested Readings:

1. Neuroscience: Exploring the Brain" by Mark F. Bear et al.
2. "Principles of Neural Science" by Eric R. Kandel et al

Assessment Rubrics:

Evaluation Type		**Marks**	
		Theory	**Practical**
● End Semester Evaluation		50	15
● Continuous Evaluation		25	10
Continuous Evaluation			
Theory/Practical	Method of Assessment	Marks	
Theory			
a)	Test paper I	5	
b)	Test paper II	5	
c)	Viva-Voce/Seminar/ Discussion	10	
d)	Assignment	5	
	Total – 25 marks		
Practical			
a)	Regularity/Punctuality	5	
b)	Laboratory skill	5	
	Total – 10 marks		

KU3DSCZOO206: INTRODUCTORY BIOCHEMISTRY

Semester	Course Type	Course Level	Course Code		Credits	Total Hours
IV	DSC	200	KU3DSCZOO206		3+1	60
Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture/Tutorial	Practical		CE	ESE	Total	
3	2		25	75	100	1.5

Course Description:

Biochemistry is the branch of science that explores the chemical processes within and related to living organisms. This course provides an in-depth examination of the molecular mechanisms underlying biological functions, emphasizing the structure, function, and regulation of biomolecules. Students will gain a comprehensive understanding of the fundamental principles governing cellular processes and their significance in health and disease

Course Prerequisite:

Course Outcomes:

	Expected Outcome	Learning Domains
CO1	Understand how living things work at a molecular level, including how cells use molecules like proteins, carbohydrates, fats, and DNA.	U
CO2	Apply this knowledge to solve simple problems and understand common laboratory techniques used in biochemistry.	A
CO3	Appreciate the importance of biochemistry in fields like medicine, agriculture, and environmental science.	An
CO4	Communicate basic biochemical concepts clearly, both in writing and verbally.	A
CO5	To introduce students to the basic principles of biochemistry	U

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

Mapping of Course Outcomes to PSOs

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	0	0	3	3	1
CO2	0	0	3	3	0
CO3	2	0	3	3	2
CO4	0	0	2	3	0
CO5	0	0	1	3	0

COURSE CONTENTS

Module I: Biochemistry and the living state **(5 hr)**

Unit I: Biochemistry and the living state

1.1 Mention micro, macro & trace elements/ mineral ions – their biological significance.

1.2 Water – molecular structure & dipolar nature, dissociation

1.3 Concept of pH, buffers

Module II: Biomolecules **(17hr)**

Unit I

2.1 Classification of carbohydrates, Biological functions of carbohydrates

2.2 Classification of amino acids

2.3 Peptide bonds

2.4 Structural levels of proteins – primary, secondary, tertiary and quaternary structure.

2.5 Molecular chaperones.

2.6 Classification of proteins.

2.7 Biological importance of proteins and amino acids.

Unit II

2.8 Lipids. Basic structure and biological importance of lipids.

2.9 Classification of lipids.

2.9.1 Simple lipids – Fats, oils and waxes

2.9.2 Compound lipids - Phospholipids (lecithin, cephalin), Glycolipids (cerebrosides, gangliosides), Lipoproteins

2.9.3 Derived Lipids - Steroids (cholesterol)

2.10 Nucleotides, Biologically important Nucleotides. Mention structure and importance of ATP, cyclic AMP, UTP, NAD, NADP, FMN, FAD.

Module III: Enzymes and Vitamins **(10 hr)**

Unit I: Enzymes and Functions

3.1 Enzymes- Classification and Nomenclature (IUB) – 6 major classes.

3.2 Mechanism of enzyme action (lock and key & induced fit hypothesis)

3.3 Factors influencing the velocity of enzyme action- effect of pH, temperature, enzyme and substrate concentration

3.4 Regulation of enzyme action- activation and inhibition (competitive, non competitive, allosteric and feedback)

Unit II: Vitamins and biological importance

3.5 Fat soluble and Water soluble vitamins (vitamin B (Thiamine, Riboflavin, Niacin, Pantothenic acid, Cyanocobalamin, Folic acid, Pyridoxin) and C.

Module IV **(13 Hours)**

Unit 1

4.1 Carbohydrate metabolism

4.1.1 Glycolysis

4.1.2 Glycogenolysis

4.1.3 Glycogenesis

4.1.4 Gluconeogenesis

4.1.5 Pentose Phosphate pathway

4.2 Protein metabolism

4.2.1 Deamination

4.2.2 Transamination

4.2.3 Decarboxylation

4.3 Lipid metabolism

4.3.1 Oxidation of glycerol and fatty acids

4.3.2 Biosynthesis of fatty acids

(*Structural details of metabolic pathways are not expected*)

Unit II

4.4 Kreb's cycle

4.5 Electron Transport System (ETS) and oxidative phosphorylation; Chemiosmotic hypothesis

Module V Practical **(30 hours)**

1. Qualitative tests for identification of carbohydrates, proteins and lipids.
2. To find the concentration of given solution using standard curve
3. Detection of abnormal constituents of urine (Glucose, albumin and ketone bodies
4. Separation of amino acids (or any other compounds) from a mixture by using
5. paper chromatography (Demonstration).
6. Detection of proteins: [Biuret test, Nitric acid test, Xanthoproteic test].
7. Detection of lipids: [Sudan III or IV test, Spot test].

Teacher Specific Module	9 Hours
Directions: **20 percent of the experiments can be modified by the course teacher**	

Essential Readings:

1. David L. Nelson and Michael Cox (2012): Lehninger Principles of Biochemistry 6th Edition, ISBN-10: 1429234148, W.H. Freeman, 1328 pages
2. David L. Nelson and Michael Cox (2017): Lehninger Principles of Biochemistry 7th Edition, ISBN-10: 1-4641-2611-9, W.H. Freeman, 1172 pages
3. David P. Plummer (2017)- Introduction to Practical Biochemistry, 3rd Edition, ISBN-10: 9780070994874, McGraw Hill Education, 498 pages
4. Donald Voet, Charlotte W. Pratt and Judith G. Voet (2001): Principles of Biochemistry 4th Edition, ISBN-10: 9780471417590, Wiley
5. Geoffrey L Zubay (1999): Biochemistry 4th Edition, ISBN-10: 0697219003, Wm. C. Brown Publishers, 1104 pages

Suggested Readings:

1. Biochemistry" by Lubert Stryer et al.
2. Molecular Biology of the Cell by Bruce Alberts et.al

Assessment Rubrics:

Evaluation Type		**Marks**	
		Theory	**Practical**
1. End Semester Evaluation		50	15
2. Continuous Evaluation		25	10
Continuous Evaluation			
Theory/Practical	Method of Assessment	Marks	
Theory			
a)	Test paper I	5	
b)	Test paper II	5	
c)	Viva-Voce/Seminar/ Discussion	10	
d)	Assignment	5	
	Total – 25 marks		
Practical			
a)	Regularity/Punctuality	5	
b)	Laboratory skill	5	
	Total – 10 marks		

KU4DSCZOO207: CYTOGENETICS

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
IV	DSC	200	KU4DSCZOO207	3+1	60

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/Tutorial	Practical	CE	ESE	Total	
3	2	25	75	100	1.5

Course Description: This course helps the students to gather overall knowledge regarding the basic unit of life, the Cell. This course is designed to enable them to understand the functions of Cellular components in supporting all the life processes. Students also achieve a comprehensive & detailed understanding of the chemical basis of Heredity and its various applications in day today life.

Course Prerequisite:

Course Outcomes:

	Expected Outcome	**Learning Domains**
CO1	Learn the role of cell in supporting life activities & comprehend the activities of cellular organelles	U
CO2	Learn the fundamental principles of inheritance	U
CO3	Recognize abnormal cellular structures and functions associated with diseases, such as cancer, infections, and genetic disorders	An
CO4	Encompass both theoretical understanding of cellular biology and practical skills relevant to clinical and research applications	E

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

Mapping of Course Outcomes to PSOs

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	0	0	3	3	0
CO2	1	0	3	2	1
CO3	2	0	3	3	2
CO4	1	0	3	3	1

COURSE CONTENTS

Module I: Overview of Cells and Structure & functions of Cell organelles (13 hours)

Unit I- Cell types

1.1 Prokaryotic & Eukaryotic cell

1.2 Virus & Mycoplasma

Unit II- Plasma Membrane & Cytoskeleton

1.2.1 Plasma membrane: Structure (Fluid mosaic model)

1.2.2 Plasma membrane: Functions (Transport & Cytosis)

1.2.3 Cytoskeleton: Microtubules, microfilaments, intermediate filaments

Unit III- Mitochondria& Microbodies

1.5 Mitochondria: Structure, oxidative phosphorylation, electron transport chain

1.5.1 Endosymbiotic hypothesis

1.6 Microbodies: Peroxisomes & Glyoxysomes: Functions

Module II: Nucleus & Cell Reproduction (11 hours)

Unit I: Nucleus – Structure & Functions

2.1 Nucleus- structure, nuclear envelop, nucleolus, nuclear pore complex

2.2 Nucleus- functions

Unit II: Chromosomes & its types

2.3 Types of Chromosomes

2.4 Chromatin-Euchromatin & heterochromatin

2.5 Nucleosome concept

Unit III: Cell Reproduction & Cancer

2.6 Cell cycle

2.7 Mitosis

2.8 Meiosis

2.9 Cancer-

2.9.1 Types

2.9.2 Characteristics

2. 9. 3 Cancer Therapy

Module III: Inheritance, Linkage & Crossing over (11 hours)

Unit I: Inheritance types

3.1. Basic principles of inheritance- Mendelian inheritance

3.2 Incomplete dominance, co dominance, multiple alleles, lethal genes, epistasis, pleiotropy, polygenic inheritance

Unit II: sex Linked Inheritance

3.3 Sex linked, sex influenced & sex- limited characters inheritance

3.4 X- linked, Y -linked & XY-linked

Unit III: Linkage

3.5 Linkage- Principle

3.5.1 Coupling & Repulsion theory

3.5. 2 Linkage groups

3.5. 3 Types of linkage

3.6 Crossing over

3.7 Recombination

3.7.1 Factors affecting

3.7.2 significance

Module IV: Mutations, Sex determination and Cytoplasmic inheritance (10 hours)

Unit I: Mutation

4.1 Chromosomal mutations

4.1.1 Structural aberrations

4. 1.2 Numerical aberrations

4.2 Gene mutations

4.3 Mutagens

Unit II: Sex determination

4.4 Chromosomal mechanism of sex determination

Unit III: Cytoplasmic Inheritance

4.5 Characteristics

4.5.1 Shell coiling in Limnaea

4.5.2 Kappa particles

Module V: Practicals **(30 hours)**

1. Micrometry -Measurement of microscopic objects.
2. Study of mitotic stages – Onion root tip squash preparation.
3. Study of meiosis – Grasshopper testis squash.
4. Salivary gland Chromosome- Drosophila
5. Staining of buccal epithelial cells.
6. Chi-square analysis using beads
7. Study of human karyotype (normal & abnormal)
8. Buccal smear – Identification of Barr Body

Teacher Specific Module	**9 Hours**
Directions: **20 percent of the experiments can be modified by the course teacher**	

Essential Readings:

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). Principles of Genetics. VIII Edition. Wiley India. ISBN No. 978-8126510436.
2. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc. ISBN No. 978-0470388259
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). Concepts of Genetics. X Edition. Benjamin Cummings. ISBN No. 978-0321724120.

4. Russell, P. J. (2009). Genetics- A Molecular Approach.III Edition. Pearson Education India. ISBN No. 978-0321569769.
5. Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. (2007) Introduction to Genetic Analysis. IX Edition. W. H. Freeman and Co. ISBN No. 978-0716768876
6. Fletcher H., Hickey I, Winter P (2006). BIOS Instant Notes in Genetics. III Edition. GS, Taylor and Francis Group, New York and London. ISBN No. 978-0415376198.

Assessment Rubrics:

<table>
<tr><th colspan="2">Evaluation Type</th><th colspan="2">Marks</th></tr>
<tr><td colspan="2"></td><td>Theory</td><td>Practical</td></tr>
<tr><td colspan="2">1. End Semester Evaluation</td><td>50</td><td>15</td></tr>
<tr><td colspan="2">2. Continuous Evaluation</td><td>25</td><td>10</td></tr>
<tr><td colspan="3">Continuous Evaluation</td><td></td></tr>
<tr><td>Theory/Practical</td><td>Method of Assessment</td><td>Marks</td><td></td></tr>
<tr><td>Theory</td><td></td><td></td><td></td></tr>
<tr><td>a)</td><td>Test paper I</td><td>5</td><td></td></tr>
<tr><td>b)</td><td>Test paper II</td><td>5</td><td></td></tr>
<tr><td>c)</td><td>Viva-Voce/Seminar/ Discussion</td><td>10</td><td></td></tr>
<tr><td>d)</td><td>Assignment</td><td>5</td><td></td></tr>
<tr><td></td><td colspan="2">Total – 25 marks</td><td></td></tr>
<tr><td>Practical</td><td></td><td></td><td></td></tr>
<tr><td>a)</td><td>Regularity/Punctuality</td><td>5</td><td></td></tr>
<tr><td>b)</td><td>Laboratory skill</td><td>5</td><td></td></tr>
<tr><td></td><td colspan="2">Total – 10 marks</td><td></td></tr>
</table>

KU4DSCZOO208: BIOCHEMISTRY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
IV	DSC	200	KU4DSCZOO208	3+1	60

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/Tutorial	Practical	CE	ESE	Total	
3	2	25	75	100	1.5

Course Description:

Biochemistry is the branch of science that explores the chemical processes within and related to living organisms. This course provides an in-depth examination of the molecular mechanisms underlying biological functions, emphasizing the structure, function, and regulation of biomolecules. Students will gain a comprehensive understanding of the fundamental principles governing cellular processes and their significance in health and disease

Course Prerequisite:

Course Outcomes:

	Expected Outcome	Learning Domains
CO1	Understand how living things work at a molecular level, including how cells use molecules like proteins, carbohydrates, fats, and DNA.	U
CO2	Apply this knowledge to solve simple problems and understand common laboratory techniques used in biochemistry.	A
CO3	Appreciate the importance of biochemistry in fields like medicine, agriculture, and environmental science.	An
CO4	Communicate basic biochemical concepts clearly, both in writing and verbally.	A
CO5	To introduce students to the basic principles of biochemistry	U

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)*****Mapping of Course Outcomes to PSOs**

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	0	0	3	3	1
CO2	0	0	3	3	0
CO3	2	0	3	3	2
CO4	0	0	2	3	0
CO5	0	0	1	3	0

COURSE CONTENTS

Module I: Biochemistry and the living state **(5 hr)**

Unit I: Biochemistry and the living state

1.1 Mention micro, macro & trace elements/ mineral ions – their biological significance.
1.2 Water – molecular structure & dipolar nature, dissociation
1.3 Concept of pH, buffers
1.4 Henderson Hassel Bach equation; Biological functions of water.

Module II: Biomolecules **(17hr)**

Unit I

2.1 Classification of carbohydrates, Biological functions of carbohydrates
2.2 Classification of amino acids
2.3 Peptide bonds
2.4 Structural levels of proteins – primary, secondary, tertiary and quaternary structure.
2.5 Ramachandran plot.
2.6 Molecular chaperones.
2.7 Classification of proteins.
2.8 Biological importance of proteins and amino acids.

Unit II

2.9 Lipids. Basic structure and biological importance of lipids.
2.10 Classification of lipids.
  2.10.1 Simple lipids – Fats, oils and waxes
  2.10.2 Compound lipids - Phospholipids (lecithin, cephalin), Glycolipids (cerebrosides, gangliosides), Lipoproteins
  2.10.3 Derived Lipids - Steroids (cholesterol)
  2.10.4 Prostaglandins.
2.11 Nucleotides, Biologically important Nucleotides. Structure and importance of ATP, cyclic AMP, UTP, NAD, NADP, FMN, FAD.

Module III: Enzymes and Vitamins **(10 hr)**

Unit I: Enzymes and Functions

3.1 Enzymes- Classification and Nomenclature (IUB) – 6 major classes.
3.2 Concept of active sites
3.3 Mechanism of enzyme action (lock and key & induced fit hypothesis)
3.4 Factors influencing the velocity of enzyme action- effect of pH, temperature, enzyme and substrate concentration
3.5 Regulation of enzyme action- activation and inhibition (competitive, non competitive, allosteric and feedback)

Unit II: Vitamins and biological importance

3.6 Fat soluble and Water soluble vitamins (vitamin B (Thiamine, Riboflavin, Niacin, Pantothenic acid, Cyanocobalamin, Folic acid, Pyridoxin) and C.

Module IV **(13 Hours)**

Unit 1

4.1 Basal metabolism- Calculation of BMR by Harris-Benedict formula;

4.2 Carbohydrate metabolism

- 4.2.1 Glycolysis
- 4.2.2 Glycogenolysis
- 4.2.3 Glycogenesis
- 4.2.4 Gluconeogenesis
- 4.2.5 Pentose Phosphate pathway
- 4.2.6 Kreb's cycle

4.3 Protein metabolism

- 4.3.1 Deamination
- 4.3.2 Transamination
- 4.3.3 Decarboxylation

4.4 Lipid metabolism

- 4.4.1 Oxidation of glycerol and fatty acids
- 4.4.2 Biosynthesis of fatty acids

(*Structural details of metabolic pathways are not expected*)

Unit II

4.5 Electron Transport System (ETS) and oxidative phosphorylation; Chemiosmotic hypothesis

Module V Practical **(30 hours)**

1. Qualitative tests for identification of carbohydrates, proteins and lipids.
2. To find the concentration of given solution using standard curve
3. Detection of abnormal constituents of urine (Glucose, albumin and ketone bodies
4. Separation of amino acids (or any other compounds) from a mixture by using
5. paper chromatography (Demonstration).
6. Detection of proteins: [Biuret test, Nitric acid test, Xanthoproteic test].
7. Detection of lipids: [Sudan III or IV test, Spot test].

Teacher Specific Module	**9 Hours**
Directions: **20 percent of the experiments can be modified by the course teacher**	

Essential Readings:

1. David L. Nelson and Michael Cox (2012): Lehninger Principles of Biochemistry 6th Edition, ISBN-10: 1429234148, W.H. Freeman, 1328 pages
2. David L. Nelson and Michael Cox (2017): Lehninger Principles of Biochemistry 7th Edition, ISBN-10: 1-4641-2611-9, W.H. Freeman, 1172 pages

3. David P. Plummer (2017)- Introduction to Practical Biochemistry, 3rd Edition, ISBN-10: 9780070994874, McGraw Hill Education, 498 pages
4. Donald Voet, Charlotte W. Pratt and Judith G. Voet (2001): Principles of Biochemistry 4th Edition, ISBN-10: 9780471417590, Wiley
5. Geoffrey L Zubay (1999): Biochemistry 4th Edition, ISBN-10: 0697219003, Wm. C. Brown Publishers, 1104 pages

Suggested Readings:

1. Biochemistry" by Lubert Stryer et al.
2. Molecular Biology of the Cell" by Bruce Alberts et.al

Assessment Rubrics:

Evaluation Type		**Marks**	
		Theory	**Practical**
1. End Semester Evaluation		50	15
2. Continuous Evaluation		25	10
Continuous Evaluation			
Theory/Practical	Method of Assessment	Marks	
Theory			
a)	Test paper I	5	
b)	Test paper II	5	
c)	Viva-Voce/Seminar/ Discussion	10	
d)	Assignment	5	
		Total – 25 marks	
Practical			
a)	Regularity/Punctuality	5	
b)	Laboratory skill	5	
		Total – 10 marks	

KU4DSCZOO209: IMMUNOLOGY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
4	DSC	200	KU4DSCZOO209	4	60

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/Tutorial	Practical	CE	ESE	Total	
4	-	30	70	100	2

Course Description: This course explores the fascinating world of immunology, explaining body's remarkable defense system. This course is designed to equip the students with a foundational understanding of immunology, providing valuable insights into how your body defends itself and maintains health. The historical roots of immunology along with its fundamental principles are dealt in this course. A deep understanding of the key players in the immune system – the organs and cells, along with the mechanisms- that work tirelessly to protect the body will be gained by the participants.

The course unpacks the different types of immunity and explores how the immune system mounts a primary and secondary response to combat invaders, and how it adapts throughout our lives.

Course Prerequisite:

Course Outcomes:

	Expected Outcome	Learning Domains
CO1	Understand the basics Immunity	U
CO2	Understand the interrelationship between immune response, health and diseases	An
CO3	Distinguish between different types of immune mechanisms	An

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	0	0	2	3	3
CO2	0	0	3	3	3
CO3	0	0	3	2	3

COURSE CONTENTS

Module I: Introduction to Immunology (12 hours)

Unit I: Definition & scope

Unit II: Types of Immunity

1.2 Natural and Acquired immunity

1.3 Active and passive immunity

1.4 Cell mediated immunity, Humoral immunity

Unit III: Immune response

1.5 Primary immune response

1.6 Secondary immune response

Module II: Cells and Organs of Immune system (12 hours)

Unit I: Organs of Immune System

2.1 Thymus

2.2 Spleen

2.3 Bursa of Fabricius

2.4 Lymph nodes

2.5 Mucosa Associated Lymph Tissue

Unit II: Cells of Immune System

2.6 T cells

2.7 B Cells

2.8 Granulocytes

2.9 Mast Cells & Dendritic Cells

Unit III: Antibody

2.10 Structure of Antibody

2.11 Diversity of antibody

2.12 Genetic basis of antibody diversity - Somatic recombination theory

Module III: Immune Disorders (12 hours)

Unit I: **Hypersensitivity**

3.1 Types of hypersensitivity- I, II, III & IV.

3.2 Brief accounts of allergy and anaphylaxis

Unit II**: Immune deficiency**

3.3 AIDS

3.4 SCIDS

Unit III**: Autoimmunity**

3.5 System specific

3.6 Organ specific

Module IV: Vaccination, Transplantation Immunology & **Immunological Techniques (12 hours)**

Unit I: Vaccination

4.1 Definition, principles

4.2 Vaccines-types (Brief account)

4..3 National Immunization Programme

4.3.1 BCG

4.3.2 DPT

4.3.3 OPV

Unit II: Transplantation Immunology

4.4 Types of grafts

4. 5 Graft rejection

4. 6 Prevention of Graft rejection

4 .7 Immunotherapy: - brief account

Unit III: Immunological Techniques

4.8 ELISA

4.9 RIA

Module V: Practicals	**(15 hours)**
1. Blood Grouping (ABO & Rh factor) 2. Histology Slides- Lymphocyte, Thymus, Tonsil, Spleen, MALT 3. Immunodiffusion 4. ELISA (Demo) 5. DOT ELISA (Demo) 6. RIA (Demo) 7. Effect of temperature on enzyme activity in immune cells	

Teacher Specific Module	**12 Hours**
Directions: **20 percent of the experiments can be modified by the course teacher**	

Essential Readings:

1. Kuby- Immunology
2. Susan Panicker & George Abraham (Editors) (2008), Micro Biology and Immunology, Zoological Society of Kerala, Kottayam.
3. Abbas- Cellular & Molecular Immunology
4. Ivan Roitt- Essentials of Immunology

Assessment Rubrics:

Evaluation Type		**Marks**
1. End Semester Evaluation		70
2. Continuous Evaluation		30
Continuous Evaluation		
Theory	Method of Assessment	Marks
a)	Test paper I	6
b)	Test paper II	6
c)	Viva-Voce	6
d)	Assignment	6
e)	Seminar	6
		Total – 30 marks

LEVEL 300 DSC COURSES

KU5DSCZOO301: INVERTEBRATA-SYSTEMATICS, FORM AND FUNCTION

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
V	DSC	300	KU5DSCZOO301	3+1	60

Learning Approach (Hours/Week)		Marks distribution			Duration of ESE(Hours)
Lecture/Tutorial	Practical	CE	ESE	Total	
3	2	25	75	100	1.5

Course Description:

Invertebrates, with their astonishing diversity, adaptive prowess, and intricate life cycles, are integral components of ecosystems worldwide. By understanding and appreciating the complexities of these spineless wonders, we gain insights into the interconnected web of life that sustains our planet. Let us celebrate the marvels of invertebrates and strive to conserve and protect their habitats for generations to come.

Course Pre requisite:

Course outcomes

	Expected Outcome	**Learning Domains**
CO1	Compare characteristics and systems in invertebrates	An
CO2	Explore the diversity and importance of invertebrates	U
CO3	Understand the evolutionary significance in certain invertebrates and their larvae	E
CO4	Apply taxonomical knowledge to identify beneficial and harmful species	An
CO5	Apply the knowledge gained on invertebrates for human and animal welfare	A

**Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)*

Mapping of Course Outcomes to PSOs

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	2	2	3	2	1
CO2	3	2	1	0	1
CO3	1	2	2	0	0
CO4	1	3	3	1	2
CO5	0	1	2	1	3

COURSE CONTENTS

Module I: Protista, Porifera, Cnidaria and Ctenophora (12 hours)
Unit I 1.1 Protista: Introduction to classification of Protists. 1.2 Various locomotory structures such as flagella, cilia, and pseudopodia in protists **Units II** 1.3 Porifera: Classification. 1.4 Canal system in Porifera (Structure and function of the canal system in Porifera. 1.5 Types of canal systems: asconoid, syconoid and leuconoid with example **Unit III** 1.6 Cnidaria and Ctenophora**:** Classification. 1.7 Polymorphism in Cnidaria (Different forms and life stages. Examples of polymorphism.) 1.8 Metagenesis in Obelia. 1.9 Coral and Coral reefs (Structure and formation of coral reefs. Ecological significance and types of coral reefs).
Module II: Platyhelminthes, Nematoda, Annelida and Onychophora (11 hours)
Unit I 2.1 Platyhelminthes: Classification: Overview of the classification. 2.2 Brief account on the life cycle of *Fasciola hepatica* (liver fluke). Stages of development and intermediate hosts. 2.3 *Taenia solium*: Life cycle, adaptations and pathogenicity. **Unit II:** 2.4 Nematoda: Classification 2.5 Detailed description of the life cycle of *Ascaris lumbricoides* (roundworm).

2.6 Overview of *Wuchereria bancrofti*, life cycle, transmission, and impact on human health. **Unit III:** 2.7 Annelida: Classification. 2.8 Circulatory System of Earthworm 2.9 Parasitic adaptations of leech. 2.10 Swarming in Nereis: Behaviour and ecological significance of swarming in Nereis. 2.11 Evolutionary significance of Peripatus
Module III: Arthropoda and Mollusca **(11 hours)**
Unit I: 3.1 Arthropoda: Classification. (Major Classes: Insecta, Crustacea, Arachnida, and Myriapoda. Key characteristics and examples of each class) **Unit II:** 3.2 Structure of Eye and Antennary Gland in Prawn: Anatomy and function of the compound eye in prawns. Structure and role of the antennary gland in excretion and osmoregulation**.** 3.3 Social Insects: Characteristics and examples of social insects (e.g., bees, ants, termites). 3.4 Lifecycle of Silkworm: Stages of development in the lifecycle of the silkworm (*Bombyx mori*). **Unit III:** 3.5 Mollusca: Classification. 3.6 Economic importance of molluscans. 3.7 Mantle cavity of pila. 3.8 Ultrastructure of molluscan shell.

Module IV: Echinodermata, Hemichordata, Minor Invertebrate Phyla and Larval forms in Invertebrates (11 hours)

Unit I:

4.1Echinodermata**:** Classification.

4.2 Water vascular system-Structure and functions.

Unit II:

4.3 Affinities of Hemichordata.

4.4 Salient features of the following minor phyla with one example each: Phylum Gastrotricha, Phylum Rotifera, Phylum Ectoprocta [Bryozoa], Phylum Echiura

Unit III:

4.5 Larval forms in Invertebrates: Identification and description of following invertebrate larval forms. Parenchymula, Planula, Redia, Trochophore, Glochidium, Zoea, Bipinnaria and Tornaria.

Module V: Practicals (30 hours)

I. **Mountings**

a) Earthworm setae
b) Mouth parts of Honeybee
c) Prawn appendages

II. **Major Dissections**

2. Nervous system of Prawn
3. Nervous system of Cockroach

III. **Minor Dissection**

a) Female reproductive system in Cockroach
b) Cockroach salivary gland.

IV. **Histology**: T.S of Hydra, Planaria, Ascaris and Earthworm.

V.	**Identification of specimens:** Paramecium, Spongilla, Physalia, Fasciola, Ascaris, Leech, Peripatus, Belostoma, Spider, Limulus, Sepia and Starfish. Identification of larval forms: Mysis, Caterpillar, Cercaria, Glohidium and Pluteus (specimens or diagrams).

Teacher Specific Module	**12 Hours**
Directions: **20 percent of the experiments can be modified by the course teacher**	

Core Compulsory Readings

1. Dhami P.S & Dhami J.K. Invertebrate Zoology, R. Chand and Company, New Delhi
2. Ekambaranatha Ayyar M & Ananthakrishnan T.N; A manual of Zoology. Vol.1&2
3. Jordan E.L & Verma P.S. Invertebrate Zoology, S. Chand and Company, New Delhi
4. Kotpal R.L; Modern Text book of Zoology: Invertebrates, Rastogi Publications.
5. Pechenik J.A; Biology of the Invertebrates, TMH, 2002

Assessment Rubrics:

Evaluation Type		**Marks**	
		Theory	**Practical**
1. End Semester Evaluation		50	15
2. Continuous Evaluation		25	10
Continuous Evaluation			
Theory/Practical	Method of Assessment	Marks	
Theory			
a)	Test paper I	5	
b)	Test paper II	5	
c)	Viva-Voce/Seminar/ Discussion	10	
d)	Assignment	5	
		Total – 25 marks	
Practical			
a)	Regularity/Punctuality	5	
b)	Laboratory skill	5	
		Total – 10 marks	

KU5DSCZOO302: ENVIRONMENTAL SCIENCE

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
V	DSC	300	KU5DSCZOO302	3+1	60

Learning Approach (Hours/Week)		Marks distribution			Duration of ESE(Hours)
Lecture/Tutorial	Practical	CE	ESE	Total	
3	2	25	75	100	1.5

Course Description:

This course on ecology aims to provide the student deep knowledge about various concepts in ecology and create awareness about the interaction of organism and the environment. The student will be able to compare the physical and biological components in different ecosystem. Students will also be able to identify the different environmental issues and analyze the impact of anthropogenic activities on environment.

Course Pre requisite:

Course outcomes:

	Expected Outcome	**Learning Domains**
CO1	Understand the different concepts in ecology and conservation of animals (U)	U
CO2	Compare the different ecosystem, populations and community (E)	E
CO3	Explore the trophic diversity (An)	An
CO4	Interpret the effect of anthropogenic activities on environment (E)	E

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

Mapping of Course Outcomes to PSOs

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	2	1	1	1	2
CO2	2	2	3	1	2
CO3	2	1	3	2	2
CO4	2	0	3	1	3

COURSE CONTENTS

Module I: Ecosystem and Biogeochemical Cycles (11 hours)

Unit I:

1.1 Concept of ecosystem
1.2 Trophic levels, trophic structure
1.3 Food chain and food web

Unit II:

1.4 Ecosystem Energetics: Energy flow in the ecosystem and Lindeman's model of energy flow.
1.5 Concept of productivity: Primary productivity and Secondary productivity.

1.6 Pyramid of energy, Pyramid of numbers, Pyramid of Biomass

Unit III:

1.7 Biogeochemical Cycles:

1.7.1Gaseous (nitrogen and carbon cycles)
1.7.2Sedimentary (phosphorous and sulphur cycles)

1.8 Law of limiting factors

Module II: Population and Community Ecology (12 hours)

Units I:

2.1 Population ecology**:** Properties of population and Population dynamics

Unit II:

2.2 Population interactions: Mutualism, commensalisms, parasitism, predation, competition and protocooperation.

Units III:

2.3 Community Ecology: Characteristics of community and Community periodicity.

Module III: Habitat ecology and Zoogeography (11 hours)

Unit I:

3.1 Types of ecosystem: Aquatic ecosystem (Freshwater and Marine Ecosystem).

Unit II:

3.2 Terrestrial ecosystem (Forest, Grassland, Desert, Tundra and Cave biomes)

3.3 Ecological succession

3.4 Concept of ecotone and niche

Unit III:

3.5 Zoogeographic realms

3.6 Types of distribution

Module IV: Global environmental issues and Techniques in ecology (11 hours)

Units I:

4.1 Ozone depletion

4.2 Greenhouse effect

4.3 Acid rain

4.4 Biomagnification

4.5 Eutrophication

4.6 BOD

Unit II:

4.7 Environmental disaster (Flood, Earth quakes, climate change, Forest fire and Cyclones). and its management (EIA and EIS)

Units III:

4.8 Ecological Techniques: Radio collaring, Remote Sensing and GIS

Module V: Practicals (30 hours)

1. Estimation of dissolved oxygen using Winkler's method. (Major)
2. Estimation of dissolved carbon dioxide in water. (Major)
3. Qualitative analysis of fresh water / marine plankton. (Minor)
4. Analysis of soil fauna. (Minor)
5. Measurement of salinity
6. Measurement of water pH using pH paper.
7. Turbidity using Secchi disc
8. Estimation of hardness of three different water samples.
9. Study of Mutualism (Hermit crab and sea anemone), commensalism (Echeneis and shark), Parasitism (Sacculina on crab), Predation (Snake and Rat)
10. Study of zoogeographical realms and distribution of animals using map

Teacher Specific Module	6 hours
Directions: **20 percent of the experiments can be modified by the course teacher**	

Core Compulsory Readings:

1. Agarwal, K.C. (2008) Environmental Biology, Nidi Publishers, Bikaner. Hardcover: 552pages, ISBN-13: 978-8189153021
2. Aravind Kumar: Text Book of Environmental Science; APH Pub Corporation (New Delhi).
3. Arora, S. (1995). Fundamentals of Environmental Biology, Kalyani Publ., New Delhi.
4. Bhaskaran, K.K. (2015) Environmental Biology and Wild life conservation, Manjusha Publications
5. Chapman & Reiss: Ecology- Principles and Applications; Cambridge.
6. Dev, S. C. Environmental Management, Jaico Pub., New Delhi.
7. De A.K. Environmental Chemistry, Wiley Eastern Ltd. ISBN 10: 8122426174
8. May R. M & Mc Lean: Theoretical Ecology – Principles and Applications; Oxford Uty Press.
9. Miller T.G. Jr. (2008) Environmental Science, Wadsworth Publishing Co. (TB) ISBN 9781111988937
10. Misra and Pandey- Essential Environmental Studies-Ane Books India
11. Odum, E.P. (1971). Fundamentals of Ecology. W.B. Saunders Co. USA, 574p ISBN 10: 0721669417
12. Sharma, P.D (2008). Ecology and Environment, 7th Edition; Rastogi ISBN-10: 8171335810
13. Townsend C., Harper J, and Michael Begon, Essentials of Ecology, Blackwell Science (TB) ISBN1-40510-328-0

Assessment Rubrics:

Evaluation Type		Marks	
		Theory	**Practical**
1. End Semester Evaluation		50	15
2. Continuous Evaluation		25	10
Continuous Evaluation			
Theory/Practical	Method of Assessment	Marks	
Theory			
a)	Test paper I	5	
b)	Test paper II	5	
c)	Viva-Voce/Seminar/ Discussion	10	
d)	Assignment	5	
		Total – 25 marks	
Practical			
a)	Regularity/Punctuality	5	
b)	Laboratory skill	5	
		Total – 10 marks	

KU5DSCZOO303: DEVELOPMENTAL BIOLOGY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
V	DSC	300	KU5DSCZOO303	4	60

Learning Approach (Hours/Week)		Marks distribution			Duration of ESE(Hours)
Lecture/Tutorial	Practical	CE	ESE	Total	
4	-	30	70	100	2

Course Description:

This course aims to explain the different concepts in Developmental biology and to create awareness about the cellular events during embryonic development. The student will be able to compare the properties of cells in adult with the cells in embryo. Students will learn about stem cells and about the influence of differential gene expression on development.

Course Pre requisite:

Course outcomes:

	Expected Outcome	**Learning Domains**
CO1	Understand and compare different developmental events among animals	E
CO2	Explore the major cellular and molecular events during development	An
CO3	Interpret the effect of gene expression on embryonic development	E
CO4	Apply the knowledge in developmental biology for human welfare	A

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

Mapping of Course Outcomes to PSOs

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	2	2	3	1	0
CO2	0	0	2	3	0
CO3	0	0	2	3	1
CO4	0	0	1	1	3

COURSE CONTENTS

Module I: Early processes in developmental biology (15 hours)
Unit I 1.1 Gametes and gametogenesis 1.1.1 Egg: 1.1.1.1 Oogenesis 1.1.1.2 Structure of a typical egg (frog) 1.1.1.3 Classification of egg based on: 1.1.1.3.1 the amount of yolk (micro, meso & macrolecithal), 1.1.1.3.2 the distribution (iso, centro & telolecithal), 1.1.1.3.3 Presence or absence of shell (cleidoic& non-cleidoic), 1.1.1.3.4 the development (determinate & indeterminate) with examples. 1.1.1.4 Egg membranes (primary, secondary and tertiary). 1.2.1 Sperm: 1.2.1.1 Spermatogenesis 1.2.1.2. Structure of sperm **Unit II** 1.3 Early development 1.3.1 Cleavage: Types of cleavage with examples 1.3.1.1 based on planes (meridional, vertical, equatorial and latitudinal); 1.3.1.2 Based on the amount of yolk (Holoblastic & Meroblastic); 1.3.1.3 Based on Development (Determinate & Indeterminate); 1.3.1.4 Based on Pattern (Radial & Spiral). 1.3.2 Bastulation: 1.3.2.1 Different types of blastula: Coelobastula, Stereoblastula, Discoblastula &

Blastocyst

1.3.3 Morphogenetic movements:

1.3.3.1 Emboly (Invagination, involution, convergence, divergence, infiltration, delamination & ingression)

1.3.3.2 Epiboly

Unit III

1.4 Potency, cell differentiation, and gene action during development

1.4.1 Potency- totipotency, pluripotency

1.4.2 Cell differentiation- differentiation, dedifferentiation, redifferentiation

1.4.3 Genomic equivalence, Metaplasia

Module II: Development in Amphioxus, Chick, and Mammals (Man) (15 hours)

Unit I

2.1 Development of Amphioxus

2.1.1 Fertilization

2.1.2 Cleavage, blastulation, gastrulation

2.1.3 Neurulation

Unit II

2.2 Chick development

2.2.1 Structure of egg

2.2.2 Fertilization, cleavage, blastulation & gastrulation

2.2.3 Salient features of chick embryo at 18, 24 & 48hour stage (Torsion and flexion).

Unit III

2.3 Human development

2.3.1. Structure of Graafian follicle

2.3.3. Brief account of events in the menstrual cycle.

2.3.4. Ovulation

2.3.5. Capacitation, fertilization, acrosomal reaction

2.3.6 Prevention of polyspermy.

2.3.7 Cleavage, blastulation, implantation, gastrulation

2.3.8 Gestational changes (trimesters)

2.3.9 Parturition

2.3.10 Lactation

Module III: Organogenesis Parthenogenesis, and Regeneration (15 hours)

Unit I

3.1 Organogenesis

3.1.1 Development of brain in amphibians

3.1.2 Eye development in amphibians

Unit II

3.3 Parthenogenesis and its types

3.4 Regeneration:

3.4.1 Types of regeneration- stem cell-mediated, epimorphosis, morphallaxis, and compensatory regeneration. (Brief account)

3.4.2 Affecting factors

Unit III

3.5 Extraembryonic membranes

3.5.1 In chick- amnion, chorion and allantois

3.5.2 Placentation: Types of placenta

Module IV: Experimental embryology, Reproductive technology, and Teratology (15 hours)

Units I

4.1 Experimental embryology

4.1.1 Work of Hans Spemann: constriction experiments (importance of grey crescent and the potency of nuclei)

4.1.2 Organizers in amphibian development (primary, secondary & tertiary).

4.1.2 Cloning- Creating Dolly the sheep

4.1.3 Cell lineage studies in *Planocera*

4.1.4 Fate map (example frog)

4.1.5 Methods of fate map construction:

4.1.5.1 Natural marking

4.1.5.2 Artificial methods: Vital staining, carbon particle marking and radio labelling

Units II

4.4 Assisted reproduction:

4.4.1 Fertility medications

4.4.2 Assisted Reproductive Technologies (ART):

4.4.2.1 IVF (steps),

4.4.2.1 IUI, ICSI, GIFT, ZIFT, PROST

Unit III

4.5 Teratology: Influence of alcohol, retinoic acid, thalidomide, DES and BPA

Teacher Specific Module	**12 hours**
Directions: **20 percent of the content can be modified by the course teacher**	

Core Compulsory Readings

1.Balinsky B.I (1981) An introduction to embryology

2.Scott F. Gilbert (2016) Developmental Biology 11th edition. Oxford university press

3.Verma P.S and Agarwal V.K (2010) Chordate Embryology, Chand publications

4.Wolpert L (1994) Principles of development 3rd edition. Oxford university press

5.Bruce Carlson (2013) Human embryology and Developemntal biology.5th edition.

Assessment Rubrics:

Evaluation Type		Marks
1. End Semester Evaluation		70
2. Continuous Evaluation		30
Continuous Evaluation		
Theory	Method of Assessment	Marks
a)	Test paper I	6
b)	Test paper II	6
c)	Viva-Voce	6
d)	Assignment	6
e)	Seminar	6
	Total – 30 marks	

KU5DSEZOO304: GENERAL PARASITOLOGY(Elective)

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
V	DSE	300	KU5DSEZOO304	4	60

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/Tutorial	Practical	CE	ESE	Total	
4	-	30	70	100	2

Course Description:

This course covers a wide range of topics related to parasites, their vectors, and the diseases they cause, as well as methods for controlling vectors and preventing the spread of diseases. It provides a comprehensive understanding of parasitology and medical entomology, which are crucial fields for understanding and managing infectious diseases.

Course Prerequisite:

Course Outcomes:

	Expected Outcome	**Learning Domains**
CO1	Understand basic concepts about parasitic animals	U
CO2	Differentiate between various ectoparasites & endoparasites	E
CO3	Apply vector management strategies in preventing vector borne diseases	A
CO4	Evaluate mechanisms involved in the transmission of Zoonotic diseases	E

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

Mapping of Course Outcomes to PSOs

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO 1	2	2	0	0	2
CO 2	3	3	1	0	3
CO 3	2	2	2	0	3
CO 4	2	2	2	2	3

COURSE CONTENTS

Module I: General concepts of Parasitology & Parasitic protists (12 hours)

Unit I: Introduction to Parasitology

1.1 Parasites, parasitoids, hosts

1.2 Basic concepts of parasitism, symbiosis, commensalism, mutualism

1.3 Types of parasites & types of hosts

1.4 Host parasite relationship, transmission of parasites

Unit II: Parasitic Protists

Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of

1.5 *Entamoeba histolytica*

1.6 *Giardia intestinalis*

1.7 *Trypanosoma gambiense*

1.8 *Leishmania donovani*

1.9 *Plasmodium vivax*

Module II: Parasitic Platyhelminthes (12 hours)

Unit I: Parasitic Trematodes

Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of-

2.1 *Fasciola hepatica*

2. 2 *Schistosoma haematobium*

Unit II Parasitic Cestodes

Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of-

2.3 *Taenia solium*

2.4 *Hymenolepis nana*

Module III: Parasitic Nematodes **(12 hours)**

Unit I: Intestinal nematodes

Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of

3.1 *Ascaris lumbricoides*

3. 2 *Ancylostoma duodenale*

Unit II: Tissue dwelling nematodes

Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of

3. 3 *Wuchereria bancrofti*

3. 4 *Loa loa*

Module IV: Parasitic Arthropods & Vertebrates **(12 hours)**

Unit I: Parasitic Arthropods

Biology, importance and control of

4.1 Ticks & mites (eg: Boophilus and Sarcoptes)

4. 2 *Pediculus humanus* (head and body louse),

4.3 *Xenopsylla cheopis*

4.4 *Cimex lectularius*

Unit II: Parasitic Vertebrates

Biology, importance and control of

4.5 Cookicutter Shark

4.6 Hood Mocking bird

4.7 Vampire bat & their parasitic behaviour

Teacher Specific Module	12 Hours
Directions: **20 percent of the content can be modified by the course teacher**	

Essential Readings:

1. Arora, D. R and Arora, B. (2001) Medical Parasitology. II Edition. CBS Publications.
2. E.R. Noble and G.A. Noble (1982) Parasitology: The biology of animal parasites. V Edition.
3. Ahmed, N., Dawson, M., Smith, C. and Wood, Ed. (2007) Biology of Disease. Taylor and Francis Group.
4. Parija, S. C. Textbook of medical parasitology, protozoology & helminthology (Text and colour Atlas), II Edition, All India Publishers & Distributers, Medical Books Publishers, Chennai, Delhi.
5. Meyer, Olsen & Schmidt's Essentials of Parasitology, Murray, D. Dailey, W.C. Brown Publishers.
6. K. D. Chatterjee (2009). Parasitology: Protozoology and Helminthology. XIII Edition, CB Sn P.
7. Gunn, A. and Pitt, S.J. (2012). Parasitology: An Integrated Approach. Wiley Blackwell.
8. Noble, E. R. and G.A. Noble (1982) Parasitology: The biology of animal parasites. V th Edition, Lea & Febiger.
9. Paniker, C.K.J., Ghosh, S. [Ed} (2013). Paniker‘s Text Book of Medical Parasitology. Jaypee, New Delhi.
10. Parija, S.C. Text Book of Medical Parasitology, Protozoology & Helminthology (Text and color Atlas), II Edition, All India Publishers & Distributers, Medical Books Publishers, Chennai, Delhi.
11. Roberts, L.S and Janovy, J. (2009). Smith & Robert ‘s Foundation of Parasitology. 8th. Ed. McGraw Hill.
12. Bogitsh, B. J. and Cheng, T. C. (2000). Human Parasitology. 2nd Ed. Academic Press, New York.

13. Chandler, A. C. and Read. C. P. (1961). Introduction to Parasitology, 10th ed. John Wiley and Sons Inc.
14. Cheng, T. C. (1986). General Parasitology. 2nd ed. Academic Press, Inc. Orlando. U.S.A.
15. Schmidt, G. D. and Roberts, L. S. (2001). Foundation of Parasitology. 3rd ed. McGraw Hill Publishers.
16. Schmidt, G. D. (1989). Essentials of Parasitology. Wm. C. Brown Publishers.

Assessment Rubrics:

Evaluation Type		**Marks**
1. End Semester Evaluation		70
2. Continuous Evaluation		30
Continuous Evaluation		
Theory	Method of Assessment	Marks
a)	Test paper I	6
b)	Test paper II	6
c)	Viva-Voce	6
d)	Assignment	6
e)	Seminar	6
	Total – 30 marks	

KU5DSEZOO305: GENERAL ENTOMOLOGY(Elective)

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
V	DSE	300	KU5DSEZOO305	4	60

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/Tutorial	Practical	CE	ESE	Total	
4	-	30	70	100	2

Course Description:

Entomology is the study of insects. Entomology deals with the development, diversity and the applied nature of the insects. Entomology emerged as a distinct field of study in the early 19th century. The scope of entomology typically includes the study of any terrestrial and aquatic insects belonging to the phylum Arthropoda. Insects are the largest group of animals, which constitute 75% of all living animals. There are more than one million living species in the world and many more yet to be discovered. They were the first flying creatures and still the only invertebrates that can fly. They are the most successful animals inhabiting every conceivable ecological condition.

Course Prerequisite:

Course Outcomes:

	Expected Outcome	**Learning Domains**
CO1	Gain Knowledge about insect morphology and classification	U
CO2	Analyse the modification of structures in different insects	An
CO3	Recognise of different groups insects	E
CO4	Describe the adaptations of insects to various environments	E
CO5	Identify insects of economic importance	A

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

Mapping of Course Outcomes to PSOs

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO 1	2	3	1	1	1
CO 2	2	3	2	2	3
CO 3	3	3	2	0	1
CO 4	2	3	3	1	2
CO 5	3	3	2	1	3

COURSE CONTENTS

Module I: External morphology **(12 Hrs)**

Units I

1.1 General morphology of the head: Opisthognathous, hypognathous and prognathous

1.2 Head skeleton- different sutures and sclerites

1.3 Tentorium

1.4 Cephalic appendages

Units II

1.5 Thorax: Thoracic segmentation, Thoracic skeleton, Endothorax

1.6 Thoracic appendages

1.7 Modifications of thoracic legs

1.8 Wings: structure, venation.

Units III

1.9 Abdomen: Segmentation, Skeletal composition, pregenital and post genital segments

1.10 Abdominal appendages

1.11 External genitalia: male and female

Module II: Insect classification **(12 hrs)**

Units I

2.1 Introduction to classification of insects: Apterygota, Exopterygota, Endopterygota, Hemimetaboly, Holometaboly.

Units II

2.2 Apterygota: Diagnostic characteristics of the following Orders: Collembola, Protura, Diplura and Thyasanura.

Units III

2.3 Exopterygota: Diagnostic characteristics of the following Orders: Ephemeroptera, Odonata - mention dragon flies and damsel flies, Isoptera- Castes, Phasmida, Blattaria, Mantoidea, Orthoptera, Hemiptera, Thysanoptera, Psocoptera, Phthiraptera, Dermaptera, Plecoptera, Embioptera, Zoraptera.

2.3 Endopterygota: Diagnostic characteristics of the following Orders: Coleoptera, Lepidoptera, Hymenoptera, Diptera, Siphonoptera, Strepsiptera, Neuroptera, Mecoptera, Megalaoptera, Raphidioptera, Trichoptera.
Module III: Ecology of Insects (12 hrs) **Units I** 3.1Aquatic insects: Factors influencing the aquatic life, food capture, respiration, anchorage, locomotion 3.2 Adaptations of swimming forms **Units II** 3.3 Gall forming insects: definition and features, common gall pests, gall as dwelling place 3.4 Adaptation for the gall making habits. **Units III** 3.5 Leaf mining insects: definition and identification, forms of leaf mines, feeding habits and frass disposal.
Module IV: Behaviour of Insects (12 hrs) **Units I** 4.1Social insects – social organisation**:** Caste differentiation – Termites, Honey bees and ants **Units II** 4.2 Communication – acoustic, visual, tactile and chemical method (pheromones) **Units III** 4.3 Co-evolution **–** insect plant co – evolution

Teacher Specific Module	**12 Hours**
Directions: **20 percent of the content can be modified by the course teacher**	

References

1. Ananthakrishnan, T.N. (1992): Dimensions of Insect-Plant Interactions, Oxford & IBH Publishing Co. Pvt. LTD.

2. Aswathy, V.B. (1998) Introduction to General and Applied Entomology. ISBN.

3. Borror, D.J. and Delong, D.M. (1964). An Introduction to the study of Insects. Holt Reineheart and Winston, New York.

4. Carde, R, T. and Bell, W.J. (1995): Chemical Ecology of Insects-2. Chapman and Hall, New York

5. Essig, E. O. (1974): College Entomology. Mac Millon Co. London

6. Richard, Wand Davies, R.G.G. (1977). Imm's general text book of Entomology, 10th edition, Chapman & Hall.

7. Mani, M, S. (1974): Modern classification of Insects. Satish Book Enterprise., Agra.

8. Mani, M.S. (1982): A general text book of entomology, Oxford & IBH, New Delhi.

9. Nayar, K.K., Ananthakrishnan, T.N., & David, B.V. (1976). General and Applied Entomology, Tata Mac Grew Hill. New Delhi.

10. Ross, H.H. et al., A general text book of entomology, John Wiley Sons NY. Scientific Publishers, Jodhpur.

11. Snodgrass, R, E. (1935): Principles of Insect Morphology. Mac Graw Hill Book.

12. Tembhare, D.B., Modern Entomology, Himalaya publishing House

13. Wilson, E.O. (1972): The Insect societies. Belknap, Harward University Press.

14.Gillot, C. (2005) Entomology. 3rded. Springer.

15. Romoser, W.S. and Stoffolano, J.G. (1994). The Science of Entomology.3rd ed. WCB Publishers, Oxford, England.

16.Wigglesworth, V.B. (1964). The life of Insects. Heindenfield and Necolson, London.

Assessment Rubrics:

Evaluation Type		Marks
1. End Semester Evaluation		70
2. Continuous Evaluation		30
Continuous Evaluation		
Theory	Method of Assessment	Marks
a)	Test paper I	6
b)	Test paper II	6
c)	Viva-Voce	6
d)	Assignment	6
e)	Seminar	6
	Total – 30 marks	

Employability for the Course:

- Insect taxonomist
- Job as farm supervisors and pest control advisers
- Scientist in ICAR and ICMR institutes
- Entomologist in ZSI, agriculture and public health organisations

KU5DSEZOO306: MARINE BIOLOGY(Elective)

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
V	DSE	300	KU5DSEZOO306	4	60

Learning Approach (Hours/Week)		Marks distribution			Duration of ESE(Hours)
Lecture/Tutorial	Practical	CE	ESE	Total	
4	-	30	70	100	2

Course Description:

This comprehensive course offers a deep dive into the oceanographic features, diverse habitats, biodiversity assessment methods, conservation measures, and management strategies crucial for safeguarding India's marine ecosystems. Whether aspiring for a career in marine science, conservation, or environmental management, this course equips you with the knowledge and skills needed to navigate the challenges and opportunities in this dynamic field.

Course Pre requisite:

Course outcomes:

	Expected Outcome	**Learning Domains**
CO1	Demonstrate a comprehensive understanding of marine ecosystems and current research trends in marine biology	U
CO2	Identify and evaluate the diversity of marine habitats and resources and assess their ecological significance and conservation challenges	An
CO3	Classify and analyze marine flora and fauna	An
CO4	Apply practical skills in sampling techniques and data analysis to interpret data related to marine biology	A
CO5	Observe and evaluate data to conserve marine fauna and flora	E

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

Mapping of Course Outcomes to PSOs

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	1	0	0	0	1
CO2	3	1	3	0	3
CO3	3	3	3	0	0
CO4	2	3	3	1	1
CO5	3	2	3	1	3

COURSE CONTENT

Module I: Introduction to Marine Biology	**(12 hours)**
Unit I: 1.1.Historical Development of Marine Biology in India **Unit II:** 1.2. Major Oceanographic Features **Unit III:** 1.3.Current Research Trends in Marine Ecosystems	
Module II: Marine Habitats and Resources	**(12 hours)**
Unit I: 2.1. Diversity of Marine Habitats **Unit II:** 2.2. Coastal Wetlands, Coral Reefs and Deep- sea Ecosystems **Unit III:** **2.3.** Ecological Significance and Conservation Challenges	
Module III : Marine Flora and Fauna Classification	**(12 hours)**
Unit I: 2.1. Classification Method **Unit II:** 2.2.Roles within Marine Ecosystems and Fisheries **Unit III:** 2.3.Impact of Environmental Factors on Populations	
Module IV: Practical Skills in Marine Research	**(12 hours)**
Unit I: 4.1. Sampling Techniques and Quantitative Analysis of Plankton and Benthos **Unit II:** 4.2. Biodiversity Assessment **Unit III:** 4.3. Data Interpretation using Software Tools	

Teacher Specific Module	**12 Hours**
Directions: **20 percent of the content can be modified by the course teacher** **Suggestions:** •Conservation Issues in Marine Biology • Endangered Species Management •Marine Protected Areas and Sustainable Coastal Zone Management Practices	

Core Compulsory Readings

1.Peter Castro, Michael E Huber (2013) Marine Biology. Mc Graw- Hill International.
2.Philip V. Mladenov (2013) Marine Biology: A Very Short Introduction. Oxford University press
3.Jeffrey S Levinton (2017). Marine Biology Function, Biodiversity, Ecology, 5 th edition), Oxford University Press.
5. Stephen J. Hawkins, Katrin Bohn, Louise B. Firth, Gray A Williams (2019). Interactions in the Marine Benthos. Cambridge University Press.
6. Ewart, Newell., Newell, R.C. (2006). Marine Planktons Facsimile Edition. Pisces Conservation Ltd

Core Suggested Readings

1.Williams, S. Johnson., Dennise, M. Allen., & Marni, Fylling. (2012). Zooplankton of the Atlantics & Gulf Coasts: A Guide to Their Identification & Ecology
2. Anasta sios, Eleftheriou Alsdair, Mclntyre. (2013). Methods for the Study of Marine Benthos (4 th Edition). Wiley Blackwell.
3. Se Shappa, G. (1992). Indian Marine Biology. South Asia
4. George, Karleskint., Richard, Turner & James, Small. (2012). Lab Manual: Introduction to Marine Biology (4 th Edition). Brooks Cole.
5. James, W. Ngbkken Ngbkken, Mark, D. Bertness. (2004). Marine Biology: An Ecological Approach (6th Edition). Benjamin Cummings.
6. Manal, Al Khandari., Kholood, Al Rifaie., Faiza, Al Yamini (2009). Marine Phytoplankton Atlas of Kuwait’s waters. Kuwait Institute of Scientific Research Publications.
7.Rupert F.G. Ormond, John D. Gage & Martin V Angel (2005). Marine Biodiversity patterns and processes (1 st edition). Cambridge University Press.
8.Williams, S. Johnson., Dennise, M. Allen., & Marni, Fylling. (2012). Zooplanktons of the Atlantics & Gulf Coasts: A Guide to Their Identification &Ecology (2nd Edition). The Johns Hopkins University Press.
9. https:// marinespecies.org
10. https:// coml.org
11. http s:// boldsystems.org
12. https://obis.org/
13 https://www.s ealifebase.ca

Assessment Rubrics:

Evaluation Type		Marks
1. End Semester Evaluation		70
2. Continuous Evaluation		30
Continuous Evaluation		
Theory	Method of Assessment	Marks
a)	Test paper I	6
b)	Test paper II	6
c)	Viva-Voce	6
d)	Assignment	6
e)	Seminar	6
	Total – 30 marks	

KU5DSEZOO307- WILDLIFE BIOLOGY (Elective)

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
V	DSE	300	KU5DSEZOO307	4	60

Learning Approach (Hours/Week)		Marks distribution			Duration of ESE(Hours)
Lecture/Tutorial	Practical	CE	ESE	Total	
4	-	30	70	100	2

Course Description:
In the intricate web of life, every organism interacts intimately with its natural environment, shaping and being shaped by the delicate balance of ecosystems. In this discourse, we delve into the realm of wildlife biology, unraveling the diverse interactions between organisms and their habitats, understanding key ecological concepts, addressing threats to wildlife, and exploring strategies for conservation. Additionally, we scrutinize the complex dynamics of human-wildlife conflicts and the far-reaching impacts of anthropogenic activities on the survival of Earth's precious biodiversity.

Course Pre requisite:

Course outcomes:

	Expected Outcome	**Learning Domains**
CO1	Understand the different concepts in wildlife biology	U
CO2	Appreciate nature and biodiversity	U
CO3	Evaluate the major threats to wildlife	E
CO4	Interpret the effect of anthropogenic activities on the deterioration of wildlife	E
CO5	Analyze the different environmental issues and its impact on wildlife	E

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

Mapping of Course Outcomes to PSOs

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	2	0	0	0	1
CO2	0	1	0	0	0
CO3	1	1	3	0	3
CO4	1	1	2	0	3
CO5	1	1	3	1	3

COURSE CONTENTS

Module I. Biodiversity **(12 hours)**

Units I

1.1 Biodiversity: Kinds of biodiversity
1.2 Biodiversity hot spots
1.3 Endemism
1.4 Values of species diversity

Units II

1.5 Animal diversity in Western Ghats: amphibia, reptiles, snakes, birds and mammals

Units III

1.6. Sociobiology of Lion and Elephant
1.7. Territoriality
1.8. Flyways and peculiarities of bird migration in the Indian Subcontinent.

Module II. Methods in Wildlife Study **(12 hours)**

Units I

2.1 Population estimation

2.1.1 Direct Count: - Total count, Drive count, Time area counts and transect count

2.1.2 Indirect Count - Call count, Track count and Pellet count .

Units II

2.2. Capturing and Marking Techniques

2.2.1. Live trapping of birds and Mammals, Chemical immobilization, methods of marking captured birds and mammals
2.2.2. Peterson or Lincoln Index method
2.2.3. Determination of Age and sex in animals.

Units III

2.3. Modern Methods of Wildlife study: Wildlife photography: Still and Videography, recording of calls, study of animal evidences. Remote sensing and Radio telemetry.

Module III. Threats to Biodiversity **(12 hours)**

Units I

3.1Degradation and loss of Ecosystem:

3.1.1 Contamination (brief account on pollution in water and soil)

3.1.2 Soil erosion

3.1.3 Deforestation

3.1.4 Desertification

3.1.5 Fragmentation

3.1.6 Overexploitation

Units II

3.2Threatened species, Extinction of species, Red data book and IUCN Red list categories.

Units III

3.3Man and Wildlife conflict - crop depredation, cattle lifting and human encounters.

Module IV. Conservation of Wildlife (12 hours)

Units I

4.1.Conservation measures:

4.1.1. Conservation projects: Project Tiger, Elephant and Project Lion

4.1.2 Wild life protection Act.1972

Units II

4.2 Biodiversity conservation strategies:

4.2.1 Protection of endangered species- Ex situ conservation: conservation in Seed banks, Gene banks, Germ plasm banks, Zoo and Botanical gardens.

Units III

4.3 In situ conservation:
Wildlife Sanctuaries -Thattekkad, Parambikulam and Periyar WLS;
National Parks- Eravikulam and Silent Valley NP; Biosphere Reserves - Nilgiri and Agasthyamalai BR; Community reserve- Kadalundy.

Teacher Specific Module	**12 hours**
Directions: **20 percent of the content can be modified by the course teacher**	

Core Compulsory Readings

1. Alfred, J.R.S., Das, A.K. and Sanyal, A. K. (1998): Faunal diversity in India, ZSI Calcutta

2. Barret, E.C and Anton Micallef (1991): Remote Sensing for Hazard Monitoring and Disaster Assessment, Taylor and Francis, London.

3. Canter, L.W. and Graw, MC, Environmental Impact Assessment, Hill publication, New

York

4. Chang – Kang, Tsung (2002): Introduction to Geographic information system. Tata McGraw-Hill Publishing Company Limited. New Delhi

5. Choudary, Suahant and Malik, Pradeep. A guide to chemical Restraint of Wild Animals. Nataraj Publishers, Dehradun

6. Daneil, J.C. The book of Indian Reptiles and Amphibians, Oxford publ.

7. Giles R.H. Jr. (Ed) (1984): Wildlife management techniques-3rd Edition, the wildlife society, Washington D.C.

8. Hosetti, B.B. (1997): Concepts in Wildlife Management, Daya Publishing House, Delhi.

9. Lilleand, T.M, and Kieffer, R.W., John Wiley and Sons. Remote Sensing and image Interpretation

10. Negi, S.S. (1993) Biodiversity and its conservation in India. Indus Publishing Co., New Delhi.

11. Prater, S.H. The Book of Indian Animals. BNHS/Oxford

12.Rodgers W.A (1991): Techniques for wildlife census in India.

13. Salim Ali (2002). The book of Indian Birds, revised edn. BNHS & Oxford university press, New Delhi.

14. Singh, S.K (2005): Textbook of Wildlife Management. IBDC. Lucknow

15. Trothy, J.B. Boyle and Boontawee – Measuring and monitoring Biodiversity in Tropical and Temperate Forest. Centre for International forestry Research, Bogor, Indonesia

16. Wild life wing west Bengal: Field Handbook on Chemical Restraint of Wild Animals

Assessment Rubrics:

Evaluation Type		Marks
1. End Semester Evaluation		70
2. Continuous Evaluation		30
Continuous Evaluation		
Theory	Method of Assessment	Marks
a)	Test paper I	6
b)	Test paper II	6
c)	Viva-Voce	6
d)	Assignment	6
e)	Seminar	6
		Total – 30 marks

KU5DSEZOO308: ECONOMIC ZOOLOGY(Elective)

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
V	DSE	300	KU5DSEZOO308	4	60

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/Tutorial	Practical	CE	ESE	Total	
4	-	30	70	100	2

Course Description:

The course will provide the fundamentals of economically important animals and farming them. It will explore the different animal rearing methods. Specifically, the course is made up of units on: Parasitism, pests and their control; apiculture, Seri culture, Lac culture, aquaculture, poultry and Animal husbandry. These topics will include identification and control of various parasites and pests and describing the various important rearing methods. Economically important of fish, honey bee, silk insect, lac insect, dairy, poultry, rabbit, prawn, mussels, oysters etc. are also studied.

Course Pre requisite:

Course Outcomes:

	Expected Outcome	**Learning Domains**
CO1	Acquire knowledge about different beneficial and harmful animals (U)	U
CO2	Understand about mode of transmission and disease caused by pests and parasites and evaluate methods to mitigate their ill-effects (E)	E
CO3	Evaluate the economic viability of farming beneficial organisms as a means of income (An)	An
CO4	Evaluate quality of animal products and suggest methods to improve their storage and consumption (E)	E

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

Mapping of Course Outcomes to PSOs

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	3	0	0	1
CO2	2	3	0	0	3
CO3	0	0	2	0	1
CO4	0	0	3	0	3

COURSE CONTENTS

Module I: Pests and Parasitism 12 Hrs.

Unit I:

1.1. Parasitism in relation to man, Classification of Parasites and Hosts, Modes of infection

1.2 Protozoan parasites infecting humans- *Entamoeba histolytica*, *Naegleria fowleri, Plasmodium vivax* (brief account on Morphology, Life cycle, Pathogenicity, prevention and treatment).

1.3 Helminth parasites infecting humans-*Taenia solium*, *Schistosoma haematobium, Ancylostoma duodenale*, *Wuchereria bancrofti*, *Enterobius vermicularis* (brief account on Morphology, Life cycle, Pathogenicity, prevention and treatment).

Unit II:

1.4 Classifiction of pests- potential pests, key pests, occasional pests, regular pests, seasonal pests, persistent pests, sporadic pests- with example.

1.5 Pests of Paddy, Stored Grains, Coconut, and Mango (Rice swarming caterpillar, rice bug, red palm weevil, rhinoceros beetle, coconut mite, rice weevil, pulse beetle and mango stem borer) scientific name of pest, Damage caused & control methods.

Unit III:

1.6 Insect vectors of human diseases and their control- *Anopheles, Culex, Aedes, Xenopsylla, Cimex*, *Pediculus* and *Phthirus* - Life cycle, pathogenicity and control, rodent control.

1.7 Insect control - Cultural, mechanical chemical and Biological control; Insecticides and insect resistance; Integrated Pest Management; Beneficial vertebrates, insects, nematodes, and microbes.

Module I: Pests and Parasitism 12 Hrs.

Unit I:

1.1. Parasitism in relation to man, Classification of Parasites and Hosts, Modes of infection

1.2 Protozoan parasites infecting humans- *Entamoeba histolytica*, *Naegleria fowleri*, *Plasmodium vivax* (brief account on Morphology, Life cycle, Pathogenicity, prevention and treatment).

1.3 Helminth parasites infecting humans-*Taenia solium*, *Schistosoma haematobium*, *Ancylostoma duodenale*, *Wuchereria bancrofti*, *Enterobius vermicularis* (brief account on Morphology, Life cycle, Pathogenicity, prevention and treatment).

Unit II:

1.4 Classifiction of pests- potential pests, key pests, occasional pests, regular pests, seasonal pests, persistent pests, sporadic pests- with example.

1.5 Pests of Paddy, Stored Grains, Coconut, and Mango (Rice swarming caterpillar, rice bug, red palm weevil, rhinoceros beetle, coconut mite, rice weevil, pulse beetle and mango stem borer) scientific name of pest, Damage caused & control methods.

Unit III:

1.6 Insect vectors of human diseases and their control- *Anopheles, Culex, Aedes, Xenopsylla, Cimex, Pediculus* and *Phthirus* Life cycle, pathogenicity and control, rodent control.

1.7 Insect control - Cultural, mechanical chemical and Biological control; Insecticides and insect resistance; Integrated Pest Management; Beneficial vertebrates, insects, nematodes, and microbes.

Module III: Aquaculture 12 Hrs

Unit I:

3.1 Aquaculture- Introduction, significance, diversity of aquaculture, Modern fish farming techniques- aquaponics, RAS, Biofloc, aquascaping, culture of aquarium plants

3.2 Pisciculture - Impotance of Pisciculture, construction & Management of pond

3.3 Common culturable food fish- Etroplus, common carps, Tilapia - seed production and collection, breeding and types of culture, composite fish farming.

3.4 Fish diseases- Dropsy, furunculosis, cotton mouth disease- pathogen, symptoms, treatment, prevention and control.

Unit II:

3.5 Ornamental fish farming- methods of aquarium keeping, different types of aquaria, setting up of aquarium, maintenance of aquarium

3.6 Ornamental fishes- indigenous and exotic- *Puntius* species, *Mystus*, *Horabagrus*, gold fish, gourami, platy, sword tail; Ornamental fish breeding.

Unit III:

3.7 Prawn culture- culturable species, culture methods, induced breeding

3.8 Pearl Culture- culturable species, culture methods, Preparation of nuclei, host and graft tissue, implantation, nursing.

3.9 Mussel culture- culturable species, culture methods, seed collection, induced spawning, rearing of larvae, farming

Module IV: Poultry Science, Dairy and Animal Husbandry 12 Hrs

Unit I:

4.1 Poultry farming- Importance of egg production, Nutritive value of eggs, testing of egg.

4.2 Poultry breeds- Indigenous breeds (Chittagong, Aseel, Brahma, Giriraja) & Exotic breeds (Rhode Island Red, Plymouth Rock, New Hampshire, Sussex, Leghorn, Minorca)

4.3 Breeding for sustainable economy- Laying, Meet, Dual purpose; meat products.

4.4 Diseases of fowl: Ranikhet, fowl pox, coccidiosis – pathogen, symptoms, treatment, prevention and control.

Unit II:

4.5 Duck farming- breeds of ducks (Khaki campbell and White pekin)

4.6 Advantages of duck farming, duck feed, Methodology of duck farming.

4.7 Diseases of duck: duck plague, duck cholera, avian flu – pathogen, symptoms, treatment, prevention and control.

Unit III:

4.8 Dairy and Animal Husbandry - Cattle farming- production and care of cattle- Cattle breeds- Dairy breeds, Draught breeds, Dual purpose breeds, Exotic breeds, cross breeds, Native breeds, Cross breeds (Gir, Red Sindhi, Sahiwal, Halliker, Hariana, Ongole, Jersey, Holstein- Friesian, Brown Swiss, Ayrshire, Jersey cross, Holstein- Friesian cross, Murrah, Surti).

4.9 Pasteurization, Quality of milk, Artificial insemination, dairy equipments, fodder production, caring during pregnancy and caring of calves, Milk products, gobar gas production.

4.10 Diseases- Anthrax, Foot and mouth diseases, Brucellosis- pathogen, symptoms, treatment, prevention and control.

4.11 Rabbit farming- soft wool and meat- methodology of rabbit farming.

Teacher Specific Module	12 hours
Directions: **20 percent of the content can be modified by the course teacher** *Suggestion:* Vermicomposting/ shrimp culture/ fishing crafts and gears.	

Text Books:

1. Atwal, A.S. (1993) Agricultural Pests of India and Southeast Asia. Kalyani Publishers, New Delhi.
2. Dawes, J. A. (1984) The Freshwater Aquarium, Roberts Royee Ltd. London.
3. Jaiswal, V. and Jaiswal, K. (2014) Economic Zoology, PHI learning.
4.Pradeep, V.J (2008) Textbook of Applied Zoology, Discovery Publishing.
5. Ravindranathan, KR (2013) A Textbook of Economic Zoology, Wisdom Press.
6. Shukla, G.S. and Upadhyay, V.B 2002: Economic Zoology, 4e, Rastogi.
7. Singh, S. Bee keeping in India, ICAR.
8. Srivastava, C.B.L. (2002): Fishery Science and Indian Fisheries, Kitab Mahal.
9. Yadav, M. (2013) Economic Zoology, Discovery publishing.

References

1. Banerjee, G.C. (2000). A Text Book of Animal Husbandry. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
2. Chaterjee, K.D. (2009) Parasitology: Protozoology & Helminthology. CBS Publishers.
3. Dokuhon, Z.S. (1998). Illustrated Textbook on Sericulture. Oxford & IBH Publishing Co., Pvt. Ltd. Calcutta.
4. Foley, R.C., Bath, D.L., Dickinson, F.N. and Tucker, H.A. (1973). Dairy Cattle: Principles, Practices, Problems, Profits. Lea & Febiger, Philadelphia.
5. Gupta, S.K. & Gupta, P.C. General and Applied Ichthylogy (Fish & Fisheries). S. Chand & Co. Ltd., New Delhi.
6. Khanna, S.S. and Singh, H.R. A Textbook of Fish Biology & Fisheries Published by Narendra Publishing House.3rd Edition. (ISBN13: 9789384337124)

7. Tembhare, D. B. (2017) Modern Entomology. Published by Himalaya Publishing House.

8. www.agritech.tnau.in.

9. www.cifri.res.in

10. https://krishijagran.com/animal-husbandry/how-to-do-profitable-commercial-rabbit-farming-in-india/

11. Swayam.gov.in. Applied and Economic Zoology.

Assessment Rubrics:

Evaluation Type		Marks
1. End Semester Evaluation		70
2. Continuous Evaluation		30
Continuous Evaluation		
Theory	Method of Assessment	Marks
a)	Test paper I	6
b)	Test paper II	6
c)	Viva-Voce	6
d)	Assignment	6
e)	Seminar	6
	Total – 30 marks	

Employability

- Jobs in the field of epidemic surveillance and control and pest control.
- Self employment in the field of apiculture, sericulture, lac culture, Animal husbandry and aquaculture.
- Research Institutions and Universities: Opportunities in research and scientific roles in identification of pests and parasites, developing novel methods in apiculture, sericulture, lac culture, Animal husbandry and aquaculture.
- Industry: Opportunities in honey, wax, silk, lac, fisheries management, aquaculture, marine technology, dairy, poultry and eco-tourism ventures.
- Education and Communication: Career paths in teaching, science communication, media.

KU6DSCZOO309: CHORDATA-SYSTEMATICS AND COMPARATIVE ANATOMY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VI	DSC	300	KU6DSCZOO309	3+1	60

Learning Approach (Hours/Week)		Marks distribution			Duration of ESE(Hours)
Lecture/Tutorial	Practical	CE	ESE	Total	
3	2	25	75	100	1.5

Course Description:
Course create awareness about the chordates, explain the taxonomic features of chordates and compare the adaptive features in different chordates. By the end of this course, students will emerge with a comprehensive understanding of chordate systematics and comparative anatomy, equipped with valuable knowledge and skills applicable to further studies, research endeavors, and careers in the biological sciences.

Course Pre requisite:

Course outcomes:

	Expected Outcome	**Learning Domains**
CO1	Understand the diversity and important features in different Chordates and comprehend their diversity	U
CO2	Understand the comparative anatomy and its evolutionary significance among vertebrates	U
CO3	Analyze the adaptive features in different Chordates	E
CO4	Evaluate the importance of diagnostic characters in classifying chordates	An

**Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)*

Mapping of Course Outcomes to PSOs

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	2	1	1	2
CO2	2	3	1	1	2
CO3	2	3	3	1	2
CO4	2	3	3	0	2

COURSE CONTENTS

Module I: Chordates **(11 hours)**

Unit I

1.1Types of Chordates: Cephalochordata, Urochordata and Vertebrata

Units II

1.2 General classification of fishes up to Orders.

1.2.1 Class Placodermi, Chondrichthyes: Subclass Elasmobranchii and Holocephali

1.2.2 Scoliodon: Nervous system and circulatory system

Unit III

1.3 Accessory respiratory structures in fishes.

Module II: Amphibia and Reptiles **(11 hours)**

Unit I

2.1 Amphibia characters and classification with examples

Unit II

2.2 Types of Reptiles: Ctylosauria, Chelonia, Rhyncocephalia and Squamata.

Unit III

2.3 Snakes:

2.3.1. Biting mechanism

2.3.2. Snake venom

2.3.3. Taxonomic key for the identification of poisonous snakes.

Module III: Birds and Mammals **(12 hours)**

Unit I

3.1 Flight adaptation in birds (Mention skeletal features, feathers, flight muscles, respiratory system and eye)

3.2 Classification of birds: Archaeornithes and Neornithes and Flightless birds.

Unit II

3.3 Mammals: Characters and classification (Prototheria, Metatheria and Eutheria).

Unit III

3.4 Types of Eutherians: Chiroptera, Artiodactyla, Perissodactyla, Carnivora and Cetacea (Mention Adaptations in aquatic mammals).

Module IV: Comparative anatomy of Vertebrates **(11 hours)**

Unit I

4.1Dentition in mammals

4.2 Jaw suspension in Vertebrates

Unit II

4.3 Arterial system of Frog and Rabbit

Unit III

4.4 Kidney in different Vertebrates; Pronephros, Mesonephros, Metanephros and Opisthonephros.

Module V: Practicals **(30 hours)**

1. TAXONOMY: specimens should be identified by their generic name. Students should examine the specimens in the lab and draw labelled sketches. Notes should contain classification, morphological and functional peculiarities and other significant features. The record should be in the form of an observation book. Artistic diagrams are not needed.

Hemichordata (1) Protochordata (2) Agnatha (1) Chonrichthyes (2) Osteicthyes(3) Amphibia (4) Reptilia (5) Aves (2) Mammalia (2)

Identification of fish (up to sub-class and species characters): *Cirrhinus mrigala, Labeo rohita, Labeo calbasu, Catla catla, Channa striatus, Mystus vittatus, Pampus argenteus, Harpadon nehereus*. (Any 4)

2. Identification of different types of bird feathers (quill, countor, filoplumes and down)
3. OSTEOLOGY: Shark – vertebra Frog – typical, 7th, 8th, 9th vertebrae and urostyle. Rabbit vertebrae – atlas, axis. Bird - Pectoral girdle, cervical vertebra, synsacrum, sternum. Mammal-Pelvic girdle – rabbit.
4. MOUNTINGS: Fish Scales (Cycloid, Placoid)

Teacher Specific Module	**9 hours**
Directions: **20 percent of the experiments can be modified by the course teacher**	

Core Compulsory Readings

1. Chanda, S. K. (2002). Hand book – Indian Amphibians. Zoological Survey of India, Kolkata.
2. Das, I. (2002). A Photographic Guide to Snakes and Other Reptiles of India. Ralph Curtis Books, Florida.
3. Daniel, J. C. (2002). The Book of Indian Reptiles and Amphibians. Oxford University Press & Bombay Natural History Society, Mumbai.
4. Daniels, R. J. R. (2005). Amphibians of Peninsular India. Indian Academy of Sciences & Universities Press, Hyderabad.
5. Daniels, R. J. R. (2002). Freshwater Fishes of Peninsular India. Indian Academy of Sciences & Universities Press, Hyderabad.

6. Day, F. (1971). The Fishes of India: Being a Natural History of the Fishes Known to Inhabit the Seas and Fresh Waters of India, Burma, and Ceylon. Volume I & II.MJP Publishers, Chennai.
7. Dhami, P. S. & Dhami, J. K. (2009) Chordate Zoology. R. Chand & Co., New Delhi.
8. Grimmett, R., Inskipp, C. & Inskipp, T. (2011). Birds of the Indian Subcontinent. 2nd Edition. Christopher Helm Publishers, London.
9. Groves, C. P. (2001). Primate Taxonomy. Smithsonian Institute, Washington D.C, USA.
10. Harvey Pough, F., Janis, C. M. & Heiser, J. B. (2009). Vertebrate Life. 8th illustrated edition. Benjamin Cummings (Pearson Education Inc., Indian Edition).
11. Johnsingh, A. J. T. & Manjrekar, N. (2012). Mammals of South Asia – Volume 1 & 2. Orient Black Swan Publishing, Hyderabad.
12. Jordan, E. L. & Verma, P. S. (2014). Chordate Zoology. S. Chand & Company Ltd., New Delhi.
13. Kardong, K. V. (2014). Vertebrates: Comparative Anatomy, Function and Evolution. McGraw-Hill Higher Education, New York.
14. Kent, G. C. & Carr, R. K. (2001). Comparative Anatomy of the Vertebrates, 9th Edition. Tata McGraw-Hill Publishing, New Delhi.
15. Kotpal, R. L. (2007) Modern Textbook of Zoology: Vertebrates. Rastogi Publications, Meerut.
16. McKenna, M. C. & Bell, S. K. (1997). Classification of Mammals: Above the Species Level. Columbia University Press, USA.
17. Menon, V. (2014). Indian Mammals: A Field Guide. Hachette India, New Delhi.
18. Pande, S. (2003). Birds of Western Ghats, Kokan & Malabar: Including Birds of Goa. Bombay Natural History Society, Mumbai.
19. Parker, J. J. & Haswell, W. A. (2012)
20. Textbook of Zoology: Vertebrates. 7th Edition. AITBS Publishers & Distributors, New Delhi.
21. Prater, S. H. (1971). The Book of Indian Animals. Bombay Natural History Society, Mumbai.
22. Salim Ali (1997). The Book of Indian Birds. 12th Edition. Bombay Natural History Society & Oxford University Press.

23. Whitaker, R. (2006). Common Indian Snakes: A Field Guide. 2nd Edition. MacMillan & Co, India. Whitaker, R. & Captain, A. (2016). Snakes of India: The Field Guide. Westland/ Draco Books.
24. Wilson, D. E. & Reeder, D. M. (2005). Mammal Species of the World: A Taxonomic and Geographic Reference, Volume 1. Johns Hopkins University Press, USA.

Assessment Rubrics:

Evaluation Type		**Marks**	
		Theory	**Practical**
1. End Semester Evaluation		50	15
2. Continuous Evaluation		25	10
Continuous Evaluation			
Theory/Practical	Method of Assessment	Marks	
Theory			
a)	Test paper I	5	
b)	Test paper II	5	
c)	Viva-Voce/Seminar/ Discussion	10	
d)	Assignment	5	
	Total – 25 marks		
Practical			
a)	Regularity/Punctuality	5	
b)	Laboratory skill	5	
	Total – 10 marks		

KU6DSCZOO310: MOLECULAR BIOLOGY, BIOINFORMATICS AND BIOTECHNOLOGY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VI	DSC	300	KU6DSCZOO310	4	60

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/Tutorial	Practical	CE	ESE	Total	
4	-	30	70	100	2

Course Description:

This course provides an in-depth exploration of the fundamental principles governing the structure, function, and regulation of biological molecules at the molecular level. Topics covered include DNA replication, transcription, translation, gene expression regulation, and mechanisms of genetic variation. The course introduces students to the interdisciplinary field of biotechnology, focusing on the application of biological principles and techniques to address societal challenges and advance various industries. Students will explore the ethical, legal, and social implications of biotechnology, as well as current trends and emerging technologies in the field. This course also provides an introduction to the interdisciplinary field of bioinformatics, which combines principles of biology, computer science, and statistics to analyze and interpret biological data.

Course Pre requisite:

Course Outcomes:

	Expected Outcome	**Learning Domains**
CO1	Gain a deep understanding of fundamental molecular biology principles	U
CO2	Utilize knowledge on molecular biology for biological research and solve complex biological problems	E
CO3	Perform DNA and protein sequence analysis, including sequence alignment and	Ap
CO4	Gain a comprehensive understanding of key concepts in biotechnology	U
CO5	Demonstrate a comprehensive understanding of different types of cloning vectors and their applications in genetic engineering	An

**Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)*

Mapping of Course Outcomes to PSOs

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	0	0	1	3	0
CO2	0	0	3	3	0
CO3	0	0	3	1	1
CO4	0	0	1	3	3
CO5	1	0	2	3	3

COURSE CONTENTS

Module I: Introduction to Molecular Biology **(12 hours)**

UNIT I. Early experiments proving DNA as the genetic material:

1.1 Griffith's experiment (Bacterial transformations)

1.2 Avery, McLeod and McCarthy

1.3 Hershey and Chase Experiments

UNIT II. Concept of Gene:

1.4 Classical concepts (one gene one enzyme hypothesis, one gene one polypeptide hypothesis)

1.5 Modern concept of genes, split genes, overlapping genes, pseudogenes, jumping genes, cryptic genes, housekeeping genes

1.6 Gene action: Central dogma of molecular biology and central dogma reverse (Brief Account only)

1.7 Mention Genome and non-coding DNA

1.8 C-Value Paradox

UNIT III.

1.9 DNA Replication

- 1.9.1 Meselson and Stahl experiment
- 1.9.2 Semi-conservative and semi-discontinuous mode of DNA replication,
- 1.9.3 chemistry of DNA synthesis (Role of 3' OH and 5'PO4)
- 1.9.4 Role of RNA primase in *E. coli*
- 1.9.5 Role of RNaseH
- 1.9.6 DNA polymerases (types in prokaryotes and few types in eukaryotes)
- 1.9.7 Direction of DNA synthesis, leading and lagging strands

1.9.8 primer removal and joining of Okazaki fragments

1.9.9 Simultaneous synthesis on leading and lagging strands

1.9.10 Enzymes involved in DNA replication (Helicase, Topoisomerase, Ligase, DNA polymerase, Primase, RNase)

1.9.11 Other proteins involved in DNA replication (Sliding clamps, clamp loaders, SSBP)

Module II: Gene Expression and Regulation **(12 hours)**

Unit I:

2.1 Genetic code

2.1.1 properties of the genetic code

2.1.2 Concept of wobble

2.2 Transcription

2.2.1 RNA polymerases of eukaryotes and prokaryotes

2.2.2 promoters, terminators, enhancers and silencers

2.2.3 Transcription unit- mono and polycistronic transcription units

2.2.4 coupling of transcription with translation in bacteria

2.2.5 Initiation, elongation and termination of transcription

2.2.6 Post-transcriptional modification of the primary transcript – hnRNA, capping, polyA-tailing and splicing, spliceosomes

Unit II:

2.3 Translation:

2.3.1 Activation of amino acids and aminoacyl tRNA synthetases

2.3.2 structure of tRNA, role of tRNA as adaptor molecules in translation

2.3.3 Structure of ribosome, Role of ribosomes and active centres of ribosomes

2.3.4 Initiation, elongation and termination of translation

2.3.5 Post translational modification of the peptide chain: cleavage, formation of disulfide-bridges, acetylation, glycosylation, myristoylation, sulphation, hydroxylation, prenylation, nitrosylation, ubiquitination and SUMOylation,

2.3.6 Protein folding and role of molecular chaperones

Unit III:

2.4 Regulation of gene expression

2.4.1 Operon organization of bacterial transcription units

2.4.2 Lac operon, trp operon and its regulation

2.4.3 Regulatory RNAs – ncRNAs, miRNAs, piRNAs, siRNAs and RNA interference

(Brief account only).

Module III: Fundamentals of Bioinformatics **(12 hours)**

UNIT I: Bioinformatics:

3.1 Definition of bioinformatics

3.2 Role of bioinformatics in life sciences

3.3 Major Databases in Bioinformatics

- 3.3.1 Classification format of biological databases (any two suitable examples may be provided for the following groups)
- 3.3.2 Primary databases: Nucleotide sequence databases
- 3.3.3 Protein sequence databases
- 3.3.4 Structure databases
- 3.3.5 Special databases
- 3.3.6 Secondary databases
- 3.3.7 Composite databases

3.4 Advantages and disadvantages of bioinformatics databases.

UNIT II

3.5 Sequence similarity search – pair wise searches BLAST, FASTA

UNIT III:

3.6 Concept and applications of Genomics, Proteomics, Transcriptomics, Metabolomics. Metagenomics. (Brief account only)

Module IV: Biotechnology and its Applications **(12 hours)**

UNITI: Introduction to Biotechnology

4.1 Overview of biotechnology, history and scope

4.2 Genetic engineering: Introduction

4.3 rDNA technology and its enzymes - Exonuclease, Endonuclease, Restriction enzyme DNA ligase, DNA polymerase, Reverse transcriptase

4.4 Gene cloning: Cloning vectors (plasmids, phages, cosmids, BAC, YAC)

UNIT II: Techniques in Biotechnology:

4.5 DNA hybridisation techniques – Southern Blotting, Microarrays (Brief account)

4.6 Other hybridisation techniques – Northern Blotting, Western Blotting and Elisa (Brief account)

4.7 Polymerase Chain Reaction

4.9 CRISPR-Cas9 Genome Editing (Brief Account only)

4.10 Transfection: methods, transgenic animals and ethical issues of transgenic animals **UNIT III:** Applications of Biotechnology: 4.11 Agricultural biotechnology- genetically modified organisms (GMOs), crop improvement, and pest resistance. 4.12 Medical biotechnology- diagnostics, therapeutics, gene therapy, and personalized medicine 4.13 Environmental biotechnology- wastewater treatment, biofuels, and sustainable practices 4.14 Biotechnology entrepreneurship, innovation, and commercialization

Teacher Specific Module	**12 hours**
Directions: **20 percent of the experiments can be modified by the course teacher**	

Core Compulsory Readings

Gupta, P. K., 2018. Molecular Biology and Biotechnology, Rastogi Publications (3rd Reprint).

Assessment Rubrics:

Evaluation Type		**Marks**
1. End Semester Evaluation		70
2. Continuous Evaluation		30
Continuous Evaluation		
Theory	Method of Assessment	Marks
a)	Test paper I	6
b)	Test paper II	6
c)	Viva-Voce	6
d)	Assignment	6
e)	Seminar	6
	Total – 30 marks	

KU6DSCZOO311: BIOLOGICAL INSTRUMENTATION AND METHODOLOGY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VI	DSC	300	KU6DSCZOO311	4	60

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/Tutorial	Practical	CE	ESE	Total	
4	-	30	70	100	2

Course Description:

This course provides students with a comprehensive understanding of the various instruments and methodologies used in biological research. Students will learn about the principles behind the instrumentation and techniques commonly used in biological studies. Students will learn to design a research work on a topic and apply scientific methods in research.

Course Prerequisite:

Course Outcomes:

	Expected Outcome	Learning Domains
CO1	Learn about instruments used in biological research and their applications in biological research	U
CO2	Comprehend the principles and use of different instruments used in biological research	U
CO3	Develop the ability to evaluate scientific literature and experimental methodologies in biological research	E
CO4	Design and conduct biological experiments, analyse data, and present findings in written reports and oral presentations	A
CO5	Analyse and interpret biological data using appropriate statistical methods and graphical representation techniques.	An

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

Mapping of Course Outcomes to PSOs

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	0	0	1	1	0
CO2	0	0	1	1	0
CO3	0	0	2	0	0
CO4	0	0	0	0	1
CO5	0	0	3	0	1

COURSE CONTENTS

Module I: Biological Instrumentation **(12 hours)**

Unit I

1.1 Microscopy Techniques

- 1.1.1 Principle of microscopy and applications
- 1.1.2 Types of microscopes- light microscopy, dark field microscopy, phase-contrast microscopy, fluorescence microscopy, confocal microscopy, electron microscopy, Scanning probe microscopy.
- 1.1.3 Camera lucida and micrometry.

Unit II

1.2 Tools and Techniques (Principle, working methodology, and applications).

1.2.1 Separation Techniques

1.2.1.1 Centrifugation: Different types of centrifuges, principle, and application; Differential and density gradient centrifugation; Ultracentrifuge.

1.2.1.2 Chromatography: Paper chromatography; Thin-layer chromatography (TLC); Column chromatography; High-performance liquid chromatography (HPLC).

1.2.1.3 Electrophoresis: Paper and Gel Electrophoresis; Polyacrylamide gel; electrophoresis (PAGE); Agarose gel electrophoresis.

Unit III

1.3 Photometry-Colorimetry and Spectrophotometry, NMR spectroscopy (mention)

1.4 pH meter

Module II: Methodology in Science **(12 hours)**

Unit I

2.1Introduction to Science and Scientific Methods

2.1.1 Definition of science as a type of knowledge and process.

2.1.2 Principles and criteria of science – natural causality, universality, objectivity, falsifiability.

Unit II

1.2 Scientific attitude and scientific temper, pseudoscience, Inductive and deductive approach.

Unit III

2.3 Major steps of scientific methods.

Module III: Basic Concepts of Research **(12 hours)**

Unit I

3.1 Meaning, Objectives, Approaches, Types of research.

Unit II

3.2 Research Process (different steps of deductive research – identifying problem, review of literature, hypothesis, experiment, analysis of data, discussion, publication

Unit III:

3.3 Experimentation and Publication

3.3.1 Principles of experimentation – replication, randomization and local control.

3.3.2 Dependent and independent variables.

3.3.3 Pilot study.

3.3.4 Research report writing (Structure of scientific paper).

3.3.5 Presentation techniques: Oral presentation, Assignment, Seminar, Debate, Workshop, Colloquium, Conference.

3.3.6 Peer review

3.3.7 Plagiarism.

Module IV: **(12 hours)**

Unit I

4.1 Biostatistics – Definition, Role of statistics in life sciences.

4.2 Data Collection-Population and Sample; sampling - sample size, sampling errors and brief account of sampling methods

4.3 Presentation of data

4.3.1 Graphic representation- histogram, frequency polygon, and frequency curve

4.3.2 Diagrammatic representation - line diagram, bar diagram and pie diagram.

Unit II

4.4 Analysis of Data (for grouped and ungrouped data)

4.4.1 Measures of central tendency – mean, median and mode.

4.4.2 Measures of dispersion – range, mean deviation and standard deviation.

4.4.3 Testing of Hypothesis – Simple, composite, null and alternative hypothesis.

4.4.4 Types of errors - critical region, significance levels, power of test.

4.4.5 Tests of significance – ANOVA, chi-square test and goodness of fit.

Unit III:

4.4 Correlation and regression (brief account).
4.5 Data analysis packages – SPSS, R etc (brief mentioning only).
4.6 Measurement of biodiversity-diversity indices (species richness, evenness and dominance)

Teacher Specific Module (for 4 credit full theory course)	**12 Hours**
Directions: **20 percent of the content can be modified by the course teacher**	

Essential Readings:

1. Allen, T. (2015). Microscopy: A Very Short Introduction. Oxford University Press.
2. Bajpai, P. K. (2008). Biological Instrumentation and Methodology. S. Chand and Company Ltd.
3. Banerjee, P. K. (2008). Introduction to Biophysics. S. Chand Publishing.
4. Braithwaite, A., & Smith, F. J. (2008). Chromatographic Methods. Royal Society of Chemistry.
5. Gupta, K. C., Bhamrah, H. S., & Sandhu, G. S. (2006). Research Techniques in Biological Sciences. Dominant Publishers and Distributors, New Delhi.
6. Gupta, S. P. (2021). Statistical Methods (46th ed.). Sultan Chand & Co.
7. Kothari, C. R., & Garg, G. (2014). Research Methodology: Methods and Techniques (3rd ed.). New Age International (P) Limited, Publishers.
8. Prasad, S. (2004/2005). Elements of Biostatistics. Rastogi Publications, Meerut.
9. Roy, K. N. (2013). A Text Book of Biophysics. New Central Book Agency.
10. Wilson, K., & Walker, J. (2005). Principles and Techniques of Biochemistry and Molecular Biology. Cambridge University Press.

Suggested Readings:

1. Aggarwal, S. K. (2008). Foundation Course in Biology. Ane Books India, New Delhi. (Reference 1, 13)
2. Arora, P. N., & Malhotra, P. K. (1996). Biostatistics. Himalaya Publishing House. (Reference 2, 14)
3. Bailey, N. T. J. (2007). Statistical Methods in Biology (3rd ed.). Cambridge University Press. (Reference 20)
4. Collins, H., & Pinch, T. (1993). The Golem: What Everyone Should Know About Science. Cambridge University Press. (Reference 3, 15)

5. Gieryn, T. F. (1999). Cultural Boundaries of Science. University of Chicago Press. (Reference 4, 8, 17)

6. Gupta, S. P. (2002). Statistical Methods (31st ed.). Sultan Chand & Co. (Reference 5, 9)

7. Holmes, D., Moody, P., & Dine, D. (2006). Research Methods for the Biosciences. Oxford University Press. (Reference 6, 10, 16)

8. Keith Wilson, & John Walera. (2008). Principles and Techniques of Biochemistry and Molecular Biology. Cambridge University Press. (Reference 19)

9. Pechenik, J. A. (1987). A Short Guide to Writing About Biology. Little, Brown and Company. (Reference 7, 11)

10. Rastogi, V. (2008). Fundamentals of Biostatistics. Ane Books India, Chennai. (Reference 22)

11. Ruxton, G. D., & Colegrave, N. (2006). Experimental Design for the Life Sciences (2nd ed.). Oxford University Press. (Reference 12, 18)

12. Sokal, R., & Rohlf, F. (1973). Introduction to Biostatistics. Toppan Co Japan. (Reference 21)

Assessment Rubrics:

Evaluation Type		**Marks**
1. End Semester Evaluation		70
2. Continuous Evaluation		30
Continuous Evaluation		
Theory	Method of Assessment	Marks
a)	Test paper I	6
b)	Test paper II	6
c)	Viva-Voce	6
d)	Assignment	6
e)	Seminar	6
		Total – 30 marks

KU6DSEZOO313: MEDICAL PARASITOLOGY(Elective)

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
6	DSE	300	KU6DSEZOO313	4	60

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/Tutorial	Practical	CE	ESE	Total	
4	-	30	70	100	2

Course Description:

This course provides a comprehensive understanding of medical parasitology, including the biology, epidemiology, and diagnosis of parasitic infections, with a focus on various types of parasites and their associated diseases. It vividly explain parasitic protists as well as parasitic vertebrates. Various clinical diagnostic techniques including molecular diagnostic methods of various parasites are included for the students.

Course Prerequisite:

Course Outcomes:

	Expected Outcome	Learning Domains
CO1	Understand various diseases caused parasites	U
CO2	Apply the best diagnostic technique to identify infections, based on analysis of symptoms or available data	An
CO3	Employ immunoassays or serological techniques for laboratory diagnosis of endoparasites using marker molecules	A

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

Mapping of Course Outcomes to PSOs

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	1	0	1	3
CO2	0	0	2	1	3
CO3	0	0	0	1	2

COURSE CONTENTS

Module I: Medical Entomology 1.1 Vectors, morphological adaptations of vectors. 1.2. Vector borne diseases 1. 2.1 Mosquito -borne:- Chikungunya, Dengue fever 1. 2. 2 Flea -borne:- Plague, flea borne typhus 1. 2. 3 Lice -borne:- Relapsing fever, epidemic typhus 1. 2. 4 Tick -borne: - Tick borne encephalitis 1. 2. 5 Mite -borne:- Lyme diseases, Rocky mountain spotted fever
Module II: Vector Control Measures 2. 1 Mechanical control 2. 2 Ecological control 2. 3 Chemical control 2. 4 Biological control 2. 5 Genetic control 2. 6 IPM 2.7 Host and vector competence
Module III: Zoonotic Diseases 3.1 Rabies 3.2 Nipah 3.3 SARS 3.4 MERS 3.5 COVID
Module IV: Medical Diagnosis and Clinical Parasitology 4.1 Examination of faces 4.2 Examination of blood 4.3 Examination of tissues 4.4 Diagnosis of parasitic diseases: old and new approaches 4.5 Advantages & disadvantages of molecular diagnosis 4.6 Immunoassay or serological techniques for lab diagnosis of endoparasites using marker molecules like 4.6.1 *Giardia intestinalis* 4.6. 2 *E. histolytica* 4.6.3 *L. donovani* & malarial parasites using ELISA, RIA, PCR

Teacher Specific Module	**12 Hours**
Directions: **20 percent of the content can be modified by the course teacher**	

Suggested Reading:

- https://www.who.int/teams/control-of-neglected-tropical-diseases/interventions/strategies/vector-control
- https://vcrc.icmr.org.in/
- https://main.icmr.nic.in/

Journal of Parasitology

Journal of Medical Parasitology

International Journal of Parasitology

Journal of Parasitic diseases

Journal of Entomological Research

Assessment Rubrics:

Evaluation Type		**Marks**
1. End Semester Evaluation		70
2. Continuous Evaluation		30
Continuous Evaluation		
Theory	Method of Assessment	Marks
a)	Test paper I	6
b)	Test paper II	6
c)	Viva-Voce	6
d)	Assignment	6
e)	Seminar	6
		Total – 30 marks

KU6DSEZOO314: AQUACULTURE(Elective)

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VI	DSE	300	KU6DSEZOO314	4	60

Learning Approach (Hours/Week)		Marks distribution			Durationof ESE(Hours)
Lecture/Tutorial	Practical	CE	ESE	Total	
4	-	30	70	100	2

Course Description:

The course provide insights into Aquaculture's fundamentals, objectives, historical context, and its current global and national significance. It helps to explore Aquaculture's contribution to rural development, covering principles, species selection criteria, and key species across India's aquatic environments. At the end, the students learn about natural seed resources for finfish and shellfish, induced breeding, hatchery techniques, live feed culture, and feed formulation in Aquaculture.

Course Pre requisite:

Course outcomes:

	Expected Outcome	**Learning Domains**
CO1	Understand the principles of aquaculture	U
CO2	Apply advanced techniques in finfish and shellfish seed production	A
CO3	Evaluate and implement sustainable practices aquaculture, mariculture	A
CO4	Design and optimize aquaculture systems integrating state-of-the-art technologies	A
CO5	Critically analyze and propose solutions for challenges in aquaculture	E

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

Mapping of Course Outcomes to PSOs

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	0	0	0	0	0
CO2	1	1	0	0	2
CO3	0	0	0	2	3
CO4	0	0	1	2	3
CO5	0	0	2	2	4

COURSE CONTENTS

Module I: Introduction to Aquaculture	**(12 hours)**
Unit I: Definition and Objectives of Aquaculture 1.1 History and Scope of Aquaculture 1.2 Global and National Scenario of Aquaculture **Unit II**: 1.3 Aquaculture for Rural Development **Unit III**: 1.4 General Principles of Aquaculture	
Module II: Species Selection and Seed Production	**(12 hours)**
Unit I: Criteria for Selection of Aquaculture Species 2.1 Commercially Important Aquaculture Species in India **Unit II**: 2.2 Natural Finfish and Shellfish Seed Resources of India and their collection Techniques **Unit III**: 2.3 Induced Breeding in Finfishes and Shellfishes & Hatchery Techniques for Seed Production	
Module 3: Farming Techniques and Practices	**(12 hours)**
Unit I: 3.1 Classification of Fish Farms **Unit II**: Farming Techniques for Freshwater, Brackish, and Marine Environments 3.2 Culture of Indian Major Carps (IMCs) 3.3 Culture of *Macrobrachium rosenbergii* and other Species **Unit III**: Live Feed Culture and Feed Formulation	
Module 4: Brackish Water Aquaculture and Mariculture	**(12 hours)**
Unit I: Traditional Brackish Water Farming Practices in India 4.1 Prawn Filtration System and Bhasabada Fisheries **Unit II:** 4.2 Culture of Milkfish, Mullets, Pearl Spot, Asian Sea Bass, Shrimps, Crabs, Lobsters & Brackish water Molluscan Species **Unit III:** 4.3 Role of Mangrove Ecosystem in Aquaculture and Fisheries	

Teacher Specific Module	**12 hours**
Directions: **20 percent of the content can be modified by the course teacher** *Suggestion:* • Aquaculture System Design and Management • Site Selection for Aquaculture Farms • Farm and Pond Design Principles • Water Supply and Quality Management • Filters and Aerators in Aquaculture Systems	

• Hatchery Site Selection and Design • Advanced Techniques: Recirculating Aquaculture Systems (RAS), Integrated Multi-Trophic Aquaculture (IMTA), Aquaponics, Bioflocs	

Core Compulsory Readings

1. Ayyappan S. (2011). Handbook of Fisheries and Aquaculture. New Delhi: ICAR
2. Pillai Pillai, T.V.R. (1972). Coastal aquaculture in the Indo-Pacific region; Papers presented at the Indo-Pacific Fisheries Council Symposium on Coastal Aquaculture, Bangkok, Thailand, November 1970
3. Kurian C. V., Sebastian V. O Pillai, V. N (1993). Prawns and Prawn Fisheries of India. Hindustan Pub Corp
4. Kumar, H D. (2003). Sustainability and Management of Aquaculture and Fisheries. New Delhi: Daya Publishing House.

Core Suggested Readings

1. Akhilesh K Singh, Anil Mittal (1999). Dictionary of Aquaculture Daya Publishing House
2. Malcolm, Beveridge. C.M. (2004). Cage Aquaculture 3 rd Edition) Oxford: Blackwell Publishing
3. FAO. (2011). Aquaculture Development: Use of Wild Fishery Resources For Capture Based Aquaculture
4. Jhingran V.G. (1975). Fish and Fisheries of India (3 rd Edition). India: Hindustan Publishing Corporation.
5. Timmonms, M.B., Ebeling, J.M., Timmonms, M.B., Ebeling, J.M., Wheaton, F.W., Summerfelt, S.T Wheaton, F.W., Summerfelt, S.T., &., & VineiVinei, B.J., B.J. (2022).Recirculating Aquaculture Systems (2nd Edition). New York: Cayuga Aqua Ventures.

Assessment Rubrics:

Evaluation Type		Marks
1. End Semester Evaluation		70
2. Continuous Evaluation		30
Continuous Evaluation		
Theory	Method of Assessment	Marks
a)	Test paper I	6
b)	Test paper II	6
c)	Viva-Voce	6
d)	Assignment	6
e)	Seminar	6
	Total – 30 marks	

KU6DSEZOO315: WILDLIFE CONSERVATION AND MANAGEMENT(Elective)

<table>
<tr><td>Semester</td><td colspan="2">Course Type</td><td colspan="2">Course Level</td><td colspan="2">Course Code</td><td>Credits</td><td>Total Hours</td></tr>
<tr><td>VI</td><td colspan="2">DSE</td><td colspan="2">300</td><td colspan="2">KU6DSEZOO315</td><td>4</td><td>60</td></tr>
<tr><td colspan="9"></td></tr>
<tr><td colspan="3">Learning Approach (Hours/Week)</td><td colspan="5">Marks distribution</td><td>Duration of ESE(Hours)</td></tr>
<tr><td colspan="2">Lecture/Tutorial</td><td>Practical</td><td colspan="2">CE</td><td>ESE</td><td colspan="2">Total</td><td></td></tr>
<tr><td colspan="2">4</td><td>-</td><td colspan="2">30</td><td>70</td><td colspan="2">100</td><td>2</td></tr>
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Course Description:

This course offers a comprehensive overview of wildlife conservation and health management, focusing on India. Students explore wildlife's scope, economic significance, and conservation challenges. They learn to diagnose and treat infectious and non-infectious wildlife diseases. Practical training in habitat assessment, GIS, and remote sensing prepares students for conservation fieldwork. Modern concepts like wildlife forensics and toxicology are covered. Through case studies and projects, students apply knowledge to address conservation issues.

Course Pre requisite:

Course outcomes:

	Expected Outcome	**Learning Domains**
CO1	Students will develop a comprehensive understanding of the scope and importance of wildlife in India	U
CO2	Students will acquire proficiency in diagnosing and treating infectious and non-infectious diseases affecting wildlife	An
CO3	Students will develop practical skills in wildlife management techniques	U
CO4	Students will gain awareness of modern concepts and practices in wildlife conservation	U

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

Mapping of Course Outcomes to PSOs

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	1	0	0	3
CO2	2	2	2	1	3
CO3	1	0	1	0	3
CO4	0	0	1	0	2

COURSE CONTENTS

Module I: Scope and Importance of Wildlife of India (12 hours)

Unit I

1.1 Definition of Wildlife

1.2 Economic Importance of Wildlife

1.3 Causes of Wildlife Depletion

Unit II

1.4 Need for Wildlife Conservation

1.5 Rare, Endangered, Threatened, and Endemic Species in India

Unit III

1.6 Basic Concepts of Man and Wildlife Conflicts-Reasons for Conflicts

1.7 Identification of Damages Caused by Wild Animals and Control Measure

1.8 Case Studies: Elephant, Tiger, and Leopard

1.9 Translocation of Wild Animals: Principles, Methods, and Applications

Module II: Exploring the Aesthetics of Wildlife (12 hours)

UNIT 1

2.1 Introduction to Wildlife Aesthetics

2.2 Defining aesthetics in the context of wildlife

2.3 Understanding the importance of wildlife appreciation for ecological balance and cultural heritage

UNIT II

2.4 Ecotourism: A Sustainable Approach to Wildlife Exploration, Definition and principles of ecotourism

2.5 Exploring ecotourism as a tool for wildlife conservation and community development

2.6 Case studies of successful ecotourism initiatives around the world

UNIT III

2.7 Sacred Groves: Sanctuaries of Biodiversity and Culture

2.8 Exploring the ecological importance of sacred groves as biodiversity hotspots

2.9 Heritage Wildlife: Preserving Natural Treasures for Future Generations

2.10 Identifying heritage wildlife sites and their importance in conservation

2.11 Learning about the challenges and strategies in preserving heritage wildlife

Module III: Wildlife Management Techniques (12 hours)

UNIT I

3.1. Vegetative Analyses: Point Centered Quadrat, Quadrat, Strip Transect

3.2. GIS and Remote Sensing in Wildlife Habitat Surveys

3.3 Habitat Manipulation: Food, Water, Shade Improvement

UNIT II

3.4 Impact and Removal of Invasive Alien Species

3.5 Making Observations and Records: Field Notes, Datasheets

3.6 Wildlife Photography: Types of Cameras, Camera Traps

UNIT III

3.7 Field Equipments: Altimeter, Pedometer, Field Compass, Binoculars

3.8 Radio Collaring, GPS, GIS, Remote Sensing in Wildlife Management

Module IV: Modern Concepts in Wildlife Conservation (12 hours)

UNIT I

4.1Wildlife Crimes: Wildlife Forensics and Its Applications

4.2 Wildlife Toxicology: Types of Contaminants, Methods of Toxicity Evaluation,

UNIT II

4.3 Bioconcentration, Bioaccumulation, and Biomagnifications

4.4 Impacts of Pesticides and Heavy Metals on Birds and Mammals

UNIT III

4.5 CAMP and PHVA: Analyses and Reports

4.6 Environmental Impact Assessment (EIA) Methods and Their Role in Wildlife Conservation

4.7 Wildlife Heritage Areas

Teacher Specific Module	12 hours
Directions: **20 percent of the content can be modified by the course teacher**	

Core Compulsory Readings

1. Alfred, J.R.S., Das, A.K. and Sanyal, A. K. (1998): Faunal diversity in India, ZSI Calcutta
2. Barret, E.C and Anton Micallef (1991): Remote Sensing for Hazard Monitoring and Disaster Assessment, Taylor and Francis, London.
3. Canter, L.W. and Graw, MC, Environmental Impact Assessment, Hill publication, New York.
4. Chang – Kang, Tsung (2002): Introduction to Geographic information system. Tata McGraw-Hill Publishing Company Limited. New Delhi
5. Choudary, Suahant and Malik, Pradeep. A guide to chemical Restraint of Wild Animals. Nataraj Publishers, Dehradun
6. Daneil, J.C. The book of Indian Reptiles and Amphibians, Oxford publ.
7. Giles R.H. Jr. (Ed) (1984): Wildlife management techniques-3rd Edition, the wildlife society, Washington D.C.
8. Hosetti, B.B. (1997): Concepts in Wildlife Management, Daya Publishing House, Delhi.
9. Lilleand, T.M, and Kieffer, R.W., John Wiley and Sons. Remote Sensing and image Interpretation

11. Negi, S.S. (1993) Biodiversity and its conservation in India. Indus Publishing Co., New Delhi.
12. Prater, S.H. The Book of Indian Animals. BNHS/Oxford
13. Rodgers W.A (1991): Techniques for wildlife census in India.
14. Singh, S.K (2005): Textbook of Wildlife Management. IBDC. Lucknow
15. M. K. Ranjitsinh: Wildlife Conservation in India
16. Ramesh K. Choudhary: Wildlife Management and Conservation in India" by "Indian Wildlife" by Raj Singh
17. Prakash S. Bisen: Conservation Biology: Principles and Practice of Wildlife Management in India by N. K. Gupta and V. B. Sawarkar: Wildlife Diseases and Their Management in India

Assessment Rubrics:

Evaluation Type		Marks
1. End Semester Evaluation		70
2. Continuous Evaluation		30
Continuous Evaluation		
Theory	Method of Assessment	Marks
a)	Test paper I	6
b)	Test paper II	6
c)	Viva-Voce	6
d)	Assignment	6
e)	Seminar	6
	Total – 30 marks	

KU6DSEZOO316: AGRICULTURAL ENTOMOLOGY(Elective)

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VI	DSE	300	KU5DSEZOO316	4	60

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/Tutorial	Practical	CE	ESE	Total	
4	-	30	70	100	2

Course Description:

Entomology is the study of insects and their relationship to humans, the environment, and other organisms. Entomologists make great contributions to such diverse fields as agriculture, chemistry, biology, human/animal health, molecular science, criminology and forensics. **Agricultural entomology** is a subdivision of **Entomology** which is the study of pests and beneficial insects of field crops, fruits and vegetables. The major objectives of agricultural entomology is to teach insects and their role in agricultural systems. Also, it aims to graduate students, to maintain an inventory of major insect pests of crops and learn to apply suitable technologies for minimizing the production losses caused by them.

Course Prerequisite:

Course Outcomes:

	Expected Outcome	**Learning Domains**
CO1	Gain knowledge about status and biology of different types of insect pests	U
CO2	Identification of different pest species	U
CO3	Control of different pest species applying proper measures without side effects	A

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

Mapping of Course Outcomes to PSOs

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	1	3
CO2	3	3	1	0	1
CO3	2	3	1	2	3

COURSE CONTENTS

Module I: Insect Pests **(12 hours)**

Unit I:

1.1. Types of damage to plants by insects: Injury by chewing insects, piercing and sucking insects, internal feeders, subterranean insects, to stored products and indirect effect of feeding

Unit II:

1.2. Classification of insect pests: Regular pests, Occasional pests, Seasonal pests, persistent pests, sporadic pests, major pests, minor pests, potential pests, key pests.

Unit III:

1.3. Causes of pest outbreak

Module II: Insect pests of crops **(12 hours)**

Unit I:

2.1. Identification, life history, damage and control of major pests of different corps: Major grains; Paddy (5 major pests including stem borers, army worm, BPH, rice hispa, rice earhead bug)

Unit II:

2.2. Pulses and vegetable crops: Pulses (2 pests - Gram pod borer, Blue butterflies) Common vegetables (3 pests – pumpkin beetle, tomato fruit borer, *Dacus cucurbitae*)

2.3. Oil yielding crops: Coconut (4 pests - Rhinoceros beetle, red palm weevil, black-headed caterpillar, Coconut mite)

Unit III:

2.4 Fruit trees and spices: Mango (2 pests; Nut weevil, stem borer) Cashew (2 pests; tree borers, Tea mosquito bug) Banana (2 pests; rhizome weevil, banana skipper) Pepper (2 pests; pollu beetle, Marginal gall thrips)

2.5 Insect pests of Stored Products: (rice weevil, pulse beetle, Red flour beetle, rice moth)

Module III: Principles of Insect pest management (12 hours)

Units I:

3.1. Curative or direct methods: Cultural methods, Mechanical methods, Physical methods, Legal methods

Units II:

3.2. Chemical control: Brief explanations and one example of following different types if insecticides - Synthetic insecticides – Organochlorines (DDT), Organophosphates (Parathione), Carbamates (Carbaryl); Inorganic compounds (Arsenic compounds), Fumigants (HCN), Botanical insecticides (Pyrethroids); Disadvantages of chemical control.

Units III:

3.3 Biological control- History of biological control, Ecological basis of biological control, Natural enemies (Parasites, Parasitoids, Predators), Feasibility of biocontrol, Advantages and disadvantages of biological control.

3.4 Integrated Pest Management- Definition, IPM in Agroecosystem, Guidelines for developing IPM, Tactics in IPM, Advantages and disadvantages of IPM.

Module IV: Insecticide formulation and Appliances (12 hours)

Units I:

4.1 Insecticide formulation (Brief note on Emulsifiable concentrates, Water- miscible liquids, Wettable powders, Water soluble powders, Oil solutions, Flowable powders, Aerosoles, Granulars, Fumigants, Ultra-low volume concentrates, Fogging concentrates, Dusts, Poison bates and Slow release insecticides)

Units II:

4.2 Insecticide appliances.

Units III:

4.3 Various insect traps used for pest control

Teacher Specific Module	12 hours
Directions: **20 percent of the content can be modified by the course teacher**	

Essential Readings:

1. Ananthakrishnan, T.N. (1977) Insect and Host Specificity, Mc Millan Co, India Ltd.
2. Ananthakrishnan, T.N. (1992) Emerging trends in Biological Control of Phytophagous Insects. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
3. Atwal, A.S., Agricultural Pests of India and South East Asia. Kalyanai Publishing, New Delhi.
4. Brown, A.W.A. (1978): Ecology of Pesticides, John Wiley Sons, N.Y.
5. D"Brien, R.D. (1967): Insecticide - action and metabolism, Academic Press, N.Y.
6. Edwards, C.A. (1973): Persistent pesticides in the environment, C.R.C. Press
7. Dent.D.(1991). Insect Pest Management. CAB International, UK.
8. Harward, R.F. and James, M.T. (1979): Entomology in Human and Animal Health. 7th Edn. Cther Mc Millan Publishing London
9. Hill, D.S. and Waller, Insect Pests of Agriculture and their Control
10. Hill, D.S., Agricultural Entomology
11. Hill, D.S., Agricultural Insect Pests of the Tropics and their control C.V.P.
12. Matsumura, F. (1975): Toxicology of Insecticides – Plenum
13. Metcalf. G.L. and Flint.W.P. (1962). Destructive and Useful Insects, their Habits and Control. Tata Mc Graw Hill Publishing. Co. Ltd. N.Y.
14. Metcalf, R.L. and Luckman, W.H., Introduction to Insect Pest management, 3rd Edn. John Wiley & Sons

14. Moriarty, F., (1975): Organochlorine insecticides persistant organic pollutants, Academic Press, INC, London

15. Nair, M.R.G.K. (1975): Insect and Mites of Crops in India, ICAR, New Delhi.

16. O‟Brian, R.D. and Yamanots, I. (1970): Biochemical Toxicology of Insecticides, Academic Press INC, London

17. Pedigo, L.P. (1996): Entomology and Pest Management Practice. Hall India Pvt. Ltd. New Delhi.

18. Perry, A.S., Yamamoto, I., Ishaaya, I. and Perry, R. (1998): Insecticides in Agriculture and Environment – Retrospects and Prospects, Narosa Publishing House, New Delhi

19. Pradhan, S. (1969), Insect pests of Crops, National Book Trust, New Delhi. 20. Romoser, W.S. and Stoffalano, J.G. (1994). The Science of Entomology. 3rd Edn. Wm. C. Brown Publishing

21. Srivastava, K.P. (1996): A Text Book of applied Entomology. Vol.1&II, Kalyani publishers, Ludhiana.

23.Thacker, J.R.M. (2002).An Introduction to Arthropod Pest Control. Cambridge University Press, UK.

24. Vasantharaj David and Kumaraswami, Hand Book of Economic Zoology.

25. Walter,G. (2003). Insect Pest Management and Ecological Research, Cambridge University Press, U K.

Assessment Rubrics:

Evaluation Type		Marks
1. End Semester Evaluation		70
2. Continuous Evaluation		30
Continuous Evaluation		
Theory	Method of Assessment	Marks
a)	Test paper I	6
b)	Test paper II	6
c)	Viva-Voce	6
d)	Assignment	6
e)	Seminar	6
	Total – 30 marks	

KU6DSEZOO317: MEDICAL ENTOMOLOGY AND VECTOR BIOLOGY(Elective)

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VI	DSE	300	KU6DSEZOO317	4	60

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/Tutorial	Practical	CE	ESE	Total	
4	-	30	70	100	2

Course Description:

The word Entomology is derived from a Greek word “entomone” and “logia”. Entomology as the branch of zoology that deals with the scientific study of insects. It also explores the linkages between insects themselves and also the relationship of insects with other organisms including plant and animal on earth. This enables the scientists to divide entomology into various branches of entomology for easy understanding of the subject and applying its knowledge. Although only 2% of the insect species are obnoxious to man, they are enough to cause heavy damage to crop, livestock and man himself. That makes them very important for human attention. Insects not only harm humans, but also animals. Medical entomology deals with the insects that harm not only humans but effect animals also. It deals everything about medical public health, and veterinary importance such as Malaria, Dengue etc.

Course Prerequisite:

Course Outcomes:

	Expected Outcome	Learning Domains
CO1	Gain knowledge about different vector borne diseases	U
CO2	Understand the diagnosis of different vector borne diseases	U
CO3	Analyse the life cycle stages of vectors and disease transmission	U
CO4	Identification of vectors using morphological data	A
CO5	Recognise various control measures preventing epidemics	E

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

Mapping of Course Outcomes to PSOs

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	1	0	2	3
CO2	2	1	0	3	3
CO3	2	3	2	3	3
CO4	2	3	3	1	3
CO5	0	0	2	1	3

COURSE CONTENTS

Module I: Vector borne diseases **(12 hours)**

Unit I:

1.1. Insect vectors, causing organism, symptoms, disease cycle, pathology, treatment and prophylaxis of human diseases

1.1.1. **Caused by viruses**: Dengue, Chikungunya, Zika, Yellow fever, West Nile fever, Sand fly fever, Kyasanur Forest disease (KFD).

Unit II:

1.1.2. **Caused by bacteria and protozoa:** Plague, Typhus, Rocky Mountain spotted fever (RMSF). Malaria, African sleeping sickness, American sleeping sickness, Kala Azar.

Unit III:

1.1.3. **Caused by worms and sand flea:** Lymphatic filariasis, River Blindness, Tungiasis,

Module II: Diagnostic features, biology and control measures of important vectors **(12 hours)**

Unit I:

2.1. Mosquitoes (Anopheles, Aedes, Culex, Mansonia)

Unit II:

2.2. Sand flies, Black fly, Tse Tse fly

Unit III:

2.3Flea, Assassin bug, Head louse, Tick

Module III: Insects in public health other than their role as vectors **(12 hours)**

Unit I:

3.1. Insects related to Myasis

Unit II:

3.2. Poisonous insects: Bees, wasps and ants- Anaphylaxis. **Unit III:** 3.3. Maggot therapy (Use of maggots in treatment).
Module IV: Forensic Entomology (12 hours) **Unit I:** 4.1. Introduction to Forensic entomology **Unit II:** 6.1. Insects used in forensic entomology (Dipterans and coleopterans), Succession of insect fauna on a cadaver. **Unit III:** 6.2. Methods of forensic entomology: Detection of time of death, mode of death and place of death. Case histories (At least 3).

Teacher Specific Module	**12 hours**
Directions: **20 percent of the content can be modified by the course teacher**	

Essential Readings:

Medical Entomology

1. Kettle D.S. (1995). Medical and Veterinary Entomology. 2nd Ed. CAB international.
2. Jeremy Farrar et al (2015). Manson's Tropical Diseases, 23rd Edition. Elsevier. Pp. 1552
3. Sun, Xinjuan; Jiang, Kechun; Chen, Jingan; Wu, Liang; Lu, Hui; Wang, Aiping; Wang, Jianming (2014). A systematic review of maggot debridement therapy for chronically infected wounds and ulcers. International Journal of Infectious Diseases 25: 32–7
4. Mike Service (2008). Medical Entomology for students.4th ed. Cambridge University Press.U K.

Forensic Entomology

1. Kenneth G.V. Smith (1987). A manual of Forensic Entomology. Cornell Univ Pr. Pp.225.
2. Sumodan P.K. (2002). Insect Detectives. Resonance.
3. Gennard, D.E. (2007). Forensic Entomology-An Introduction. John Wiley.

4. Wall, Richard and Shearer, David. (1998). Veterinary Entomology. Chapman & Hall, .

5. Smith, K.V.G. (1986). A Manual of Forensic Entomology. British Museum Natural History.

6. David, B.V. and Ananthakrishnan, T.N. (2004) General and Applied Entomology. 2nd ed. Tata McGraw Hill publishing Co. Ltd. New Delhi.

Assessment Rubrics:

Evaluation Type		**Marks**
1. End Semester Evaluation		70
2. Continuous Evaluation		30
Continuous Evaluation		
Theory	Method of Assessment	Marks
a)	Test paper I	6
b)	Test paper II	6
c)	Viva-Voce	6
d)	Assignment	6
e)	Seminar	6
	Total – 30 marks	

KU6DSEZOO318: INDUSTRIAL FISHERIES(Elective)

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VI	DSE	300	KU6DSEZOO318	4	60
Learning Approach (Hours/Week)		Marks distribution			Duration of ESE(Hours)
Lecture/Tutorial	Practical	CE	ESE	Total	
4	-	30	70	100	2

Course Description:

The course covers fishing gear technology, fish processing, fisheries management, sustainable practices, aquaculture, and fish farming. The course includes hands-on activities like gear demonstrations and fish processing labs and features visits to aquaculture facilities and market analysis projects.

Course Pre requisite:

Course outcomes:

	Expected Outcome	**Learning Domains**
CO1	Demonstrate proficiency in identifying and using various fishing gears and technologies for industrial fishing operations	U
CO2	Apply fish processing and preservation techniques effectively, ensuring quality control and food safety standards	A
CO3	Evaluate fisheries management strategies and propose sustainable practices to conserve fish stocks	E
CO4	Design and implement fish farming systems, considering species selection, management practices, and economic viability	E
CO5	Analyze market dynamics, pricing strategies, and economic factors influencing the fisheries industry	E

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

Mapping of Course Outcomes to PSOs

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	0	0	0	0	3
CO2	2	2	2	2	3
CO3	3	2	2	0	3
CO4	2	2	2	0	3
CO5	0	0	2	0	0

COURSE CONTENTS

Module 1: Introduction to Industrial Fisheries	**(12 hours)**
Unit I: Overview of Industrial Fisheries 1.1 Historical Development 1.1.1 Evolution of Fishing Techniques 1.1.2 Milestones in Fisheries Management 1.2 Industrialization of Fisheries 1.2.1 Technological Advancements 1.2.2 Impact on Fish Populations Unit II: Current Trends 1.3 Modern Fishing Practices 1.3.1 Sustainable Fishing Methods 1.3.2 Innovations in Gear Technology 1.4 Regulatory Frameworks 1.4.1 International Fishing Agreements 1.4.2 National Fisheries Policies Unit III: Importance in Global Food Security 1.5 Contribution to Food Supply 1.5.1 Role in Nutrition 1.5.2 Economic Impact on Communities 1.6 Challenges and Opportunities 1.6.1 Overfishing and Conservation 1.6.2 Future Prospects and Sustainability strategies	
Module 2: Fishing Gear Technology	**(12 hours)**
Unit I: Types of Fishing Gears 2.1Active Fishing Gears 2.1.1 Trawls 2.1.2 Seines 2.2 Passive Fishing Gears 2.2.1 Gillnets	

2.2.2 Longlines

Unit II: Design and Construction of Fishing Gears

2.3 Materials and Components

2.3.1 Nets and Lines

2.3.2 Floats and Sinkers

2.4 Assembly Techniques

2.4.1 Knotting and Splicing

2.4.2 Rigging and Setting Up

Unit III: Usage in Industrial Fishing Operations

2.5 Deployment Techniques

2.5.1 Setting and Hauling

2.5.2 Navigation and Positioning

2.6 Maintenance and Repairs

2.6.1 Inspection and Damage Assessment

2.6.2 Repair Methods and Tool

Module 3: Fish Processing and Preservation Techniques (12 hours)

Unit I: Methods of Fish Processing

3.1Cleaning and Gutting

3.1.1 Removal of Internal Organs

3.1.2 Washing and Cleaning Procedures

3.2 Filleting and Slicing

3.2.1 Fillet Extraction Techniques

3.2.2 Slicing for Packaging and Presentation

Unit II: Preservation Techniques

3.3. Chilling and Refrigeration

3.3.1 Temperature Control Methods

3.3.2 Cold Storage Practices

3.4. Freezing and Thawing

3.4.1 Freezing Technologies

3.4.2 Thawing Procedures and Best Practices

Unit III: Quality Control and Food Safety Standards

3.5 Inspection and Grading
3.5.1 Quality Assessment Parameters

3.5.2 Grading Criteria for Commercialization

3.6 Hazard Analysis and Critical Control Points (HACCP)
3.6.1 HACCP Principles and Implementation

3.6.2 Ensuring Food Safety and Compliance

Module 4: Fisheries Management and Sustainable Practices (12 hours)

Unit I: Principles of Fisheries Management and Sustainable Fishing Practices

4.1Regulatory Frameworks
4.1.1. International Agreements and Regulations
4.1.2. National Fisheries Policies
4.2.Sustainable Fishing Practices
4.2.1. Selective Fishing Methods
4.2.2. Bycatch Reduction Techniques

Unit II: Conservation of Fish Stocks

4.3 Stock Assessment Methods

4.3.1 Population Dynamics Modeling

4.3.2 Biomass Estimation Techniques

4.4 Fisheries Conservation Strategies

Unit III: Environmental Impact Assessment

4.5 Ecological Monitoring

4.5.1 Habitat Surveys and Mapping

4.5.2 Biodiversity Assessment Tools

4.6 Mitigation Measures

4.6.1 Pollution Control Measures

4.6.2 Ecosystem-Based Management Approaches

Teacher Specific Module	**12 hours**
Directions: **20 percent of the content can be modified by the course teacher** *Suggestion:* Introduction to Aquaculture ● Fish Farming Techniques ● Species Selection and Management Practices ● Economic Viability in Fish Farming	

Core Compulsory Readings

1. K P Biswas (2004) Industrial Fisheries
2. Ayyappan S. (2011). Handbook of Fisheries and Aquaculture. New Delhi: ICAR
3. Kumar, H D. (2003). Sustainability and Management of Aquaculture and Fisheries . New Delhi: Daya Publishing House.
4. M. Shahul Hameed, M. R. Boopendranath (2000) Modern Fishing Gear Technology. ISBN:9788170352235, 8170352231. Daya Publishing House
5. Food and Agriculture Organization (2022) Classification and Illustrated Definition of Fishing Gears. 9789251345146, 9251345147. Food & Agriculture Organization of the UN (FAO)
6. Rabinarayan Mishra (2022) Handbook on Fish Processing and Preservation. ISBN:9781000540345, 1000540340. Taylor & Francis.
7. Juan Carlos Castilla, Tim McClanahan (2007) Fisheries Management Progress Toward Sustainability ISBN:9780470996065, 0470996064 . Wiley

Assessment Rubrics:

Evaluation Type		**Marks**
1. End Semester Evaluation		70
2. Continuous Evaluation		30
Continuous Evaluation		
Theory	Method of Assessment	Marks
a)	Test paper I	6
b)	Test paper II	6
c)	Viva-Voce	6
d)	Assignment	6
e)	Seminar	6
	Total – 30 marks	

LEVEL 400 DSC COURSES

KU7DSCZOO401: DEVELOPMENTAL GENETICS

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VII	DSC	400	KU7DSCZOO401	3+1	60

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/Tutorial	Practical	CE	ESE	Total	
3	2	25	75	100	1.5

Course Description: This course is designed to give a clear picture on the principles of developmental biology like, cell fate, cell potency, determination, differentiation, specification, cell lineage etc. It also aims at providing an idea about the various genes involved in the development of invertebrates and vertebrates. It also focusses on embryonic and post embryonic development in invertebrates and vertebrate. Genes involved in regeneration and aging is also discussed.

Course Prerequisite:

Course Outcomes:

	Expected Outcome	**Learning Domains**
CO1	Learn about the developmental stages in organisms	U
CO2	Understand the differential expression of genes in various developmental stages of invertebrates and vertebrates	U
CO3	Evaluate different experiments on organisms' embryonic and post-embryonic development	An
CO4	Learn about the role of genes, hormones and metabolites in the process of aging and developmental defects	U

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

Mapping of Course Outcomes to PSOs

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	1	1	1	1	1
CO2	1	1	3	2	1
CO3	1	2	3	2	1
CO4	0	0	3	3	0

COURSE CONTENTS

Module 1. Basic Concepts in Developmental Biology (12 hrs)

Unit I.

1.1 Specifying identity

1.1.1 The primary germ layers and early organs (brief account only)

1.1.2. Cell differentiation

1.1.3. Levels of commitment: specification & determination

1.1.4. Types of specification: autonomous, conditional & syncytial

1.1.5. Induction & competence: Types of induction.

1.1.6. Imprinting

Unit. II.

1.2 Gametogenesis and fertilization

1.2.1 Gametogenesis in mammals-spermatogenesis and oogenesis

1.2.2 Fertilization and prevention of polyspermy in sea urchin

Unit. III.

1.3 Sex Determination

1.3.1 Mammalian pattern of sex determination- primary sex determination and secondary sex determination

1.3.2 Environmental influence on sex determination.

Module 2. Early Development in Animals (11 hrs)

Unit. I.

2.1. *Drosophila* development:

2. 1.1. Fertilization, cleavage, MBT, gastrulation

2.1.2. Axis formation- Anterior-posterior, dorsal-ventral, extremity

2.1.3. Segmentation genes: gap genes, pair-rule genes & segment polarity genes

2.1.4. Homeotic selector genes

Unit. II

2.2. Amphibian development:

2.2.1. Fertilization, cortical rotation, cleavage, MBT

2.2.2 Gastrulation

2.2.3. Specification of germ layers

2.2.4. Formation and function of amphibian organizer.

Unit III

2.3. Chick development:

2.3.1. Cleavage

2.3.2. Gastrulation, Primitive streak

2.3.3. Anterior-posterior and left-right axis formation

Module 3. Organogenesis & Post-embryonic Development (11 hrs)

Unit I

3.1. Organogenesis:

3.1.1. Differentiation of neurons.

3.1.2. Vulval induction in *Caenorhabditis elegans*

3.1.3. Tetrapod limb development

3.1.4. Vertebrate eye development

Unit II

3.2. Metamorphosis and Regeneration:

3.2.1. Metamorphosis:

3.2.1.1 Insect metamorphosis

3.2.1.2 Amphibian metamorphosis

3.2.2. Regeneration:

3.2.2.1 Regeneration in Hydra

3.2.2.2 Vertebrate limb regeneration

Unit III

3. 3. Aging and senescence:

3.3.1. Genes encoding -DNA repair enzymes, reactive oxygen species, telomerase, insulin signaling cascade, mTORC1 pathway, and chromatin modification.

3.3.2. Exceptions to the aging rule.

Module 4. Development in wider contexts: (11hrs)

Unit I.

4.1 Experimental Embryology

4.1.1 Work of Hans Spemann & Hilde Mangold: transplantation experiments

4.1.2 Gradient experiments in sea urchin

4.1.2 Mutants & transgenics in the analysis of development

4.1.3 Transgenic DNA chimeras

Unit II.

4.2 Development and environment

4.2.1 Environmental influence on normal development.

4.2.2 Developmental symbiosis:

4.2.2.1 Mechanisms of developmental symbiosis

4.2.2.1.1Vertical transmission

4.2.2.1.2 Horizontal transmission

4.2.2.2 Developmental symbiosis in mammalian intestine

Unit III

4.3. Stem cells

4.3.1. Stem cell concept

4.3.2. Potency
4.3.3. Stem cell niches
4.3.4. Medical applications of stem cells.

Module 4. Development in wider contexts: **(11hrs)**

Unit I.

4.1 Experimental Embryology

4.1.1 Work of Hans Spemann & Hilde Mangold: transplantation experiments
4.1.2 Gradient experiments in sea urchin
4.1.2 Mutants & transgenics in the analysis of development
4.1.3 Transgenic DNA chimeras

Unit II.

4.2 Development and environment

4.2.1 Environmental influence on normal development.
4.2.2 Developmental symbiosis:
4.2.2.1 Mechanisms of developmental symbiosis
4.2.2.1.1Vertical transmission
4.2.2.1.2 Horizontal transmission
4.2.2.2 Developmental symbiosis in mammalian intestine

Unit III

4.3. Stem cells

4.3.1. Stem cell concept
4.3.2. Potency
4.3.3. Stem cell niches
4.3.4. Medical applications of stem cells.

Module 5. Practicals **(30 hours)**

1. Maintenance of *Drosophila melanogaster* culture, life cycle study, and sex determination.
2. Studies on chick embryos by vital staining using the window method.
3. Preparation of stained permanent mount of any stage of chick embryo (18hrs/24hrs/ 48hrs).
4. Preparation of whole and stained mounts of larval forms.
5. Identification of *Meloidogyne* species from root-knot using females and preparation of stained mount of males and juveniles.
6. Studies on the life cycle of mosquitoes. Identification of important mosquito species by using eggs, larvae, pupae, and adults.
7. Studies on the developmental stages of any soil mite in plastic vials based with a suitable medium.

8. Observation and mounting of developmental stages of any plant mite species [egg, larva, protonymph, deutonymph, adults (male and female)].
9. Identification and preparation of temporary mount of planktons (Any 3).
10. Preparation of permanent slides of mammalian tissue sections such as liver, kidney, lung, intestine, etc – Any two (Optional).

Teacher Specific Module	**9 Hours**
Directions: **20 percent of the experiments can be modified by the course teacher**	

Reference:

1. Gilbert S F (2016) Developmental biology. 11th edition. Sinauer Associates, Inc.
2. Balinsky. B I (1981) An introduction to Embryology. Holt Saunders.
3. Berril M J and Karp G. (1978) Development. Tata Mc Graw hill.
4. Davidson H. (1986) Gene activity in early development, Academic Press.
5. Klaus Kalthoff (2001). Analysis of Biological Development. 2nd edition McGraw Hill.
6. Slack J (2001) Essential Developmental Biology. Blackwell Publ.UK.
7. Snustard, DP, Simmons, M J and Jenkins JP (1997) Principles of genetics. John Y B and Sons.
8. Wolpert, L. (2002). Principles of development. Oxford University Press.

Assessment Rubrics:

Evaluation Type		Marks	
		Theory	**Practical**
1. End Semester Evaluation		50	15
2. Continuous Evaluation		25	10
Continuous Evaluation			
Theory/Practical	Method of Assessment	Marks	
Theory			
a)	Test paper I	5	
b)	Test paper II	5	
c)	Viva-Voce/Seminar/ Discussion	10	
d)	Assignment	5	
		Total – 25 marks	
Practical			
a)	Regularity/Punctuality	5	
b)	Laboratory skill	5	
		Total – 10 marks	

KU7DSCZOO402: ANIMAL SYSTEMATICS AND EVOLUTION

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VII	DSC	400	KU7DSCZOO402	3+1	60

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/Tutorial	Practical	CE	ESE	Total	
3	2	25	75	100	1.5

Course Description:

This course is designed to give a clearer picture on the basic concepts of systematics including its newer trends and taxonomy. It describes the different levels of taxonomy and species concepts. It also gives emphasis on various taxonomic procedures and zoological nomenclature. This paper also focusses on evolution, the importance of fossil record in evolution and principles like Hardy Weinberg equilibrium, genetic drift etc. Moreover it explains the role of mutation in evolution, origin of new genes and human evolution.

Course Prerequisite:

Course Outcomes:

	Expected Outcome	**Learning Domains**
CO1	Learn about the basic concepts of systematics and taxonomy and the levels of taxonomy	U
CO2	Get an idea about the different taxonomic procedures and Zoological nomenclature	A
CO3	Understand biological evolution and different evidences related to it	An
CO4	Understand the origin of variation and genetic basis of evolution	U

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

Mapping of Course Outcomes to PSOs

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	3	0	1	3
CO2	2	3	3	0	2
CO3	2	3	3	1	2
CO4	1	3	3	1	1

COURSE CONTENTS

Module I: Systematics (11 hours)

Unit I:

1.1 Basic concepts of systematics and taxonomy

1.2 Levels of Taxonomy- alpha, beta and gamma Taxonomy

1.3 Classification-History, principles and rules, functions and kinds-phenetic, cladistic, evolutionary and hierarchial

Unit II:

1.4 Brief account of different systems of classification: Linnaean system, five kingdom system and Cavelier-Smith systems.

Unit III:

1.5 Species concept- Typological, nominalistic, biological and evolutionary concepts. Intraspecific categories-Variety, race, cline, sub species.

Module II: Taxonomic characters, procedure and Zoological nomenclature (11 hours)

Unit I.

2.1 Taxonomic characters -Morphological, Anatomical, Embryological, Biochemical, and Molecular.

2.2 Taxonomic Procedure- Types of collection, preservation, recording, storage, labelling and cataloguing of collections.

Unit II.

2.3.Zoological Nomenclature-ICZN, law of priority, synonyms and homonyms.

Unit III:

2.4 Newer trends in systematics- Chemo and Sero Taxonomy, Cytotaxonomy, Numerical

2.5 Taxonomy, Cladistics, Molecular Systematics and DNA bar coding.

Module III Mechanisms of evolution (14 hours)

Unit I

3.1. Population genetics

- 3.1.1. Populations, gene pool, gene frequency.
- 3.1.2. Hardy-Weinberg principle and evolution
- 3.1.3. Inbreeding depression.
- 3.1.4. Variability within populations – Polymorphism Balanced and transitional

3.2. Speciation

- 3.2.1. Allopatric speciation
- 3.2.2. Peripatric speciation
- 3.3.3. Parapatric speciation
- 3.3.4. Sympatric speciation

3.3. Isolating patterns and mechanisms

Unit II

3.4. Genetic drift

3.4.1. Genetic drift and evolution

3.5. Founder effect

3.6. Bottleneck phenomenon

3.7. Gene flow
3.8. Natural selection
3.9. Models of selection
3.9.1. Directional selection
3.9.2. Stabilizing selection
3.9.3. Disruptive selection

Unit III

3.10. Patterns of evolution
3.11. Phyletic gradualism and punctuated equlibrium
3.12. Anagenesis and cladogenesis
3.13. Mono, poly and paraphyletic evolution
3.14. Divergent evolution
3.15. Convergent evolution
3.16. Co evolution
3.17. Microevolution, Macroevolution and Megaevolution

Module IV **(9 hours)**
Evolutionary Time Scale and Molecular Evolution
Unit I

4.1.Evolutionary time scale
4.1.1. Eras, Periods and Epochs
4.1.2. Major events in the evolutionary time scale
4.1.3. Origin of unicellular and multicellular organisms
4.1.4. Evolution of major groups of plants and animals

Unit II

4.2.Evolution of gene families
4.3.Origin of new genes and proteins, Gene duplication
4.4.Molecular divergence and molecular clocks
4.5.Neutral theory of molecular evolution

Unit III

4.6.Molecular tools in phylogeny: protein, amino acid and nucleotide sequence analysis, Immunological techniques, DNA – DNA hybridizations, Repetitive DNA sequences, Restriction enzyme sites
4.7.Phylogenetic tree

Module V: Practicals (30 hours)

1. Construction of a phylogenetic tree.
2. Museum specimen study- Living fossils and their evolutionary significance-Eg: *Limulus*,
3. Museum specimen study- connecting links- *Peripatus*, *Balanoglossus*
4. Problems using Hardy Weinberg equilibrium.
5. Collection, preservation, identification and labelling of 10 zoological invertebrate specimens.
6. Identification of specimens using taxonomic keys.
7. Fossil studies

Teacher Specific Module	**9 Hours**
Directions: **20 percent of the experiments can be modified by the course teacher**	

Reference Distribution:

1. Kapoor, V. C. (2008). Theory and Practice of Animal Taxonomy. Oxford & IBH, Publ., Co., New Delhi.
2. Mayr, E. & Ashlock, P. D. (1991). Principles of Systematic Zoology. McGraw-Hill Inc., NY.
3. Mayr, E. (1972). Principles of Systematic Zoology. MC Graw Hill Inc., NY.
4. Mayr, E.; Linsley, E. G.& Usinger, R. L. (1953). Methods and principles of Systematic Zoology. Mc Graw Hill Book Company, Inc., New York
5. Narendran, T. C. (2006). An introduction to Taxonomy, Zoological Survey of India, Kolkata.
6. Simpson, G. G. (2012). Principles of Animal Taxonomy, Scientific Publishers India.
7. Verma, A. (2020). Principles of Animal Taxonomy, Narosa Publishing House
8. Williams, D. M. (2020). Cladistics: A Guide to Biological Classification. Cambridge University Press.
9. Winston, J. E. (1999). Describing species: practical taxonomic procedure for biologists. Columbia University Press.

Assessment Rubrics:

Evaluation Type		**Marks**	
		Theory	**Practical**
1. End Semester Evaluation		50	15
2. Continuous Evaluation		25	10
Continuous Evaluation			
Theory/Practical	Method of Assessment	Marks	
Theory			
a)	Test paper I	5	
b)	Test paper II	5	
c)	Viva-Voce/Seminar/ Discussion	10	
d)	Assignment	5	
		Total – 25 marks	
Practical			
a)	Regularity/Punctuality	5	
b)	Laboratory skill	5	
		Total – 10 marks	

KU7DSCZOO403: ADVANCED CELL AND MOLECULAR BIOLOGY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VII	DSC	400	KU7DSCZOO403	3+1	60

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/Tutorial	Practical	CE	ESE	Total	
3	2	25	75	100	1.5

Course Description:
This advanced course delves into the intricacies of cellular and molecular biology, providing a comprehensive understanding of key principles. Topics include advanced concepts in cell structure and function, molecular mechanisms of gene regulation, signal transduction pathways, and the dynamics of cellular processes. Emphasis is placed on cutting-edge research and techniques, equipping students with the knowledge and skills needed for advanced studies and research in the field.

Course Prerequisite:

Course Outcomes:

	Expected Outcome	Learning Domains
CO1	Understand the ultrastructure of cell and the various mechanisms involved in their interaction and maintenance	U
CO2	Analyze information on cellular structure and genetics to determine normalcy or cancerous nature	An
CO3	Analyze the chromosomal spreads and identify the cell division stages	E
CO4	Understand and evaluate different gene regulation mechanisms	An

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

Mapping of Course Outcomes to PSOs

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	1	0	1	1	1
CO2	1	1	3	3	1
CO3	2	1	3	1	2
CO4	1	0	3	3	1

COURSE CONTENTS

Module I:

Unit I **(11 hrs)**

1.1 Cell cycle and mechanism involved its regulation

- 1.1.1. Phases of cell cycle
- 1.1.2. Regulation of cell cycle
- 1.1.3. Role of protein kinases in regulation of Cell Cycle
- 1.1.4. Cell cycle checkpoints, Cdk inhibitors and cellular responses
- 1.1.5. M Phase (mitosis and meiosis)
- 1.1.6. Genetic recombination during meiosis

Unit II

1.2. Cellular ageing and mechanisms. Factors affecting ageing

1.3 Programmed Cell Death

- 1.3.1. Extrinsic pathway, Intrinsic pathway, Necroptosis and signalling cell survival

Unit III

1.4 Cancer

- 1.4.1. Basic properties of cancer cells
- 1.4.2. Causes of cancer
- 1.4.3. Genetics of cancer
- 1.4.4. Tumor suppressor genes (RB Gene, TP53 and other TSGs) and oncogenes
- 1.4.5. Mutant genes involved in DNA Repair
- 1.4.6. MicroRNAs and Cancer
- 1.4.7. Cancer Genome
- 1.4.8. Strategies for Combating Cancer
- 1.4.9. Immunotherapy
- 1.4.10. Inhibition of cancer-promoting proteins and Inhibition of angiogenesis
- 1.4.11. Mitochondrial role in cancer development
- 1.4.12. Cancer stem cells

1.5 Stem cells, different types of stem cells and its significance.

Module II:

Unit I **(11 hrs)**

2.1 Cell Signalling pathways

- 2.1.1. Basic elements of cell signalling
- 2.1.2. Extracellular messengers and their receptors
- 2.1.3. G Protein-coupled receptors and transduction
- 2.1.4. Second messengers
- 2.1.5. Regulation of Blood Glucose
- 2.1.6. Role of GPCRs in sensory perception
- 2.1.7. Protein-Tyrosine Phosphorylation
- 2.1.8. Ras-MAP Kinase pathways
- 2.1.9. Signalling by Insulin Receptor

2.1.10. Signalling pathways in Plants
2.1.11. Role of Calcium as an intracellular messengers
2.1.12. Convergence, Divergence and Cross Talk among different pathways
2.1.13. Role of NO as an intercellular messenger.

Unit II

2.2 The Cytoskeleton
2.2.1. Major functions of cytoskeleton
2.2.2. Microtubules structure and functions
2.2.3. Motor Proteins: Kinesins and Dyneins
2.2.4. Microtubule-Organizing Centers (MTOCs)
2.2.5. Microtubule Dynamics
2.2.6. Cilia and Flagella: Structure and Function
2.2.7. Intermediate Filaments
2.2.8. Microfilaments
2.2.9. Myosin
2.2.10. Muscle Contractility
2.2.11. Non muscle Motility
2.2.12. Cellular Motility
2.2.13. Actin-Dependent Processes during Development
2.2.14. Bacterial Cytoskeleton

Unit III

2.3 Cellular Organelles and Membrane Trafficking
2.3.1. Overview of Endomembrane system
2.3.2. Endoplasmic Reticulum
2.3.4. Membrane biosynthesis in ER, Glycosylation in in RER,
2.3.5. Destruction of misfolded Proteins
2.3.6. ER to Golgi vesicular transport
2.3.7. Golgi Complex
2.3.8. Vesicle transport and their functions
2.3.9. Sorting proteins at the Trans Golgi Network
2.3.10. Targeting vesicles to a particular compartment
2.3.11. Lysosomes
2.3.12. Endocytic pathways
2.3.13. Phagocytosis

2.4 Extracellular matrix and Cell interactions
2.4.1. Overview of ECM, the extracellular space, components of ECM
2.4.2. Dynamic properties of ECM
2.4.3. Interaction of cells with ECM
2.4.4. Anchoring cells to their substratum
2.4.5. Interaction with other cells
2.4.6. Adherens Junctions and Desmosomes
2.4.7. Role of cell-adhesion receptors in signalling
2.4.8. Tight Junctions
2.4.9. Gap junctions and plasmodesmata

Module III:

Unit I **(11 hrs)**

3.1 DNA supercoiling
3.2 Structure of the Genome, Organelle genome and significance
3.3 Stability of the genome
3.4 Jumping genes
3.5 Chromosomes and chromatin
Centromeres, telomeres, nucleosome histones, condesins and cohesins - regulation of chromatin structure. Chromosomes and their specific position in nucleus. Mention Histone code, Repetitive DNA, Cot curves and c-value paradox
3.6 Heterochromatin and Euchromatin
3.7 Mitotic Chromosomes

Unit II

3.8 Control of gene expression in bacteria: Operon (Lac, Trp and Arabinose operons) and Riboswitches
3.9 Control of Gene Expression in Eukaryotes
3.9.1. Nuclear pore-complexes and nucleo-cytoplasmic trafficking
3.9.2. RNA transport
3.9.3. Nucleus as an organized organelle
3.9.4. Epigenetics
3.9.5. Transcriptional control
3.9.6. Role of Transcription factors in regulation
3.9.7. Role of Enhancers, Promoters and Coactivators
3.9.8. Mention example of glucocorticoid receptor – transcriptional activation
3.9.9. Transcriptional repression
3.9.10. RNA processing control
3.9.11. Translational control
3.9.12. Role of MicroRNAs
3.9.13. Posttranslational control
3.10 Small regulatory RNAs and RNA silencing
3.11 Small RNAs: miRNA and piRNAs
3.12 CRISPR and other Noncoding RNAs

Unit III

3.13 Replication
3.13.1. Trombone model of replication
3.13.2. Theta model of replication
3.13.3. rolling circle replication
3.13.4. d-loop model of replication
3.13.5. Replication in eukaryotes
3.13.6. Telomerase and telomere replication
3.13.7. Structure of DNA polymerase: Domains and their roles

Module IV: **(12 hrs)**

Unit I

4.1 Structure of RNA polymerase:

4.1.1. Different channels and their roles,
4.1.2. Role of sigma factor in melting,
4.1.3. Abortive transcription,
4.1.4. Scrunching
4.2 Structure of ribosomes
4.3 Structure and function of amino-acyl tRNA synthatase
4.4 mechanism of translation and various factors involved in translation of eukaryotes and prokaryotes.
4.5 Recombination – types and mechanisms-models. Role of somatic recombination and Immune system

Unit II

4.6 Mutation
4.6.1. Types of Mutation
4.6.2. Molecular basis of mutation

Unit III

4.7 DNA repair and types in *E coli* and Eukaryotes
4.8 Concept of gene family
4.9 Mechanisms to study gene expression
4.9.1. DNA microarrays
4.9.2. RNA sequencing

Module V: Practicals (30 hours)

1. Prepare a crude extract of DNA from a given sample and report its presence
2. To study the Mitosis and cell cycle using onion root tip. Observe major phases of mitosis
3. Meiosis – grass hopper testis-observe major phases and report
4. Calculate the chiasmata frequency during first meiotic phase
5. Study the cell cycle arrest using colchicine and identify the blocked metaphase
6. Observe the giant chromosomes in *Drosophila* larvae
7. Calculate the Cell number using counting and viability method
8. Prepare present and slide cell containing Mitochondria of eukaryotes
9. Prepare Blood smear and observe different blood cells.
10. Prepare smear of Buccal Epithelium

Teacher Specific Module	9 Hours
Directions: **20 percent of the experiments can be modified by the course teacher**	

Compulsory readings

1. Karp, G., Iwasa, J., & Marshall, W. (2020). *Karp's Cell and Molecular Biology*. John Wiley & Sons. (For Modules 1 & 2)
2. Watson, J. D. (2014). Molecular Biology of the Gene. Pearson. 7th Edition. (For Modules 3 & 4)

References

1. Cooper GM. The Cell: A Molecular Approach. 2nd edition. Sunderland (MA): Sinauer Associates; 2000.
2. Alberts B, Johnson A, Lewis J, et al. Molecular Biology of the Cell. 4th edition. New York: Garland Science; 2002.
3. Brown TA. Genomes. 2nd edition. Oxford: Wiley-Liss; 2002.
4. Lodish, H., Berk, A., Matsudaira, P., Kaiser, C.A., Krieger, M., Scott, M.P., et al. (2005) Molecular cell biology. 5th Edition, W.H. Freeman and Co., New York.

Assessment Rubrics:

Evaluation Type		**Marks**	
		Theory	**Practical**
1. End Semester Evaluation		50	15
2. Continuous Evaluation		25	10
Continuous Evaluation			
Theory/Practical	Method of Assessment	Marks	
Theory			
a)	Test paper I	5	
b)	Test paper II	5	
c)	Viva-Voce/Seminar/ Discussion	10	
d)	Assignment	5	
		Total – 25 marks	
Practical			
a)	Regularity/Punctuality	5	
b)	Laboratory skill	5	
		Total – 10 marks	

KU7DSCZOO404: ADVANCED PHYSIOLOGY AND ENDOCRINOLOGY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VII	DSC	400	KU7DSCZOO404	3+1	60

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/Tutorial	Practical	CE	ESE	Total	
3	2	25	75	100	1.5

Course Description:

This course is designed to give a clearer picture on the various organ systems in body and the physiological functions they perform. It also intends to provide a detailed information on the various endocrine organs of the body, the hormones they secrete and the actions of these hormones. It also aims at giving an idea about how the hormones control and coordinate the physiological activities in a body. Moreover, it gives importance to practical experiments too.

Course Pre requisite:

Course Outcomes:

	Expected Outcome	Learning Domains
CO1	Learn about various body organ systems in detail	U
CO2	Learn about various physiological mechanisms occurring in the body in detail.	An
CO3	Understand more about the endocrine system, endocrine organs and the hormones secreted	U
CO4	Get an idea about the hormonal control in various physiological mechanisms.	An

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

Mapping of Course Outcomes to PSOs

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	1	0	0	1	1
CO2	2	1	2	3	2
CO3	2	1	0	1	2
CO4	1	1	2	3	1

COURSE CONTENTS

Module I

Nutrition, Digestion, Respiration **(11 hour)**

Unit I: Nutrition

1.1 Carbohydrates and dietary fibre
1.2 Proteins and Fats
1.3 Recommended dietary allowances
1.4 Diet during pregnancy and lactation, Diet during infancy and childhood

Unit II: Gastrointestinal System

1.5 Gastric secretion, Regulation of gastric secretion, Biliary and pancreatic secretions

Unit III: Respiration

1.6. Mechanics of respiration, Composition of respired air: pulmonary ventilation,
1.7 Exchange of gases in the lungs

1.8 Ventilation – perfusion ratio, Hypoxia, cyanosis and dyspnoea

1.9 Special features of pulmonary circulation, Artificial respiration Artificial respiration, Therapeutic use of oxygen

1.10 Respiratory adjustments - Hypoventilation, hypoxia, oxygen therapy, dyspnea, hyperventilation, hypercapnia

Module II

Fluid circulation, Thermoregulation and Osmoregulation **(11 hour)**

Unit I

2.1. Properties of cardiac muscle, Action potential and spread of impulse in the heart, E-C coupling in the myocardium

2.2 Pressure changes in the heart, Cardiac output: measurement and regulation, Nutrition and metabolism of heart, Exercise physiology

Unit II

2.3 Special features of cerebral circulation, Special features of circulation in skeletal muscles and skin

Unit III

2.4 Regulation of body temperature: Role of Hypothalamus and Neuronal-Effector mechanisms, Role of kidney in osmoregulation

Module III

Muscle physiology, neuronal and sensory physiology **(11 hour)**

Unit I

3.1 Functional anatomy of neuromuscular junction; Neuromuscular transmission, Drug modified transmission and synaptic junction

3.2 Muscle proteins, Excitation – contraction coupling 3.3Contraction kinetics of skeletal muscles, Injury and repair of nerves and muscles, Energetics of nerve and muscle 3.4 Sensory physiology- Somatic sensation – Pain receptors; pain suppression (analgesia) system in the brain and spinal cord; headache
Module IV Structure of hormones and its synthesis, Hormones and body functions **(12 hours)** **Unit I** 4.1. Structure of hormones and its synthesis, Steroid hormones, Peptide hormones, Amino acid derivatives **Unit II** 4.2 Neuro-endocrine regulation of digestion in Vertebrates. 4.3Endocrine control on Renal excretion in Mammals. **Unit III** 4.4 Hormonal control on Reproduction and Development in Animals 4.5Hormonal control on Reproduction in Invertebrates; Insects and Crustacea 4.6Hormonal control on Reproduction in Mammals

Module V: Practicals **(30 hours)**

1. Enumeration of human RBC.
2. Total and differential count of WBC
3. Determination of vertebrate haemoglobin using colorimetry
4. Determination of osmotic concentration of human RBC.
5. Determination of effect of temperature on salivary amylase activity.
6. Determination of effect of pH on salivary amylase activity
7. Determination of salinity variations on volume/weight ratio. Nervous conduction in arthropods.
8. Determination of blood pressure in humans using sphygmomanometer.

Teacher Specific Module	**9 Hours**
Directions: **20 percent of the experiments can be modified by the course teacher**	

Reference Distribution:

1. Barrett, K. E.; Barman, S. M.; Brooks, H. L.& Yuan, J. X. J. (2019). Ganong’s Review of Medical Physiology 26th Ed. Mc Graw Hill Education.
2. 2. Hall, J. E. & Hall, M. E. (2020). Guyton and Hall Text book of Medical Physiology, 14th Ed. Elsevier.
3. 3. Hoar, W. S. (1983). General and Comparative Physiology. 3rd Ed. Prentice Hall.
4. 4. Kay, I. (1998). Introduction to Animal Physiology; Garland Science

Assessment Rubrics:

Evaluation Type		**Marks**	
		Theory	**Practical**
1. End Semester Evaluation		50	15
2. Continuous Evaluation		25	10
Continuous Evaluation			
Theory/Practical	Method of Assessment	Marks	
Theory			
a)	Test paper I	5	
b)	Test paper II	5	
c)	Viva-Voce/Seminar/ Discussion	10	
d)	Assignment	5	
	Total – 25 marks		
Practical			
a)	Regularity/Punctuality	5	
b)	Laboratory skill	5	
	Total – 10 marks		

KU7DSCZOO405: METHODOLOGY FOR ZOOLOGICAL RESEARCH

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VII	DSC	400	KU7DSCZOO405	3+1	60

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/Tutorial	Practical	CE	ESE	Total	
3	2	25	75	100	1.5

Course Description:
This course gives some basic knowledge about research methodology. Students get an idea on the techniques and procedures used to identify and analyze information regarding a specific research topic.

Course Pre requisite:

Course Outcomes:

	Expected Outcome	**Learning Domains**
CO1	Understand the scientific research methodology and design of experiments	U
CO2	Enable students to develop hypothesis, test them and arrive at a conclusion	An
CO3	Ability to properly collect and manage data	A
CO4	Apply different statistical methodologies	A

**Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)*

Mapping of Course Outcomes to PSOs

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	0	1	1	0	0
CO2	0	2	3	0	0
CO3	0	2	3	0	0
CO4	0	2	3	0	0

COURSE CONTENTS

Module I: The Nature of Research (11 hours)

Unit 1:

1.1.Research:

- 1.1.1. Definition of research;
- 1.1.2. Significance and Objectives of research;
- 1.1.3. Selection of a research problem;
- 1.1.4. Components of research problem;
- 1.1.5. Steps in scientific research: identifying problem, review of literature, hypothesis, experiment, analysis of data, discussion, publication.

Unit II:

1.2. Types of Research:

- 1.2.1. Analytical and Descriptive,
- 1.2.2. Quantitative and Qualitative, Basic and Applied,
- 1.2.3. Conceptual and Empirical; Survey and Experimental

1.3. Research Methods vs Methodology - Motivation

Unit III: Research Design:

1.4. Process Formulation of research problem;

1.5. Inductive reasoning;

1.6. Preparing the research design; Need for research design;

1.7. Features of good design, Important concepts related to good design;

1.8. Observation and Facts;

1.9. Prediction and Explanation;

1.10. Development of Models -Sample design – deliberate, random, systematic, stratified, quota, cluster, area, multistage, sequential

Module II: Generation of a hypothesis and design an experiment (11 hours)

Unit I:

2.1. Hypothesis:

- 2.1.1. Definition
- 2.1.2. Types of hypothesis
- 2.1.3. Falsifiability of a Hypothesis
- 2.1.4. testing of Hypothesis

Unit II:

2.2. Sampling (Data collection)

2.2.1. Sample size

2.2.2. Sampling errors and brief account of sampling methods

2.2.3. Primary and Secondary Data, observation, interview, questionnaires

2.2.4. Schedules; categorization and summarization of data

Unit III:

2.3. Principles of experimentation – replication, randomization and local control.

2.4. Dependent and independent variables, Pilot study. Recording of Data.

Module 3: Data interpretation, writing a report, and publication (11 hours)

Unit 1:

3.1. Data Processing and Analysis Strategies:

3.1.1. Classification, Preparation of Tables, Figures, and photographs

3.1.2. Frequency Distribution; Representation of Data: Diagrammatic Representation: Histogram, Pie Diagram, Ogive Curve, and Polygon

3.1.3. Measurement of Central Tendency; Measurement of Variation: Standard Deviation, Standard Error of Mean, Coefficient of Variation

3.1.4. Test of Significance: Chi Square Test and Student 't' test

3.1.5. Measurement of Dispersion, Correlation and Regression.

3.1.6. Data analysis packages – SPSS, R, online softwares etc (brief mentioning only).

Unit II:

3.2. Research report writing: Effective writing principles (the quality of the content, clarity of expression, consistency of style and format, and active voice).

3.3 Biological databases. Sources of information - journal, reviews, monographs, bibliography.

3.4 Usage of search engine tools for retrieving research/review articles -Google Scholar, Pub med, Inflibnet, Medline, ScieHub, Digital library.

Unit III:

3.5. Preparation and Publication Scientific Report:

3.5.1. Technical Reports and Thesis writing;

3.5.2. Title and abstract writing, presentation, abbreviations, nomenclature used, and reference writing;

3.5.3. Bibliography/References: Preparation of bibliography in different formats as per journal requirements, software tools for checking plagiarism;

3.5.4. Publishing of Articles: Selection of Journals, Concepts related to journals- ISSN Number, Peer reviewed Journals, Science Citation Index, Impact factor (IF), H Index, I10 index; Open access

3.5.5. Publication charges; Web of Science, Scopus and Care list; National and International Journals

Module IV: (12 hours)

4.1. Methods in Zoology

Unit 1:

4.1.1. Taxonomic procedures: Collection - Purpose, value, scope of collection, content of collection, legal aspects of collecting animals, post collection processes,

4.1.2. Preservation: Methods, taxidermy, factors responsible for the deterioration of museum specimens; museum collection policy, preparation of material for study, housing and cataloging

4.1.3. Identification - Systematic process of sorting and labelling, procedure of identification; identification services.

4.1.4. Taxonomic keys: Types of taxonomic keys (computer aided interactive key) their merits and demerits;

4.1.5. Zoological nomenclature, formalities on declaration of new species.

Unit II:

4.2. Methodologies in systematics:

4.2.1. Morphology based taxonomy, Numerical taxonomy, Cyto-taxonomy and chemotaxonomy,

4.2.2. Molecular systematic, DNA fingerprinting & Molecular markers for detection/evaluation of polymorphism, RFLP, RAPD etc.

Unit III:

4.3. Tools and Techniques used for Purification and characterization of biomolecules:

4.3.1. Centrifugation, chromatography and electrophoresis.

4.3.2.NMR, MALDI-TOF, X-ray crystallography, Circular Dichroism CD Microscopic techniques including Fluorescence microscopy, Confocal analysis.

4.3.3. Real time PCR, DNA microarray, New generation DNA sequencing, microscopy,

Atomic force microscopy and live cell imaging FACS Protein Microarray. 4.3.4. Histochemical and Cytochemical techniques, Spectroscopy, ELISA, Animal Tissue Culture.
Module V: Practicals **(30 hours)** 1. Preparation of taxonomic key-simple dichotomous key, bracketed key, intended key, multi access key, computer aided interactive key. 2. Collection and preparation of Zoological specimens: wet and dry preservation (10 micro slides, 5 wet preserved specimens and 1 display box). 3. Sketching and labelling of biological specimens (5 Nos., sketching using camera lucida). 4. Make citations/references using Zotero software 5. NCBI Data submission (Demo)

Teacher Specific Module	**9 Hours**
Directions: **20 percent of the experiments can be modified by the course teacher**	

Reference:

Kothari, C. R. and G. Garg (2019), Research Methodology: Methods and Techniques, Fourth Multi Colour Edition, New Age International Publishers.

Suggested Readings:

Kent W. Staley (2014), An Introduction to the Philosophy of Science; Cambridge University Press.

Assessment Rubrics:

Evaluation Type		**Marks**	
		Theory	**Practical**
1. End Semester Evaluation		50	15
2. Continuous Evaluation		25	10
Continuous Evaluation			
Theory/Practical	Method of Assessment	Marks	
Theory			
a)	Test paper I	5	
b)	Test paper II	5	
c)	Viva-Voce/Seminar/ Discussion	10	
d)	Assignment	5	
	Total – 25 marks		
Practical			
a)	Regularity/Punctuality	5	
b)	Laboratory skill	5	
	Total – 10 marks		

KU8DSCZOO406: CELLULAR METABOLISM

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VIII	DSC	400	KU8DSCZOO406	4	60

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/Tutorial	Practical	CE	ESE	Total	
4	-	30	70	100	2

Course Description:
This course offers a comprehensive exploration of cellular metabolism, covering key topics such as the role of ATP and coenzymes, major metabolic pathways including carbohydrate, lipid, amino acid, and nucleotide metabolism, as well as the Kreb’s cycle, electron transport chain, photosynthesis, and the role of coenzymes and vitamins in metabolism.

Course Prerequisite:

Course Outcomes:

	Expected Outcome	**Learning Domains**
CO1	Comprehend fundamentals of organismal metabolism	U
CO2	Analyse different metabolic pathways to understand their interconnectedness	An
CO3	Understand energy changes and enzyme characteristics and their fundamental importance to animal biology	E
CO4	Understand the role of various coenzymes and nutrients in maintenance of cellular metabolism (An)	An

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

Mapping of Course Outcomes to PSOs

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	0	0	0	3	0
CO2	1	1	1	3	1
CO3	1	0	1	3	1
CO4	1	1	0	3	1

COURSE CONTENTS

Module I: Energy changes in metabolism, role of enzymes, coenzymes and vitamins in metabolism (12 hours)

Unit I:

1.1. Free energy changes in metabolism, ATP as energy carrier.
1.2. Role of oxidation and reduction in metabolism, standard reduction potential
1.3. Mechanism of enzyme action
  1.3.1. Michaelis- Menten equation
  1.3.2. Line-weaver Burk plot and its uses
  1.3.3. Significance of Km and Vmax values
  1.3.4. Regulation of enzyme action.

Unit II:

1.4. Role of Coenzymes in biologically important oxidation-reduction reactions
1.5. Coenzyme A in activation of metabolic pathways
1.6. NAD, NADP, FAD, FMN with structural details.

Unit III:

1.6 Role of Vitamin C, biotin, tetrahydrofolate, lipid vitamins, cobalamine, lipoamide, ubiquinone, cytochromes with structural details

Module II: Metabolism (12 hours)

Unit I:

2.1. Introduction to metabolism
2.2. Major pathways in cells
2.3. Metabolism of Carbohydrates : Glycolysis, gluconeogenesis, glycogenesis, glycogenolysis, pentose phosphate pathway, regulation of carbohydrate metabolism,

Unit II: Kreb's cycle

2.4. Fate of pyruvic acid
2.5. The citric acid cycle and its regulation
2.6. Energetics of citric acid cycle

Unit III:

2.7. Relation of Kreb's cycle with gluconeogenesis, transamination and deamination
2.8. Routes of entry of metabolites into citric acid cycle
2.9. Glyoxylate cycle

Module III **(12 hours)**

Unit I:

3.1. Metabolism of Lipids:

3.1.1. Lipid transport and storage,

3.1.2. Catabolism of lipids- oxidation of saturated and unsaturated fatty acids energy yield from oxidation of fatty acids

3.1.3. fatty acid synthesis,

3.1.4. cholesterol biosynthesis,

3.1.5. synthesis of phospholipids.

Unit II:

3.2. Metabolism of amino acids (Glutamic acid, Phenylalanine, Methionine. Isoleucine and Histidine): transamination, decarboxylation and deamination

3.3. Inborn errors in metabolism;

3.4. Nitrogen excretion and urea cycle

Unit III:

3.5. Metabolism of nucleotides: Purine biosynthesis and catabolism, Pyrimidine biosynthesis and catabolism, salvage pathways

Module IV: Mitochondrial oxidation and photosynthesis **(12 hours)**

Unit I:

Mitochondrial oxidation

4.1. Oxidative phosphorylation, Chemiosmotic theory, ATP synthesis Inhibitors of electron transport chain

Unit II:

4.2. Light reactions: photosystem II and water oxidation, photosystem I and NADPH synthesis, photophosphorylation.

4.3.Light independent reactions: calvin cycle, photorespiration.

Unit III:

4.4.Alternatives to C3 metabolism.

4.5.Regulation of photosynthesis.

Teacher Specific Module	**12 Hours**
Directions: **20 percent of the content can be modified by the course teacher**	

Reference:

1. Berg, J.M., Tymoczko, J.L.and Stryer,L.(2002) Biochemistry, W.H.Freeman and Co. New York.
2. Biology of the Cell(5thed.)-Garland Science
3. Campbell, Farrel,2007, Biochemistry (5^{th} ed) Thomson, Brooks and Cole Publ.
4. Das,D.(2000)Biochemistry, Academic Publishers, Calcutta
5. David D. Plummer, 2008. An Introduction to Practical Biochemistry(3rded)Tata McGraw Hill.
6. Lehninger A.L., NelsonD.L.andCoxM.M.(2000) Principles of Biochemistry, II Ed. Worth Publishers, NY
7. Stryer,L. (1995)Biochemistry, IVEd. Freeman & Co., NY.
8. Sathyanarayana, U and Chakrapani, U2008, Biochemistry(3rded.). Uppala Author Pub

Assessment Rubrics:

Evaluation Type		**Marks**
1. End Semester Evaluation		70
2. Continuous Evaluation		30
Continuous Evaluation		
Theory	Method of Assessment	Marks
a)	Test paper I	6
b)	Test paper II	6
c)	Viva-Voce	6
d)	Assignment	6
e)	Seminar	6
	Total – 30 marks	

KU8DSEZOO407: COMPUTATIONAL BIOLOGY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VIII	DSE	400	KU8DSEZOO407	3+1	60

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/Tutorial	Practical	CE	ESE	Total	
3	2	25	75	100	1.5

Course Description:

This course is designed to offer a thorough exploration of fundamental principles, methodologies, and tools in computational biology necessary for the analysis of molecular-level biological data. Through a blend of theoretical learning and hands-on practice, students will cultivate expertise in various aspects of computational biology, including sequence analysis, genome annotation, transcriptomics, and proteomics. By acquiring these skills, students will be equipped to employ computational approaches to tackle intricate biological inquiries effectively

Course Prerequisite:

Course Outcomes:

	Expected Outcome	**Learning Domains**
CO1	Understand the fundamental concepts of computational biology, including DNA composition, reading frames, sequence similarity, and basic file formats	U
CO2	Apply computational techniques for understanding various type of genomic and proteomic data	A
CO3	Evaluate the different tools for a specific genomic data analysis project and choose the best one for the application	E
CO4	Synthesize knowledge about recent trends in omic data generation, handling and analysis	U
CO5	Design and execute comprehensive bioinformatics projects integrating computational techniques	A

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO4	PSO 5
CO1	0	0	1	1	0
CO2	0	0	3	1	1
CO3	0	0	3	0	1
CO4	0	0	3	1	1
CO5	0	0	3	0	1

COURSE CONTENTS

Module I: Basics of Computational Biology **(12 hours)**

Unit 1: Introduction to Molecular Biology Concepts

1.1 Composition of DNA - Understanding Chargaff's Rule

1.2 Reading Frames - Analysis of +1, +2, +3 and -1, -2, -3 frames; Identification of Open Reading Frames (ORFs)

1.3 Codon Usage Bias - Analysis of codon usage patterns

1.4 Tandem and Inverted Repeats - Identification and characterization of repeat sequences

1.5 Sequence Similarity - Understanding concepts of homologous, orthologous, and paralogous sequences

Unit II: Data Formats and Sequence Databases

1.6. Basic File Formats - Introduction to FASTA, GenBank, Nexus, and other relevant formats

1.7 Sequence Databases - Detailed study of GenBank in NCBI; Retrieval and utilization of sequence data

Unit III: Additional Tools and Techniques

1.8. Basic Gene Statistics - Analysis of base counts and word frequencies

1.9 Vector Contamination Analysis - Identification and removal of vector sequences

1.10 Gene Finding - Predicting gene locations in DNA sequences

1.11 Splice Site Recognition - Detection of splice sites in DNA sequences

1.12 Transcription Factor Binding Site Identification - Prediction of transcription factor binding sites

1.13 SNPs, Microsatellites, Minisatellites - Identification and analysis of genetic variations

1.14 Sequence Profiles and Logos - Creation and interpretation of sequence profiles and logos

1.15 Sequence Chromatogram Visualization and Analysis - Tools for visualizing and analyzing sequence chromatograms

Module II: Sequence Alignment and Database Searches (12 hours)

Unit IV: Pairwise Sequence Alignment

2.1 Introduction to Pairwise Sequence Alignment

2.2 Scoring Schemes and Gap Penalties - Understanding linear and affine gap penalties

2.3 Effect of Scoring Schemes on Alignment Quality

2.4 Scoring Matrices - PAM, BLOSUM, and other scoring matrices for amino acid sequences

2.5 Dot-Plot Visualization - Visual representation of sequence alignments

2.6 Smith-Waterman Algorithm - Local sequence alignment algorithm

2.7 Needleman-Wunsch Algorithm - Global sequence alignment algorithm

2.8 Statistics of Sequence Alignment Scores - E-values, bit scores, sensitivity, and specificity

2.9 BLAST and Other Pairwise Database Search Tools

Unit V: Multiple Sequence Alignment (MSA)

2.10 Need for Multiple Sequence Alignment

2.11 Heuristic Algorithms for MSA

2.12 Progressive and Iterative Alignment Methods

2.13 Tools for MSA - Muscle, T-Coffee, PRANK, and ClustalW

Module III: Genome Analysis and Transcriptomics (11 hours)

Unit I: Genome Browsers and Resources

3.1. Introduction to Genome Browsers: Ensembl, UCSC, NCBI Genome Data Viewer
3.2. Other Online Genome Resources: B10k, Zfin, MolluscaBase, InsectBase, FlyBase, JGI Genome Portal
Synteny and Synteny Browsers - Studying syntenic genes and their applications
Next Generation Sequencing Projects - Types of sequence reads, assembly, annotation, and genome assemblers

Transcriptomics

3.3. Transcriptomics - Concept of Transcriptome, RNA databases, RNA structure prediction, and analysis tools

Module IV: Proteomics and Protein Structure Prediction (10 hours)

Unit I: Proteome Analysis

4.1. Protein Separation and Analysis Techniques: 2D Gel Electrophoresis, Liquid Chromatography, Mass Spectrometry
4.2. Protein Structure Determination: X-ray Crystallography, NMR Spectroscopy
4.3. Protein Databases: UniProtKB/Swiss-Prot, Interpro, PIR, PDB, SCOP & CATH, ProDom, PFAM

Structure visualization and prediction

4.4. Protein Visualization Tools: Swiss PDB Viewer, Pymol
4.5.Proteomic Tools: AA CompIdent, MultiDent, Peptide Mass, and others
4.6. Protein Structure Prediction Methods: Chou Fasman method, Homology Modeling, Ab Initio prediction, Molecular Dynamics

Module V: Practicals (30 hours)

1. Visualise a PDB file in PyMol
2. Prepare a Homology 3D model of a protein using a PDB template file
3. Survey the ab-initio 3D model prediction software/servers and prepare a report
4. Prepare a syntenic map, for a gene family of interest, for zebrafish, medaka, fugu, humans, rat and mouse (or other suitable 5 vertebrate species).
5. Using a public server (eg: Augustus) and a local programme, predict a gene from a given genomic sequence or transcriptome sequence
6. Edit chromatogram files and prepare a fasta sequence file.

7. Prepare a Multiple Sequence Alignment using - CLUSTAL/MUSCLE, PRANK, T-Coffee and compare the alignment scores. 8. Using NCBI server prepare a pairwise alignment 9. Using ENSEMBL genome browser, find out the orthologes and paralogues for a gene (1 to 1) and report the ENSEMBL IDs and phylogenetic tree 10. Using EMBOSS programme find out the open reading frames of the given sequence.

Teacher Specific Module	**6 Hours**
Directions : **20 percent of the experiments can be modified by the course teacher**	

Reference:

Kellis, M. (2016). *Computational Biology: Genomes, Networks, Evolution*.(https://bio.libretexts.org/Bookshelves/Computational_Biology/Book%3A_Computational_Biology_-_Genomes_Networks_and_Evolution_(Kellis_et_al.)

Assessment Rubrics:

Evaluation Type		**Marks**	
		Theory	**Practical**
1. End Semester Evaluation		50	15
2. Continuous Evaluation		25	10
Continuous Evaluation			
Theory/Practical	Method of Assessment	Marks	
Theory			
a)	Test paper I	5	
b)	Test paper II	5	
c)	Viva-Voce/Seminar/ Discussion	10	
d)	Assignment	5	
		Total – 25 marks	
Practical			
a)	Regularity/Punctuality	5	
b)	Laboratory skill	5	
		Total – 10 marks	

KU8DSCZOO408: IMMUNOLOGY AND MICROBIOLOGY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VIII	DSC	400	KU8DSCZOO408	4	60

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/Tutorial	Practical	CE	ESE	Total	
4	-	30	70	100	2

Course Description:

This course is intended to provide a solid grounding in immunology, starting with the basic concepts and understanding of the mechanisms of immune functioning and regulation. Knowledge in the management of Immune system disorders. This course is aimed at imparting basic knowledge about classification, structure , growth, reproduction and distribution of Bacteria, virus and fungi. This course also imparts knowledge and skills in various practical techniques in cultivation, identification and maintenance of bacteria for their study and application.

Course Prerequisite:

Course Outcomes:

	Expected Outcome	**Learning Domains**
CO1	Learn about the cells, tissues and molecules involved in human immune system	U
CO2	Explore virulence factors and antigen-antibody interactions	U
CO3	Learn about molecular and cellular mechanisms underlying immune responses to pathogens	U
CO4	Evaluate immune response in relation to vaccination, hypersensitivity and tissue-graft	An
CO5	Apply knowledge on different culture and identification methods to understand the diversity of microorganisms	A

**Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)*

Mapping of Course Outcomes to PSOs

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	0	0	0	2	0
CO2	1	0	0	3	1
CO3	0	0	0	3	3
CO4	0	0	1	3	3
CO5	1	2	1	2	2

COURSE CONTENTS

Module I: **(12 Hrs)**

Unit I:

1.1. Overview of the immune system: Types of immunity, Components of the immune system: Primary and secondary Iymphoid organs, Antigen, epitopes-properties of B and T- cell epitopes, haptens and Immunogenicity, processing and presentation of antigens, APCs

1.2. B lymphocyte development and survival, humoral immune response; T lymphocyte development and survival, cell mediated regulation of immune response, Generation of receptor diversity (BCR and TCR), subsets of T- and B- cells, recognition of antigen by B- and T- lymphocytes

Unit II:

1.2. Immunoglobulin fine structure, immunoglobulin domains, variable region domains, CDRs and antigen binding, constant region domains, Different classes of immunoglobulins (Ig A IgD, lgD, IgM and lgE), antigenic determinants on immunoglobulins- isotypic, allotypic and idiotypic determinants, monoclonal antibodies, Organization and expression of Immunoglobulin genes, Rearrangement of V, D and J gene segments, V (D) J recombinase.

Unit III:

Antigen –Antibody interactions.
1.4. Major Histocompatibility Complex: General organization: MHC class I and MHC class II, peptide interaction by class I and class II MHC, Antigen processing and presentation

Module II: **(12 Hrs)**

Unit I:

2.1. Complement system: Components of complement system, activation of complement system-Classical pathway and Lectin pathway, formation of MAC, biological effects of complement activation

2.2 Cytokines: general structure and functions, cytokine receptors, cytokine related diseases.

Unit II:

2.3 Autoimmunity- responses to self antigens, transplant rejection- responses to alloantigens, autoimmune diseases. Hypersensitivity reactions-type-I, II, III, and IV hypersensitivity.

Unit III

2.2 Immunodeficiency syndrome- SCID, ADA deficiency, Tumor immunology – malignant transformation of cells, oncogenes and cancer induction, tumors of immune system-tumor antigens, immune response to tumor, cancer immunotherapy.

2.3 Vaccines-active and passive immunization, whole organism vaccines, purified macromolecular vaccine, recombinant vector vaccines, DNA vaccines, synthetic peptide vaccine, anti-idiotype vaccines, multivalent subunit vaccines.

Microbiology

Module III: **(12 Hrs)**

Unit I:

3.1 Microbial taxonomy

Classification of bacteria–Detailed description of bacterial classification according to the Bergey's Manual of Systematic Bacteriology, Classification of viruses-classification based host, morphology and nucleic acid characteristics

Unit II:

3.2. Structural organization of bacteria: Ultra structure of bacterial cell wall, difference between Gram positive and Gram-negative bacteria, cell membrane, flagella, pili, capsule and genome; Endospores, Toxins. Structure and architecture of bacteriophages

3.3 Classification of fungi, Morphology and ultrastructure of fungi- Aspergillus sp, Penicilium sp, Fungal growth and reproduction.

Unit III:

3.4 Bacterial culturing**:** Physical and chemical methods of sterilization, growth media, physical conditions of growth, growth curve

3.5 Types of fermentations: aerobic and anaerobic; submerged and Solid State; Importance of media in fermentation, media formulation and modification

Module IV: **(12 Hrs)**

Unit I:

4.1 mechanism of genetic exchange in bacteria transformation, conjugation, and transduction, Ti plasmid transfer system and its application in creating transgenics.

Unit II:

4.2 Transposable elements in bacteria

4.3 Suicide vectors and mating out assays. Transposon mutagenesis **Unit III:** 4.4 Major pollution problems – Oxygen depletion, biodeterioration, eutrophication. Environmental monitoring- Biosensors and Biochips

Teacher Specific Module	**12 Hours**
Directions: **20 percent of the content can be modified by the course teacher**	

References:

1. Pathak S., Palan U Immunology Essential and Fundamental 3rd ed. (2011) Capital Publishing Company
2. Delves, P.J., Martin S.J., Burton, D.R., and Roitt, I.M., Roitt's Essential Immunology 13th ed. (2017) Wiley Blackwell
3. J., Stranford, S., Jones, P., and Owen, J.A., Kuby Immunology 8th ed. (2019) Punt Macmillan Education
4. Bergey DH, NR Krieg and J.G.Holt, Bergey's Manual of Systematic Bacteriology, Vol.1-4 (1984-1989) (Ed), Williams and Wilkins, Baltimore.
5. Elizabeth Moore- Landecker, Fundamentals of the fungi 1996;4 th Edition, Benjamin Cummings; Prentice Hall PTR.
6. Ananthanarayan & Panicker's Text book of Microbiology , 9th edition,2013, Universities press
7. Michael J Pelczar, Jr., E.C.S.Chan, Noel R. Krieg, 5th edition,1998,Microbiology-Tata McGraw Hill
8. Prescott's Microbiology (2011) Joanne Willey, Linda Sherwood, Christopher J Woolverton-McGraw Hill Education
9. Nester er al, Microbiology: A human perspective. McGraw Hill
10. Toratora Gerad, Berdell R Funke and Christine L Case (2011), Microbiology: An Introduction (9th Ed.) .Pearson education

Suggested Readings:

1. Pathak S.,Palan U Immunology Essential and Fundamental 3rd ed.(2011) Capital Publishing Company
2. Delves, P.J., Martin S.J., Burton, D.R., and Roitt, I.M., Roitt's Essential Immunology 13th ed. (2017) Wiley Blackwell
3. J., Stranford, S., Jones, P., and Owen, J.A., Kuby Immunology 8th ed. (2019) Punt Macmillan Education.

Assessment Rubrics:

Evaluation Type		**Marks**
1. End Semester Evaluation		70
2. Continuous Evaluation		30
Continuous Evaluation		
Theory	Method of Assessment	Marks
a)	Test paper I	6
b)	Test paper II	6
c)	Viva-Voce	6
d)	Assignment	6
e)	Seminar	6
	Total – 30 marks	

KU8DSCZOO409: ENVIRONMENTAL IMPACT ASSESSMENT AND TOXICOLOGY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VIII	DSC	400	KU8DSCZOO409	4	60

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/Tutorial	Practical	CE	ESE	Total	
4	-	30	70	100	2

Course Description:
This course has two major themes. The first theme which is discussed in two modules, examines the process of assessing the potential impacts of major developmental projects (actions) on the environment- known worldwide as Environmental Impact Assessment (EIA). This is seen globally as major tool to help deliver sustainable development. The second theme deals with the Toxicology, refers to the details of distribution of pollutants in the environment, their entry, movement, storage and transformation and assess the impact of chemicals not only on individuals but also on populations and whole ecosystems and focus on the methods to detect and estimate the concentration of toxic chemicals and other contaminating substances that are polluting the environment with an adverse effect on it.

Course Pre requisite:

Course Outcomes:

	Expected Outcome	**Learning Domains**
CO1	Discuss the critical theories of environmental impact assessment for application in varied situations	U
CO2	Identify the importance of Social Impact Assessments and public participation in the EIA process	U
CO3	Learn about various environmental pollutants and toxicants and methods to assess them	A
CO4	Assess environmental status and asses the risk to human health and devise methods to mitigate them	E

**Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)*

Mapping of Course Outcomes to PSOs

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	1	0	0	0	3
CO2	1	0	0	0	3
CO3	1	0	2	1	3
CO4	1	0	2	1	3

COURSE CONTENTS

Environmental Impact Assessment (EIA)

Module I: Introduction **(12 hours)**

Unit I:

1.1 Environmental Impact Assessment And Environmental Impact Statement.
1.2 Principles and procedures: Nature and purpose of environmental impact assessment (EIA).
1.3 EIA- As an Integral Part of The Planning Process, sustainable development.

Unit II:

1.4 Current issues in EIA.
1.5 Worldwide spread of EIA.
1.6 EIA regulations in India.

Module II : Process and Methods of EIA **(12 hours)**

Unit I:

2.1 Impact Identification, Establishing the Environmental base line.
2.2 Impact prediction on Air, Water, Noise and Land; evaluation and mitigation.
2.3 Criteria and standards for assessing significant Impact.

Unit II:

2.4 Cost- Benefit Analysis and valuation of Environmental Impacts.
2.5 EIA monitoring and auditing.
2.6 International organization for standardization (ISO), ISO 14000 standards and certification, Environmental Management System (EMS), Eco labelling.

Toxicology

Module III : Toxicants in the Environment **(12 hours)**

Unit I:

3.1 – Toxicants and toxicity, sources and entry routes, Global dispersion and circulating mechanisms of pollutants
3.2 Biotransformation, Bioaccumulation & Biomagnification.
3.3 Detoxification mechanisms – ADME – adsorption, distribution, metabolism and excretion; Acute and chronic toxicity; Concept of Dosimetry, Lethal and sub-lethal and chronic doses; LD50, LC50, MATC, LOEC, and NOEC.

Unit II:

3.4 Response to toxin exposures – dose-response relationship, frequency and cumulative response; organs of detoxification
3.5 Toxicity testing procedures; Bioassays – in vitro and in vivo; Biosensors – enzyme based, DNA based, immunosensors; whole-cell based biosensors and bio-markers; Bioindicators - metabolites, protein induction, HSP, cytochrome P450 enzymes, C reactive proteins and metallothioneins.

Module IV: Environmental Health: Global and Regional Perspectives **(12 hours)** **Unit I:** 4.1 Basic requirements for healthy environment; environmental quality; Solid & Hazardous wastes, untreated sewage, Automobile exhausts, Industrial Effluents and emissions; Agricultural run-off of Pesticides; Environmental Carcinogens and Mutagens. 4.2 Toxicant Effects: - Cellular, organismic, population & Ecosystem-Level Effects; Global Effects – Acid rain etc. 4.3 Human exposure and health impact; Environmental diseases: Asbestosis, silicosis, synopsis, asthma, fluorosis and allergies, epidemiological issues – Malaria, Kala azar, water borne diseases. **Unit II:** 4.4 Ecological and Human Health Risk Assessment- Risk assessment for industrial chemicals in EU, OECD and USA, Risk management of industrial chemicals. 4.5 Industrial hygiene- Concepts of Industrial hygiene, TLV, MAK, OES, ACGIH, OSHA 4.6 Biological monitoring of industrial solvents, metals (arsenic, cadmium, lead, mercury) and pesticides.

Teacher Specific Module	**12 hours**
Directions: **20 percent of the content can be modified by the course teacher**	

Suggested Readings:

1. Charles H.Eccleston (2011),"Environmental Impact Assessment – A Guide to best professional practice", CRC Press, Taylors and Francis Group, New York.
2. Cockerham L.G and Shane B.S, 2019. Basic Environmental Toxicology, CRC press, Bocaraton, USA.
3. Colin, W. 2014. Ecotoxicology: Effects of Pollutants on the Natural Environment, 1 st (ed), CRC Press Sparling,D.W. 2017. Basics of Ecotoxicology, 1 stEdn CRC Press.
4. George Alex (2020),"Environmental Impact Assessment (EIA) Simplified", Blue Rose Publishers, New Delhi.
5. Glasson, J. and Therivel, R. 2013. Introduction To Environmental Impact Assessment. Routledge. Kamleshwar Pandey, Shukla, J.P, Trivedi (ed) 2019, Fundamentals of toxicology, New central book agency (p) Ltd.
6. Morris. P. & Therivel. R., 2001, Methods of environmental impact assessment, 2nd Ed. Spon Press, New York, With a chapter on GIS and EIA by A.R. Bachiller & G. Wood, p. 381-401.
7. Newman, M.C. 2015. Fundamentals of Ecotoxicology: The Science of Pollution, 4thEdn. CRC Press.

8. Walker, C.H., Sibly, R.M., Hopkin, S.P., Peakall, D.B. 2017. Principles of Ecotoxicology. 4thEdn. Taylor & Francis, London.

References:

1. Blaikie, P., Cannon, T., Davis, I. and Wisner, B. 2003. At Risk: Natural Hazards, People's Vulnerability and Disasters (2nd Ed.). Abington: Routledge.
2. Brown, K. 2015. Resilience, Development and Global Change. London: Routledge
3. Calow.P. 1994. Handbook of Ecotoxicology. Blackwell Scientific Publications, London
4. Forbes,V.E. and T.L.Forbes. 1994. Ecotoxicology in Theory and Practice. Chapman & Hall, London.
5. Grumbine, R.E. and Pandit, M.K., 2013. Threats from India's Himalaya dams. Science, 339:36-37.
6. Hauser-Davis, R.A. and Parente, T.E. eds., 2018. Ecotoxicology: Perspectives on Key Issues. CRC Press.
7. Hayes, W.A. 2014. Principles and Methods of Toxicology, CRC, USA.
8. John Pallister (2012),"Environmental Management", Oxford University Press, London
9. Levin,S.A. and M.A.Harwell, J.R.Kelley and K.D.Kemball. 1989. Ecotoxicology: Problems and Approaches.
10. Pandit, M.K. and Grumbine, R.E., 2012. Potential effects of ongoing and proposed hydropower development on terrestrial biological diversity in the Indian Himalaya. Conservation Biology, 26: 1061-1071.
11. Petts Judith, 1999, Handbook of environmental impact assessment. Vol. 1, Blackwell Science.
12. Wright,D.A. and Welbourn,P. 2002. Environmental Toxicology, Cambridge University Press, London.

Assessment Rubrics:

Evaluation Type		**Marks**
1. End Semester Evaluation		70
2. Continuous Evaluation		30
Continuous Evaluation		
Theory	Method of Assessment	Marks
a)	Test paper I	6
b)	Test paper II	6
c)	Viva-Voce	6
d)	Assignment	6
e)	Seminar	6
		Total – 30 marks

KU8DSEZOO410: HUMAN GENETICS(Elective)

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VIII	DSE	400	KU7DSEZOO410	4	60

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/Tutorial	Practical	CE	ESE	Total	
4	-	30	70	100	2

Course Description:

Human Genetics is an introductory course designed to explore the fundamental principles underlying the inheritance and variation of traits in humans. Through lectures, discussions, and laboratory exercises, students will delve into the molecular mechanisms governing human heredity, genetic diseases, population genetics, and the ethical implications of genetic research and technologies.

Course Prerequisite:

Course Outcomes:

	Expected Outcome	Learning Domains
CO1	Understanding Mendelian principles and solving related genetic problems	A
CO2	Understand the genetic linkage, crossing over and sex- linked inheritance in animals	U
CO3	Capabality for Pedigree analysis and genetic counselling	An
CO4	Possess a deep knowledge on various genetic disorders in man	U

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

Mapping of Course Outcomes to PSOs

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	0	0	3	1	0
CO2	0	0	3	2	0
CO3	0	0	3	0	2
CO4	0	0	1	2	1

COURSE CONTENTS

Module I: **(12 hrs)**

Unit I:

Mendelian Principles

1.1Monohybrid and Dihybrid Experiments

1.2Interactions of Genes

1.3Incomplete dominance and Co-dominance

1.4complementary genes, supplementary genes and duplicate genes

1.5Multiple alleles with examples: coat colour in rabbit.

1.6 Human blood group inheritance: ABO, Rh factor.

Module II: **(12 hrs)**

Unit I:

Linkage and Crossing over

2.1Chromosomal theory of Linkage and Types of Linkage

2.1 Crossing over and types, Mechanism of Crossing over.

2.2 Cytological detection of Crossing over, significance of Crossing over.

2.3 Sex determination in Man and Drosophila melanogaster

Module III: **(12 hrs)**

Unit I:

Human Cytogenetics

3.1 Modern concept of gene, split gene, Fine structure of gene (cistron, muton and recon).

3.2 Human karyotype, Banding techniques

Unit II:

3.3 Gene mutation, mutagenesis

3.4 Physical and chemical mutagens

3.5 chromosomal aberration.

Module IV: **(12 hrs)**

Unit I:

Genetics disorders and Population Genetics

4.1 Sex linkage in Man

4.2 Genetic disorders in Man (Autosomal and sex linked and Multifactorial)

4.3 Biochemical Genetics: phenylketonuria, albinism, alkaptonuria.

Unit II:
4.4 Polymorphism - phenotypic & genotypic polymorphisms, transient polymorphism, balanced polymorphisms 4.5 Uses & effects of inbreeding in farm animals, genetic consequences of inbreeding, reasons for inbreeding.

Teacher Specific Module	**12 Hours**
Directions: **20 percent of the content can be modified by the course teacher**	

References:

1. Genetic: Analysis and Principles" by Robert J. Brooker
2. Principles of Genetics" by D. Peter Snustad and Michael J. Simmons
3. Human Genetics: Concepts and Applications" by Ricki Lewis
4. Introduction to Genetic Analysis" by Anthony J.F. Griffiths, Susan R. Wessler, Sean B. Carroll, and John Doebley
5. Cowell (2001). Molecular Genetics of Cancer. Bios
6. Ehrlich (2000). DNA Alterations in Cancer. Eaton
7. Gersen & Keagle (1999). Principles of Clinical Cytogenetics
8. Martin H. Johnson & Barry Everitt. Essential reproduction.
9. Pasternak (2005). An Introduction to Molecular Human Genetics. Fritzgerald. 2nd Edition
10. Ramon Pinon. Biology of Human Reproduction.
11. Rimon et al (2002) Principles and Practice of Medical Genetics, Vol I-III.
12. Strachan and Read (2011). Human Molecular Genetics 4th Ed. Wiley
13. Human Cytogenetics (vol. I & II) – J.L. Hamerton
14. Human chromosomes : E.H. FORD
15. Human Genetics – F. Vogel and A.G. Motulsky.
16. genetics and Medicine – M.W Thoson, R.R. Meinees and H.F Willard
17. Basic human genetics – E.J. Mange and A.P. Mange.
18. Medical Genetics – Jorde et al.

Assessment Rubrics:

<table>
<tr><th colspan="2">Evaluation Type</th><th>Marks</th></tr>
<tr><td colspan="2">1. End Semester Evaluation</td><td>70</td></tr>
<tr><td colspan="2">2. Continuous Evaluation</td><td>30</td></tr>
<tr><td colspan="3">Continuous Evaluation</td></tr>
<tr><td>Theory</td><td>Method of Assessment</td><td>Marks</td></tr>
<tr><td>a)</td><td>Test paper I</td><td>6</td></tr>
<tr><td>b)</td><td>Test paper II</td><td>6</td></tr>
<tr><td>c)</td><td>Viva-Voce</td><td>6</td></tr>
<tr><td>d)</td><td>Assignment</td><td>6</td></tr>
<tr><td>e)</td><td>Seminar</td><td>6</td></tr>
<tr><td></td><td colspan="2">Total – 30 marks</td></tr>
</table>

KU8DSEZOO411: BASICS OF PROGRAMMING FOR BIOINFORMATICS(Elective)

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VIII	DSE	400	KU7DSEZOO411	3+1	60

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/Tutorial	Practical	CE	ESE	Total	
3	2	25	75	100	1.5

Course Description:

In this course, students will gain a comprehensive understanding of fundamental concepts and practical skills in programming for bioinformatics. The curriculum covers Unix/Linux operating system basics, installation and usage of R and Python programming languages, and hands-on exploration of bioinformatics tools such as the APE package in R and Biopython, students will learn to navigate, manipulate, and analyze biological data efficiently. By the end of the course, students will be able to confidently utilize programming techniques to read, write, and analyze DNA sequences, as well as design and execute bioinformatics projects, culminating in the development and presentation of innovative solutions to real-world biological problems.

Course Prerequisite:

Course Outcomes:

	Expected Outcome	**Learning Domains**
CO1	Understand the basic principles of Unix/Linux operating systems and their relevance to bioinformatics tasks	U
CO2	Demonstrate proficiency in navigating and interacting with a Linux system from a terminal, including executing commands and managing files	A
CO3	Install and configure R and Python environments using the terminal, and manage packages effectively for bioinformatics analysis	A
CO4	Apply programming concepts and syntax in R and Python to read, manipulate, and analyze biological data	A
CO5	Design and implement bioinformatics projects	A

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO4	PSO 5
CO1	0	0	0	0	0
CO2	0	0	1	0	0
CO3	0	0	2	1	1
CO4	0	0	3	0	0
CO5	0	0	3	0	1

COURSE CONTENTS

Module I: **(13 hours)**

Unit I: Introduction to Unix/Linux Operating System Basics

1.1 Understanding Unix/Linux operating systems
1.2 Different distributions (distros) of Linux
1.3 Basic commands to navigate and interact with a Linux system from a terminal
1.4 Linux package management (e.g., apt, yum)

Unit II: Installation and Basics of R Programming

1.5 Installing R using the terminal
1.6 Launching R environment from the terminal
1.7 Installing packages in R using install.packages
1.8 Getting familiar with R commands
1.9 Loading and executing R scripts

Module II: **(11 Hours)**

Unit I: Working with DNA Sequences in R using APE Package

2.1 Introduction to APE package in R
2.2 Reading DNA sequences in various formats
2.3 Writing DNA sequences in different sequence formats
2.4 Preparation of parsimony and distance matrix-based phylogenetic trees

Unit II: Installation and Basics of Python Programming

2.5 Installing Python using the terminal
2.6 Launching Python environments from the terminal
2.7 Installing packages in Python using pip
2.8 Running Python scripts from the terminal

Module III: **(11 Hours)**

Unit I: Introduction to Python Programming

3.4 Understanding Python Reserved Word List
3.5 Arithmetic Operators in Python
3.6 Objects and Classes in Python
3.7 Strings manipulation in Python
3.8 Control structures: IF, FOR, WHILE loops
3.9 Lists and Dictionaries in Python
3.10 Functions and their usage in Python

Unit II: Working with Biological Data in Python using Biopython

3.11 Introduction to Biopython library
3.12 GC counting using Biopython
3.13 Counting nucleotides in DNA sequences
3.14 Reading and writing sequences in FASTA format using Biopython
3.15 Translation of DNA sequences

Module IV: **(10 Hours)**

Unit I: Interfacing with other programmes and scripting

4.1 Interfacing with other programmes (external standalone) from python
4.2 Preparing scripts to automate bioinformatics analysis in python
4.3 Downloading data from public databases and preparation of phylogenetic tree - using R and using Python/BioPython

Data visualization using R and Python

4.4 Utility of R packages like ‘ggplot2’ and Python libraries like’ Matplotlib’ and ‘Seaborn’ to create various chart types.
4.5 Introduction to ETE toolkit for phylogenetics
4.6 Details about various bioinformatics pipelines.

Module V: Practicals **(30 hours)**

1. Log-in to a linux system, demonstrate use of cd, list, mkdir, rm, cp, mv and similar commands
2. Install APE from R terminal
3. Using APE read DNA sequence in FASTA format and write in different formats
4. Using biopython read a DNA sequence and convert formats
5. Plot a phylogenetic tree using R
6. Plot a gene expression matrix (as heatmap) in R and Python
7. Read a R script from source and execute a task

8. Read a python script from source and execute a task
9. Using either R or python download few sequences form NCBI database
10. Prepare a phylogenetic tree using APE
11. Prepare an MSA and phylogenetic tree using external programmes from R or Python

Teacher Specific Module	**9 Hours**
Directions : **20 percent of the experiments can be modified by the course teacher**	

References:

- https://open.oregonstate.education/computationalbiology/
- https://cran.r-project.org/web/packages/ape/

Suggested Readings:

1. "Unix and Linux System Administration Handbook" by Evi Nemeth, Garth Snyder, Trent R. Hein, Ben Whaley
2. "R for Data Science" by Hadley Wickham and Garrett Grolemund
3. "Python for Biologists: A complete programming course for beginners" by Dr. Martin Jones
4. "Bioinformatics Programming Using Python" by Mitchell L Model

Assessment Rubrics:

Evaluation Type		**Marks**	
		Theory	**Practical**
1. End Semester Evaluation		50	15
2. Continuous Evaluation		25	10
Continuous Evaluation			
Theory/Practical	Method of Assessment	Marks	
Theory			
a)	Test paper I	5	
b)	Test paper II	5	
c)	Viva-Voce/Seminar/ Discussion	10	
d)	Assignment	5	
		Total – 25 marks	
Practical			
a)	Regularity/Punctuality	5	
b)	Laboratory skill	5	
		Total – 10 marks	

KU8DSEZOO412: NUTRITION AND DIETITICS(Elective)

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VIII	DSE	400	KU8DSEZOO412	3+1	60

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/Tutorial	Practical	CE	ESE	Total	
3	2	25	75	100	1.5

Course Description:

This course provides zoology students with an introduction to the principles of nutrition and dietetics, focusing on the relationship between dietary components and animal health and physiology. Students will explore the nutritional requirements of animals, the role of nutrients in metabolism and growth, and the impact of diet on animal behavior and ecology. Emphasis will also be placed on understanding the nutritional needs of different animal species and the implications for conservation and management.

Course Prerequisite:

Course Outcomes:

	Expected Outcome	**Learning Domains**
CO1	Understand about the essential nutrients for an organism and their roles in maintaining bodily functions (U)	U
CO2	Understand the impact of diet on animal behavior, reproduction and well being in humans and animals (U)	U
CO3	Appreciate the role of nutrients in maintaining health and preventing nutrient deficiencies in animals (Ap)	A

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

Mapping of Course Outcomes to PSOs

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	0	0	0	2	2
CO2	1	0	0	3	3
CO3	0	0	0	3	3

COURSE CONTENTS

Module I: **(12hrs)**

Unit I: Introduction to Nutrition

1.1 Basic concepts of nutrition: macronutrients, micronutrients, and dietary requirements

1.2 Nutritional terminology and units of measurement

1.3 Nutritional guidelines and recommendations for animals

Unit II: Macronutrients and Micronutrients

1.4 Carbohydrates: functions, sources, and metabolism

1.5 Proteins: amino acids, protein quality, and protein metabolism

1.6Lipids: types of fats, lipid digestion, and metabolism

1.7Vitamins: classification, functions, and sources

1.8Minerals: essential minerals, mineral absorption, and metabolism

Module II: **(11hrs)**

Unit I: Nutritional Physiology

2.1Digestion, absorption, and metabolism of nutrients in animals

2.2Energy metabolism and nutrient partitioning

2.3Regulation of appetite and food intake

Module III: **(11hrs)**

Unit I: Nutritional Requirements of Different Animal Groups

3.1Herbivores, carnivores, omnivores: adaptations and dietary strategies

3.2Nutritional needs of aquatic animals, birds, mammals, and invertebrates

3.3Specialized diets for zoo animals, pets, and captive wildlife

Module IV: **(11hrs)**

Unit I: Nutritional Ecology and Behavior

4.1Foraging strategies and dietary preferences in animals

4.2Nutritional adaptations to different habitats and ecological niches

4.3Impact of diet on animal behavior, reproduction, and fitness

Unit II: Clinical Nutrition and Disease

4.4Malnutrition and nutritional deficiencies in animals

4.5Role of nutrition in disease prevention and management

4.6Nutritional support and dietary interventions in veterinary medicine

Module V: Practicals **(30 hours)**

1. Determining the nutrient composition of different foods using methods like titration, spectrophotometry, or chromatography.
2. Investigating how different foods are digested and absorbed in the body through experiments with simulated digestive systems or animal models.
3. Assessing metabolic rates using techniques like indirect calorimetry to understand how diet affects energy expenditure.
4. Conducting sensory evaluations to assess the taste, texture, and overall acceptability of food products, which can inform dietary recommendations and food product development.
5. Designing and conducting controlled experiments to evaluate the effectiveness of dietary interventions in managing conditions like obesity, diabetes, or heart disease.
6. Testing methods for detecting contaminants or assessing the quality of food products to ensure they meet safety and regulatory standards.
7. Compare the nutrient content of various foods before and after cooking using methods like boiling, steaming, baking, or frying.
8. Nutrient Absorption in the Small Intestine: Use techniques like intestinal perfusion to study the absorption kinetics of specific nutrients (e.g., glucose, amino acids) in the small intestine.

Teacher Specific Module	**9 Hours**
Directions: **20 percent of the experiments can be modified by the course teacher**	

References:

1. "Animal Nutrition" by Peter McDonald, James Sillence, and C. John C. Phillips.
2. "Nutrition of the Dog and Cat: Waltham Symposium Number 7" edited by P. J. Rogers and Ian H. McDonald.
3. "Handbook of Vitamins, Minerals, and Hormones" edited by Robert J. Shils, Maurice Edward Shils, and Moshe Shike.
4. "Wildlife Feeding and Nutrition" by Charles T. Robbins and Dale T. H. Elwood.
5. "Clinical Nutrition for the Small Animal Practitioner" by Theresa Fossum.

Assessment Rubrics:

Evaluation Type		**Marks**	
		Theory	**Practical**
1. End Semester Evaluation		50	15
2. Continuous Evaluation		25	10
Continuous Evaluation			
Theory/Practical	Method of Assessment	Marks	
Theory			
a)	Test paper I	5	
b)	Test paper II	5	
c)	Viva-Voce/Seminar/ Discussion	10	
d)	Assignment	5	
		Total – 25 marks	
Practical			
a)	Regularity/Punctuality	5	
b)	Laboratory skill	5	
		Total – 10 marks	

KU8DSEZOO413: ANIMAL BEHAVIOUR(Elective)

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VIII	DSE	400	KU8DSEZOO413	4	60

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/Tutorial	Practical	CE	ESE	Total	
4	-	30	70	100	2

Course Description:
This course mainly aims at giving the students a clear picture of various behavioural patterns in different kinds of animals. It also focusses on the neural mechanisms involved in animal behaviour. Students also get an idea on the role of genetic and environmental factors in animal behaviour. They also get an idea on communication among animals and their social behaviour.

Course Prerequisite:

Course Outcomes:

	Expected Outcome	**Learning Domains**
CO1	Learn about various behavioural patterns in animals and their neural basis	U
CO2	Understand about the role of genetic and environmental factors in behaviour	U
CO3	Understand developmental behaviour	U
CO4	Understand about social behaviour in animals	U

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO4	PSO 5
CO1	1	1	0	1	1
CO2	1	1	0	1	1
CO3	1	1	0	1	1
CO4	1	1	0	1	1

COURSE CONTENTS

Module I: Animal behaviour- Introduction and neural control of behaviour

(12 hour)

Unit I:

1.1 Ethology as a branch of biology- Animal psychology

1.2 Classification of behavioural patterns

1.3 Analysis of behaviour (Ethogram)

1.4 Innate Behaviour

Unit II:

1.5 Neural behaviour

1.5.1 Brain and behaviour

1.5.2 Role of nervous system upon reflexes

Module II: Hormonal control of behaviour; Developmental behaviour

(12 hour)

Unit I:

2.1 Hormonal behaviour

2.2 Basic categories of hormones related to animal behaviour

2.2.1. Activational or releaser hormones

2.2.2 Organizational hormones

2.2.3 Groups of hormones controlling animal behaviour

Unit II:

2.3 Developmental behaviour

2.2.2.1 Primary or direct producers of behaviour

2.2.2.2 Secondary or indirect producers of behaviour

2.2.3 Hormonal impact on various behavioural patterns

Unit III:

2.2 Genetic components and Environmental components in behaviour

2.3 Ecological aspects of behaviour

2.3.1 Habitat selection, Food selection, Optimal forage theory, Anti predation defense, Aggression, Homing, Territoriality, Dispersal

2.3.2 Host parasite relations

Module III: Social behaviour **(12 hour)**

Unit I:

3.1 Basic Social Units

3.2 Cultural transmission

3.2.1 Social learning

3.2.2 Teaching

3.3 Modes of cultural transmission

3.3.1 Vertical cultural transmission

3.3.2 Horizontal cultural transmission

3.3.3 Oblique cultural transmission

Unit II:

3.4 Schooling in fishes, Flocking in birds, Herding in mammals,
3.5 Migration of fishes, turtles and birds
3.6 Social organization in Insects and Primates

Unit III

3.7 Co-operation- Group selection, Kin selection, reciprocity, byproduct mutualism

3.8 Role of altruism and reciprocal altruism in cooperation.
3.9 Mating systems, Courtship, Sperm competition, Sexual selection

Module IV: Biological Communication **(12 hours)**
Unit I:
4.1 Nature and functions of biological communication
4.2 Components of communication system

4.2 Forms of signals

Unit II

4.3.Costs and benefits of signalling

Unit III
4.4 Types of communications-
4.4.1 Chemical communication
4.4.2 Visual communication
4.4.3. Auditory communication
4.4.4 Tactile communication
4.4.5 Electrical communication
4.4.6 Complex communication systems

Teacher Specific Module	12 Hours
Directions: **20 percent of the content can be modified by the course teacher**	

References:

1. Amita Sarkar, 2004. Development of Animal Behaviour, discovery publishing house

2. Bolchuis JJ and Hogan JA. (1999). The development of Animal Behaviour. Blackwell Publishers.

3. Boulenger, E.G2003,An Introduction to animal behaviour, Discovery publishing house, New Delhi.

4. Goodenough, J.; Mc Guire B. and Robert,W.(1993) Perspectives on Animal behaviour.

5. John Wiley and Sons, Lond.5. Johnalcock (2001) animal behaviour–7^{th} edition. Sinauerassn. publ.

6. John Alcock, 2005.Animal Behaviour,(8thedition).Sinauer Associates, Inc. publishers

7. Lee Alan Dugattan (2004) Principles of animal behaviour w.w. Norton & company.

8. Lehner,P. (1996) Handbook of Ethological methods. Cambridge Univ. Press, Lond.

9. Manning, A. and Dawkins, M.S.(1995) An Introduction to Animal Behaviour. Cambridge University Press.

Assessment Rubrics:

Evaluation Type		**Marks**
1. End Semester Evaluation		70
2. Continuous Evaluation		30
Continuous Evaluation		
Theory	Method of Assessment	Marks
a)	Test paper I	6
b)	Test paper II	6
c)	Viva-Voce	6
d)	Assignment	6
e)	Seminar	6
	Total – 30 marks	

KU8DSEZOO414: CHORDATE COMPARATIVE ANATOMY AND PHYLOGENY(Elective)

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VIII	DSE	400	KU8DSEZOO414	4	60

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/Tutorial	Practical	CE	ESE	Total	
4	-	30	70	100	2

Course Description:

This course delves into the fascinating world of chordate anatomy, exploring the shared characteristics, diversity, and evolution of this animal phylum. Through lectures, discussions, and hands-on activities (where applicable), you'll gain a comprehensive understanding of the major organ systems in chordates and how they compare across different groups.

Course Prerequisite:

Course Outcomes:

	Expected Outcome	**Learning Domains**
CO1	Explain the functions of each chordate characteristic and their evolutionary significance	U
CO2	Compare and contrast different hypotheses regarding the origin of chordates (annelid/arthropod vs. echinoderm) based on available evidence	An
CO3	Describe the role of Hox genes in the evolution of diverse vertebrate body plans	An
CO4	Evaluate the importance of different systems and their evolution for the diversification and success of vertebrates	E

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

Mapping of Course Outcomes to PSOs

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	2	0	1	0
CO2	2	3	1	0	0
CO3	2	1	1	1	0
CO4	2	2	1	1	1

COURSE CONTENTS

Module I: **(12 hours)**

Unit I: (Chordate characteristics and body plan)

1.1 Chordate Phylogeny
1.2 Chordate Characteristics
- 1.2.1 Notochord
- 1.2.2 Pharyngeal slits
- 1.2.3 Endostyle or thyroid gland
- 1.2.4 Dorsal and tubular nerve cord
- 1.2.5 Postanal Tail

1.3 Chordate body plan.

Unit II: (Chordate origin and phylogeny)

1.4 Protochordates
- 1.4.1 Hemichordata: Entropneusta, Pterobranchia, Hemichordate phylogenetic affinities to chordates, Hemichordate phylogenetic affinities to echinoderms
- 1.4.2 Cephalochordata
- 1.4.3 Urochordata: Ascidiacea, Larvacea, Thaliacea

1.5 Overview of protochordates
1.6 Hypothesis regarding chordate origins:
- 1.6.1 Chordates from annelids and arthoropods
- 1.6.2 Chordates from Echinoderms, Auricularian hypothesis, larval echinoderm to chordate tadpole

1.7 Chordate origins and phylogenetic affinities.

Module II: **(12 Hours)**

Unit I: (Evolution of vertebrates)

2.1.1 Vertebrate origins
2.1.2 Vertebrate classification: Overview of Agnathan evolution, Gnathostomes, Teleostomi, Tetrapods, Amniotes
2.1.3 Overview of early embryonic development of vertebrates (brief discussion only no type to be studied), Development of Coelom and its compartments
2.1.4 Maturation: metamorphosis, Heterochrony
2.1.5 Hox Genes and their role in vertebrate evolution

Unit II: (Comparative anatomy of integumentary system)

2.2.1 General Features of the integument, dermis, epidermis,
2.2.2 Integument of fishes
2.2.3 Integument of Tetrapods

2.2.4 Specializations of the integument

Module III: (12 Hours)

Unit I: (Comparative anatomy of the skull)

3.1 Skeletal system: Skull
3.1.1 Chondrochranium
3.1.2 Splanchnocranium
3.1.3 Dermatocranium
3.2 Overview of skull morphology
3.3 Phylogeny of the skull

Unit II: (Comparative anatomy of the Respiratory system)

3.4 Respiratory system: respiratory organs in chordates, ventelatory mechanisms,
3.5 phylogeny of respiration and respiratory structures in chordates
3.6 Circulatory system: Blood, artery, vein, capillaries
3.6.1 Single and double circulation
3.7 Phylogeny of cardiovascular system in chordates
3.8 Comparative account of vertebrate heart
3.9 Lymphatic system

Module IV: (12 hours)

Unit I: (Comparative anatomy of the Circulatory systems)

4.1 Digestive system
4.2 Buccal cavity,
4.3 pharynx
4.4 Alimentary canal
4.5 Associated glands of digestion
4.6 Function and evolution of digestive system

Unit II: (Comparative anatomy of the urogenital, endocrine and nervous systems)

4.7 Urogenital system
4.7.1 Urinary system, Structure of mammalian kidney,
4.7.2 phylogeny of kidney in vertebrates,
4.7.3 evolution of vertebrate kidney
4.8 Nervous system: types of cells,
4.8.1 peripheral nervous system
4.8.2 central nervous system
4.9 Sensory organs in chordates: General sensory organs, special sensory organs.

Module V: Teacher Specific Module
Directions
Module V (can be modified by the course teacher; only for internal assessment) (12 Hours) 5.1 Muscular system 5.1.1 Origin of muscles, classification of muscles (skeletal, cardiac, smooth), Muscle functions

5.2 Skeletal system: Axial skeleton
5.2.1 Types of vertebrae
5.2.2 Ribs
5.2.3 Sternum
5.2.4 Gastralia
5.3 Embryonic development of vertebrae in major groups of vertebrates
5.4 Phylogeny of vertebrae in major group of vertebrates
5.5 Appendicular skeleton
5.5.1 Basic components: fins and limbs
5.5.2 Origin of paired fins
5.5.3 phylogeny of appendicular skeleton
5.5.4 Evolution of appendicular skeleton: Dual origin of pectoral girdle, adaptive advantage of lobe fins
5.5.5 Swimming and terrestrial locomotion
5.6 Endocrine organs in chordates, endocrine coordination, endocrine system and environment

Reference:

Kardong, K. V. (1997). Vertebrates: comparative anatomy, function, evolution. Heinle and Heinle Publishers.

Suggested Readings:

1. Verma, P. S. (2010). Chordate zoology. S. Chand Publishing.
2. Sedgwick, A. (1905). A Student's Text-book of Zoology (Vol. 2). Allen & Unwin.

Assessment Rubrics:

Evaluation Type		**Marks**
1. End Semester Evaluation		70
2. Continuous Evaluation		30
Continuous Evaluation		
Theory	Method of Assessment	Marks
a)	Test paper I	6
b)	Test paper II	6
c)	Viva-Voce	6
d)	Assignment	6
e)	Seminar	6
	Total – 30 marks	