

ANNAMALAI UNIVERSITY

(Affiliated Colleges)

208 - B.Sc. ZOOLOGY

Programme Structure and Scheme of Examination (under CBCS)

(Applicable to the candidates admitted from the academic year 2023 -2024 onwards)

Part	Course Code	Study Components & Course Title	Credit	Hours/ Week	Maximum Marks		
					CIA	ESE	Total
		SEMESTER - I					
I	23UTAMC11/ 23UHINL11/ 23UFREL11	Language - I – பொதுதமிழ்- I: தமிழிலக்கிய வரலாறு-1/ Hindi-I/ French-I	3	6	25	75	100
II	23UENGL12	General English – I	3	6	25	75	100
III	23UZOOC13	Core - I: Invertebrata	5	5	25	75	100
	23UZOOP14	Core - II: Practical – I: Invertebrata Practical (Covering 23UZOOC 13)	5	4	25	75	100
	23UBOTE15 23UBOTEP1	Elective - I: Botany - I Botany Practical - 1	2 1	3 2	25 25	75 75	100 100
	23UTAMB16 23UTAMA16	Skill Enhancement Course -1* NME-I/ Basic Tamil – I / Advanced Tamil - I	2	2	25	75	100
	23UZOOF17	Foundation Course: Ornamental Fish Farming and Management	2	2	25	75	100
		Total	23	30			800
		Semester – II					
I	23UTAMC21/ 23UHINL21/ 23UFREL21	Language – II: பொது தமிழ் -II: தமிழிலக்கிய வரலாறு-2/ Hindi-II/ French-II	3	6	25	75	100
II	23UENGL22	General English – II	3	6	25	75	100
III	23UZOOC23	Core - III: Chordata	5	5	25	75	100
	23UZOOP24	Core - IV: Practical – II: Chordata Practical (Covering 23UZOOC 23)	5	4	25	75	100
	23UBOTE25 23UBOTEP2	Elective - II: Botany - II Botany Practical – 1I	2 1	3 2	25 25	75 75	100 100
	23UTAMB26 23UTAMA26	Skill Enhancement Course -II * NME-II/ Basic Tamil – II / Advanced Tamil - II	2	2	25	75	100
IV	23USECG27	Skill Enhancement Course – III: Internet and its Applications (Common Paper)	2	2	25	75	100
	23UNMSD01	Language Proficiency for employability: Overview of English Communication**	2	-	25	75	100
		Total	25	30			900

Part	Course Code	Study Components & Course Title	Credit	Hours/ Week	Maximum Marks		
					CIA	ESE	Total
		SEMESTER - III					
I	23UTAML31/ 23UHINL31/ 23UFREL31	Language - III – பொதுதமிழ்- III: தமிழக வரலாறும், பண்பாடும்/ Hindi-III/ French-III	3	6	25	75	100
II	23UENGL32	General English – III	3	6	25	75	100
III	23UZOOC33	Core - V: Cell and Molecular Biology	5	5	25	75	100
	23UZOOP34	Core - VI: Practical –III: Cell and Molecular Biology	5	3	25	75	100
	23UCHEE35	Elective - III: Chemistry for Biological Sciences - I	2	3	25	75	100
	23UCHEEP3	Chemistry Practical for Biological Sciences – I	1	2	25	75	100
IV	23UZOOS36-1 / 23UZOOS36-2	Skill Enhancement Course -IV: Apiculture/ Basics of Marine Biology	1	1	25	75	100
	23UZOOS37-1/ 23UZOOS37-2	Skill Enhancement Course -V: Animal Behaviour/ Nano Biology	2	2	25	75	100
V		Environmental Studies	-	1	-	-	-
		Total	22	30			800
		Semester – IV					
I	23UTAML41/ 23UHINL41/ 23UFREL41	Language – IV: பொதுதமிழ்- IV: தமிழும் அறிவியலும்/ Hindi-IV/ French-IV	3	6	25	75	100
II	23UENGL42	General English – IV	3	6	25	75	100
III	23UZOOC43	Core - VII: Genetics	5	5	25	75	100
	23UZOOP44	Core - VIII: Practical – IV: Genetics Practical	5	3	25	75	100
	23UCHEE45	Elective - IV: Chemistry for Biological Sciences – I	2	3	25	75	100
	23UCHEEP4	Chemistry Practical for Biological Sciences – II	1	2	25	75	100
IV	23UZOOS46-1/ 23UZOOS46-2	Skill Enhancement Course – VI: Medical Lab Technology/ Aquaculture	2	2	25	75	100
	23UZOOS47-1/ 23UZOOS47-2	Skill Enhancement Course – VII: Food, Nutrition and Health/ Agricultural Entomology	2	2	25	75	100
V	23UEVSG48	Environmental Studies	2	1	25	75	100
		Total	25	30			900

		SEMESTER - V					
III	23UZOOC51	Core Course – IX Developmental Biology	4	5	25	75	100
	23UZOOC52	Core - X: Animal Physiology	4	5	25	75	100
	23UZOOP53	Core –XI : Practical – V: Developmental Biology & Animal Physiology Practical	4	5	25	75	100
	23UZOOD54	Core –XII : Project with Viva-Voce	4	5	25	75	100
	23UZOOE55-1/ 23UZOOE55-2	Elective - V: Biophysics & Bio Statistics/ Wild life Conservation and Management	3	4	25	75	100
	23UZOOE56-1/ 23UZOOE56-2	Elective - VI: Bio composting for Entrepreneurship / Basic Course in Ornithology	3	4	25	75	100
IV	23UVALG57	Value Education	2	2	25	75	100
	23UZOOI58	Summer Internship ⁺⁺	2	-	25	75	100
		Total	26	30			800
		Semester – VI					
III	23UZOOC61	Core - XIII: Environmental Biology	4	6	25	75	100
	23UZOOC62	Core - XIV: Evolution	4	6	25	75	100
	23UZOOP63	Core - XV: Practical VI. Environmental Biology & Evolution	4	6	25	75	100
	23UZOOE64-1/ 23UZOOE64-2	Elective - VII: Bio- Instrumentation / Bio Technology	3	5	25	75	100
	23UZOOE65-1/ 23UZOOE65-2	Elective - VIII: Microbiology / Radiation Biology	3	5	25	75	100
IV	23UZOOF66	Professional Competency Skill Environmental Biotechnology and Herbal Science	2	2	25	75	100
V	23UZOOX67	Extension Activity	1	-	100		100
		Total	21	30			700
		Grand Total	142				4900

Non-Major Elective Courses (NME) to other Departments)

IV	23UZOON16	Economic Zoology	2	2	25	75	100
	23UZOON26	Ornamental Fish Farming & Management	2	2	25	75	100

* PART-IV: NME / Basic Tamil / Advanced Tamil (Any one)

Students who have not studied Tamil upto 12th Standard and have taken any Language other than Tamil in Part-I, must choose Basic Tamil-I in First Semester & Basic Tamil-II in Second Semester.

Students who have studied Tamil upto 10th & 12th Standard and have taken any Language other than Tamil in Part-I, must choose Advanced Tamil-I in First Semester and Advanced Tamil-II in Second Semester.

** The course “23UNMSD01: Overview of English Communication” is to be taught by the experts from Naan Mudhalvan Scheme team. However, the faculty members of Department of English should coordinate with the Naan Mudhalvan Scheme team for smooth conduct of this course.

⁺⁺Students should complete two weeks of internship before the commencement of V semester.

Elective Courses offered to other Science Department in I and II Semesters

III		Elective - I: (General/Discipline Specific)					
	23UZOOE15	Zoology - I	2	3	25	75	100
	23UZOOEP1	Zoology Practical - 1	1	2	25	75	100
		Elective - II: (General/Discipline Specific)					
	23UZOOE25	Zoology - II	2	3	25	75	100
	23UZOOEP2	Zoology Practical - II	1	2	25	75	100

Choice Based Credit System (CBCS), Learning Outcomes Based Curriculum Framework (LOCF) Guideline Based Credit and Hours Distribution System for all UG courses including Lab Hours

First Year – Semester-I

Part	List of Courses	Credit	No. of Hours
Part I	Language – Tamil	3	6
Part II	English	3	6
Part III	Core Theory, Practical & Elective Courses	13	14
Part IV	Skill Enhancement Course SEC-1 (NME-I)	2	2
	Foundation Course	2	2
		23	30

Semester-II

Part	List of Courses	Credit	No. of Hours
Part I	Language – Tamil	3	6
Part II	English	3	6
Part III	Core Theory, Practical & Elective Courses	13	14
Part IV	Skill Enhancement Course -SEC-2 (NME-II)	2	2
	Skill Enhancement Course -SEC-3 (Discipline / Subject Specific)	2	2
		23	30

Second Year – Semester-III

Part	List of Courses	Credit	No. of Hours
Part I	Language - Tamil	3	6
Part II	English	3	6
Part III	Core Theory, Practical & Elective Courses	13	14
Part IV	Skill Enhancement Course -SEC-4 (Entrepreneurial Based)	1	1
	Skill Enhancement Course -SEC-5 (Discipline / Subject Specific)	2	2
	E.V.S	-	1
		22	30

Semester-IV

Part	List of Courses	Credit	No. of Hours
Part I	Language - Tamil	3	6
Part II	English	3	6
Part III	Core Theory, Practical & Elective Courses	13	13
Part IV	Skill Enhancement Course -SEC-6 (Discipline / Subject Specific)	2	2
	Skill Enhancement Course -SEC-7 (Discipline / Subject Specific)	2	2
	E.V.S	2	1
		25	30

Third Year**Semester-V**

Part	List of Courses	Credit	No. of Hours
Part III	Core Theory, Practical, Project & Elective Courses	22	28
Part IV	Value Education	2	2
	Internship / Industrial Visit / Field Visit	2	-
		26	30

Semester-VI

Part	List of Courses	Credit	No. of Hours
Part III	Core Theory, Practical & Elective Courses	18	28
Part IV	Professional Competency Skill	2	2
Part V	Extension Activity	1	-
		21	30

Consolidated Semester wise and Component wise Credit distribution

Parts	Sem I	Sem II	Sem III	Sem IV	Sem V	Sem VI	Total Credits
Part I	3	3	3	3	-	-	12
Part II	3	3	3	3	-	-	12
Part III	13	13	13	13	22	18	92
Part IV	4	4	3	6	4	2	23
Part V	-	-	-	-	-	1	1
Total	23	23	22	25	26	21	140

***Part I, II, and Part III components will be separately taken into account for CGPA calculation and classification for the under graduate programme and the other components Part IV, V have to be completed during the duration of the programme as per the norms, to be eligible for obtaining the UG degree.**

CREDIT DISTRIBUTION FOR U.G. PROGRAMME

Part	Course Details	No. of Courses	Credit per course	Total Credits
Part I	Tamil	4	3	12
Part II	English	4	3	12
Part III	Core Courses	15	4/5	68
	Elective Courses: Generic / Discipline Specific (3 or 2+1 Credits)	8	3	24
Part I, II and III Credits				116
Part IV	Skill Enhancement Courses / NME / Language Courses	7	1/2	15
	Professional Competency Skill Course	1	2	2
	Environmental Science (EVS)	1	2	2
	Value Education	1	2	2
	Internship	1	2	2
Part IV Credits				23
Part V	Extension Activity (NSS / NCC / Physical Education)	1	1	1
Total Credits for the UG Programme				140

Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	100 Marks
Methods of Assessment		
Recall (K1)	Simple definitions, MCQ, Recall steps, Concept definitions	
Understand/Comprehend (K2)	MCQ, True/False, Short essays, Concept explanations, Short summary or overview	
Application (K3)	Suggest idea/concept with examples, Suggest formulae, Solve problems, Observe, Explain	
Analyze(K4)	Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas, Map knowledge	
Evaluate(K5)	Longer essay/Evaluation essay, Critique or justify with pros and cons	
Create(K6)	Check knowledge in specific or off beat situations, Discussion, Debating or Presentations	

Programme Outcomes:	PO1: Disciplinary knowledge: Capable of demonstrating comprehensive knowledge and understanding of one or more disciplines that form a part of an undergraduate Programme of study PO2: Communication Skills: Ability to express thoughts and ideas effectively in writing and orally; Communicate with others using appropriate media; confidently share one's views and express herself/himself; demonstrate the ability to listen carefully, read and write analytically, and present complex information in a clear and concise manner to different groups. PO3: Critical thinking: Capability to apply analytic thought to a body of knowledge; analyse and evaluate evidence, arguments, claims, beliefs on the basis of empirical evidence; identify relevant assumptions or implications; formulate coherent arguments; critically evaluate practices, policies and theories by following scientific approach to knowledge development. PO4: Problem solving: Capacity to extrapolate from what one has learned and apply their competencies to solve different kinds of non-familiar problems, rather than replicate curriculum content knowledge; and apply one's learning to real life situations. PO5: Analytical reasoning: Ability to evaluate the reliability and relevance of evidence; identify logical flaws and holes in the arguments of others; analyze and synthesize data from a variety of sources; draw valid conclusions and support them with evidence and examples, and addressing opposing viewpoints. PO6: Research-related skills: A sense of inquiry and capability for asking relevant/appropriate questions, problem arising, synthesising and articulating; Ability to recognise cause-and-effect relationships, define problems, formulate hypotheses, test hypotheses, analyse, interpret and draw conclusions from data, establish hypotheses, predict cause-and-effect relationships; ability to plan, execute and report the results of an experiment or investigation PO7: Cooperation/Team work: Ability to work effectively and respectfully with diverse teams; facilitate cooperative or coordinated effort on the part of a group, and act together as a group or a team in the interests of a common cause and work efficiently as a member of a team PO8: Scientific reasoning: Ability to analyse, interpret and draw conclusions from quantitative/qualitative data; and critically evaluate ideas, evidence and experiences from an open-minded and reasoned perspective. PO9: Reflective thinking: Critical sensibility to lived experiences, with self awareness and reflexivity of both self and society. PO10 Information/digital literacy: Capability to use ICT in a variety of learning situations, demonstrate ability to access, evaluate, and use a variety of relevant information sources; and use appropriate software for analysis of data. PO 11 Self-directed learning: Ability to work independently, identify appropriate resources required for a project, and manage a project through to completion.
----------------------------	--

	PO 12 Multicultural competence: Possess knowledge of the values and beliefs of multiple cultures and a global perspective; and capability to effectively engage in a multicultural society and interact respectfully with diverse groups. PO 13: Moral and ethical awareness/reasoning: Ability to embrace moral/ethical values in conducting one's life, formulate a position/argument about an ethical issue from multiple perspectives, and use ethical practices in all work. Capable of demonstrating the ability to identify ethical issues related to one's work, avoid unethical behaviour such as fabrication, falsification or misrepresentation of data or committing plagiarism, not adhering to intellectual property rights; appreciating environmental and sustainability issues; and adopting objective, unbiased and truthful actions in all aspects of work. PO 14: Leadership readiness/qualities: Capability for mapping out the tasks of a team or an organization, and setting direction, formulating an inspiring vision, building a team who can help achieve the vision, motivating and inspiring team members to engage with that vision, and using management skills to guide people to the right destination, in a smooth and efficient way. PO 15: Lifelong learning: Ability to acquire knowledge and skills, including „learning how to learn“, that are necessary for participating in learning activities throughout life, through self-paced and self-directed learning aimed at personal development, meeting economic, social and cultural objectives, and adapting to changing trades and demands of work place through knowledge/skill development/reskilling.
--	--

Programme Specific Outcomes:	PSO1 – Placement: To prepare the students who will demonstrate respectful engagement with others' ideas, behaviors, beliefs and apply diverse frames of reference to decisions and actions. PSO 2 - Entrepreneur: To create effective entrepreneurs by enhancing their critical thinking, problem solving, decision making and leadership skill that will facilitate startups and high potential organizations PSO3 – Research and Development: Design and implement HR systems and practices grounded in research that comply with employment laws, leading the organization towards growth and development. PSO4 – Contribution to Business World: To produce employable, ethical and innovative professionals to sustain in the dynamic business world. PSO 5 – Contribution to the Society: To contribute to the development of the society by collaborating with stakeholders for mutual benefit
--	---

FIRST YEAR

Semester	CORE – I	H/W	C
I	Course Code: 23UZOOC13 Course Title: Invertebrata	5	5

Course Objective :

1	To understand the basic concepts of invertebrates and observe the structure and functions.
2	To illustrate and examine the systemic and functional morphology of various group of invertebrates.
3	To differentiate and classify the various groups of animals, modes of life and to estimate the biodiversity.
4	To compare and distinguish the general and specific characteristics of reproduction in invertebrates.
5	To infer and integrate the parasitic and economic importance of invertebrates

Unit – 1: Protozoa and Porifera

Protozoa: Introduction to Classification, taxonomy and nomenclature. General characters and classification of Phylum Protozoa up to classes. Type study - *Paramecium* and *Plasmodium* - Parasitic protozoans (*Entamoeba*, *Trypanosoma* & *Leishmania*) - Economic importance. - Host-parasitic interactions in *Entamoeba* and *Plasmodium* - Nutrition and Locomotion in protozoa

Porifera: General characters and classification up to Classes. Type study - *Ascon* & *Sycon* - Canal system in sponges - Skeleton in sponges, Reproduction in sponges Economic importance of sponges.

Unit – 2: Coelenterata and Platyhelminths

Coelenterata : General characters and classification up to classes – Type study – *Obelia* and *Aurelia* - Corals and coral reefs - Polymorphism - Mesenteries in Anthozoa - Polymorphism in Hydrozoa. Economic importance of corals and coral reefs.

Platyhelminths: General characters and classification of up to classes. Type study – *Fasciola hepatica*. Nematelminthes: *Taeniasolium* – Parasitic adaptations. Host-parasitic interactions of Helminth parasites. Nematode Parasites and diseases – *Wuchereria bancrofti*, *Enterobius vermicularis*, *Ancylostoma duodenale*. Aschelminthes : General characters and classification of up to classes - Type study – *Ascaris lumbricoides*

Unit-3:Annelida and Arthropoda

Annelida: General characters and classification up to Classes. Type study –*Nereis* and *Hirudinaria granulosa*. Metamerism - Nephridium and coelomoducts - Modes of life in Annelids. Reproduction in polychaetes

Arthropoda: General characters and classification of Phylum Arthropoda up to Classes. Detailed study: *Penaeus indicus*. Affinities of *Peripatus* – Larval forms in Crustacea – Organization of Centipede and Millipede

Unit – 4: Mollusca

Mollusca: General characters and classification of Phylum Mollusca up to Classes. Detailed study: *Pila globosa*. Foot and torsion in Mollusca, Economic importance of Molluscs – Cephalopoda as the most advanced invertebrate.

Unit – 5: Echinodermata

Echinodermata: General characters and classification of Phylum Echinodermata up to Classes. Detailed study: *Asterias*. Water vascular system in Echinodermata – Larval forms of Echinoderms.

Expected Course Outcomes (CO)

At the end of the course, the student will be able to

1	Understand the basic concepts of invertebrate animals and recall its structure and functions.
2	Illustrate and examine the systemic and functional morphology of various groups of invertebrata.
3	Differentiate and classify the animal's mode of life in various taxa and estimate the biodiversity.
4	To compare and distinguish the various physiological processes and organ systems in lower animals.
5	Infer and integrate the parasitic and economic importance of invertebrate animals.

TEXT BOOKS

1. Arumugam, N., T. Murugan, B. Ramanathan and M.G Ragunathan. (2019). *A Text Book of Invertebrates*, Saras Publications, Nagercoil, Tamil Nadu.
2. Ekambaranatha Ayyar .M., (1973). *A Manual of Zoology – Part I, Invertebrata*. S. Viswanathan Printers and Publishers Pvt., Ltd., Madras.
3. Jordon, E.L. and P.S Verma, (2014). *Invertebrate Zoology*. S. Chand and Co. Ltd., New Delhi.
4. Adam Sedgwick, (1960). *A student's text book of Zoology, Vol. I & III*, General Book Depot, Allahabad.
5. Hyman, L.H. (1951). *The Invertebrates, Vol. I*, McGraw Hill Book Co., New York.

6. Kotpal.R.L., (2017). *Modern Text book of Zoology-Invertebrata, (Animal Diversity- I)*. Rastogi Publications, New Delhi.

REFERENCE BOOKS

1. Arumugam, N. (2014). *Animal diversity Volume -1 – Invertebrata*. SarasPublication, Nagercoil, Tamil Nadu.
2. FatikBaran. (2012). *Invertebrate Zoology*. **Prentice Hall of India** Pvt Ltd., New Delhi.
3. Barrington E.J.W. (2012). *Invertebrate structure and function*. Affiliated East West Press Pvt. Ltd., New Delhi.
4. Richard C. Brusca, Wendy Moore and Stephen M. Shuster. (2016). *Invertebrates*. *Oxford University Press*, USA.
5. Clarkson E.N.K. (2011). *Invertebrate Palaeontology and Evolution*. Wiley India Pvt. Ltd., New Delhi.

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO 1	S							
CO 2	M	S						
CO 3				S		S		
CO 4				S	S	M		
CO 5			S					S

S-Strong

M-Medium

L-Low

Semester	CORE – II: Practical- I	H/W	C
I	Course Code: 23UZOOP14: Course Title: Invertebrata	4	5

Course Objective :

1	To identify the different groups of invertebrate animals by observing their external characteristics.
2	To understand the organs, organ system and their functions in lower animals.
3	To get knowledge about the different modes of life and their adaptation based on the environment.
4	Able to dissect and display the internal organs and mount the mouthparts and scales of invertebrates.

Unit - 1: Major Dissection : Cockroach: Circulatory system, Nervous system, Reproductive system. Earthworm: Nervous System, Reproductive system. *Pila globosa*: Nervous system. Prawn: Nervous system (including Appendages).

Unit – 2: Minor Dissection: Cockroach: Digestive system. Earthworm: Viscera, Lateral hearts.
Pila globosa: Digestive system (Including radula).

Unit – 3: Mounting: Earthworm: Body setae; Pineal setae. *Pila globosa*: Radula.

Unit - 4: Mounting : Cockroach: Salivary apparatus, Mouth parts - Honey Bee, House fly and Mosquito mouth parts.

Unit - 5: Spotters (i). Protozoa: Amoeba, Paramoecium, Paramoecium Binary fission and Conjugation, Vorticella, *Entamoeba histolytica*, *Plasmodium vivax* **(ii). Porifera:** Sycon, Spongilla, Euspongia, Sycon - T.S & L.S, Spicules, Gemmule **(iii). Coelenterata:** Obelia – Colony & Medusa, Aurelia, Physalia, Velella, Corallium, Gorgonia, Pennatula **(iv). Platyhelminthes:** Planaria, Fasciola hepatica, Fasciolalarval forms – Miracidium, Redia, Cercaria, Echinococcus granulosus, Taeniasolium, Schistosoma haematobium **(v). Nematelminthes:** Ascaris (Male & Female), Drancunculus, Ancylostoma, Wuchereria **(vi). Annelida:** Nereis, Aphrodite, Chaetopteurs, Hirudinaria, Trochophore larva **(vii). Arthropoda:** Cancer, Palaemon, Scorpion, Scolopendra, Sacculina, Limulus, Peripatus, Larvae - Nauplius, Mysis, Zoea, Mouth parts of male & female Anopheles and Culex, Mouthparts of Housefly and Butterfly. **(viii). Mollusca:** Chiton, Pila, Unio, Pteredo, Murex, Sepia, Loligo, Octopus, Nautilus, Glochidium larva **(ix). Echinodermata:** Asterias, Ophiothrix, Echinus, Clypeaster, Cucumaria, Antedon, Bipinnaria larva

Expected Course Outcomes (CO)

At the end of the course, the student will be able to

1	Identify and label the external features of different groups of invertebrate animals.
2	Illustrate and examine the circulatory system, nervous system and reproductive system of invertebrate animals.
3	Differentiate and compare the structure, function and mode of life of various groups of animals.
4	To compare and distinguish the dissected internal organs of lower animals.
5	Prepare and develop the mounting procedure of economically important invertebrates.

Text Books (Latest Editions)

1. Ekambaranatha Iyyar and T. N. Ananthakrishnan, 1995 A manual of Zoology Vol.I (Part 1, 2) S. Viswanathan, Chennai.
2. Ganguly, Sinha and Adhikari, 2011. Biology of Animals: Volume I, New Central Book Agency; 3rd revised edition. 1008 pp.
3. Sinha, Chatterjee and Chattopadhyay, 2014. Advanced Practical Zoology, Books & Allied Ltd; 3rd Revised edition, 1070 pp.
4. Lal, S. S., 2016. Practical Zoology Invertebrate, Rastogi Publications.
5. Verma, P. S. 2010. A Manual of Practical Zoology: Invertebrates, S Chand, 497pp.

References Books

(Latest editions, and the style as given below must be strictly adhered to)

1. Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2002). *The Invertebrates: A New Synthesis*, III Edition, Blackwell Science.
2. Barnes, R.D. (1982). *Invertebrate Zoology*, V Edition. Holt Saunders International Edition.
3. Barrington, E.J.W. (1979). *Invertebrate Structure and Functions*. II Edition, E.L.B.S. and Nelson.
4. Boradale, L.A. and Potts, E.A. (1961). *Invertebrates: A Manual for the use of Students*. Asia Publishing Home.
5. Lal, S.S. 2005. A text Book of Practical Zoology: Invertebrate, Rastogi, Meerut

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO 1	S							
CO 2	M	S						
CO 3				S		S		
CO 4				S	S	M		
CO 5			S					S

S-Strong;

M-Medium;

L-Low

ELECTIVE I

SEMESTER	ELECTIVE - I	H/W	C
I	COURSE CODE : 23UBOTE15 COURSE TITLE: Botany – I	3	2

Course Objective

1	To study morphological and anatomical adaptations of plants of various habitats.
2	To demonstrate techniques of plant tissue culture.
3	To familiarize with the structure of DNA, RNA.
4	To carryout experiments related with plant physiology.
5	To perform biochemistry experiments.

Unit – 1: Algae:

General characters of algae - Structure, reproduction and life cycle of the following genera - *Anabaena* and *Sargassum* and economic importance of algae.

Unit – 2 : Fungi, Bacteria and Virus:

General characters of fungi, structure, reproduction and life cycle of the following genera – *Penicillium* and *Agaricus* and economic importance of fungi.

Bacteria - general characters, structure and reproduction of *Escherichia coli* and economic importance of bacteria. Virus - general characters, structure of TMV, structure of bacteriophage.

Unit – 3 : Bryophytes, Pteridophytes and Gymnosperms:

General characters of Bryophytes, Structure and life cycle of *Funaria*.

General characters of Pteridophytes, Structure and life cycle of *Lycopodium*.

General characters of Gymnosperms, Structure and life cycle of *Cycas*.

Unit – 4: Cell Biology:

Prokaryotic and Eukaryotic cell-structure/organization. Cell organelles - ultra structure and function of chloroplast, mitochondria and nucleus. Cell division - mitosis and meiosis.

Unit – 5: Genetics and Plant Biotechnology:

Mendelism - Law of dominance, Law of segregation, Incomplete dominance. Law of independent assortment. Monohybrid and dihybrid cross - Test cross - Back cross. Plant tissue culture - *In vitro* culture methods. Plant tissue culture and its application in biotechnology.

Expected Course Outcomes (CO)

At the end of the course, the student will be able to

1	Increase the awareness and appreciation of human friendly algae and their economic importance.
2	Develop an understanding of microbes and fungi and appreciate their adaptive strategies.
3	Develop critical understanding on morphology, anatomy and reproduction of Bryophytes, Pteridophytes and Gymnosperms.
4	Compare the structure and function of cells and explain the development of cells.
5	Understand the core concepts and fundamentals of plant biotechnology and genetic engineering.

Recommended Texts

1. Singh, V., Pande, P. and Jain, D.K. 2021. A Text Book of Botany. Rastogi Publications, Meerut.
2. Bhatnagar, S.P and Alok Moitra. 2020. Gymnosperms, New Age International (P) Ltd., Publishers, Bengaluru.
3. Sharma, O.P. 2017. Bryophyta, MacMillan India Ltd. Delhi.
4. Lee, R.E. 2008. Phycology, IV Edition, Cambridge University Press, New Delhi.
5. Rao, K., Krishnamurthy, K.V and Rao, G.S. 1979. Ancillary Botany, S. Viswanathan Pvt. Ltd., Madras.

Reference books:

1. Parihar, N.S. 2012. An introduction to Bryophyta –Pteridophytes- Surjeet Publications, Delhi.
2. Alexopoulos, C.J. 2013. Introduction to Mycology. Willey Eastern Pvt. Ltd.
3. Vashishta, P.C. 2014. Botany for Degree Students Gymnosperms. Chand & Company Ltd, Delhi.
4. Coulter, M. Jhon, 2014. Morphology of Gymnosperms. Surjeet Publications, Delhi.
5. Vashishta, P.C. 2014. Botany for Degree Students Algae. 2014. Chand & Company Ltd, Delhi.
6. Parihar, N.S. 2013. An introduction to Bryophyta –Bryophytes -, Surjeet Publications, Delhi.
7. Pandey B.P. 1986, Text Book of Botany (College Botany) Vol I & II, S.Chand and Co. New Delhi.

Web Resources

1. <https://www.kobo.com/us/en/ebook/the-algae-world>
2. [http://www.freebookcentre.net/biology-books-download/Fungi-\(PDF-15P\).html](http://www.freebookcentre.net/biology-books-download/Fungi-(PDF-15P).html)
3. <http://scitec.uwichill.edu.bb/bcs/bl14apl/bryo1.htm>
4. <https://www.toppr.com/guides/biology/plant-kingdom/pteridophytes/>
5. <https://arboretum.harvard.edu/wp-content/uploads/2013-70-4-beyond-pine-cones-an-introduction-to-gymnosperms.pdf>
6. <https://www.us.elsevierhealth.com/medicine/cell-biology>
7. <https://www.us.elsevierhealth.com/medicine/genetics>
8. <https://www.kobo.com/us/en/ebook/plant-biotechnology-1>

Mapping with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	S	S	S	S	S	S	S	S	S
CO2	S	S	S	S	S	S	S	S	S	S
CO3	M	S	S	S	S	L	S	S	S	S
CO4	S	S	M	S	S	S	M	S	M	S
CO5	S	M	M	M	M	M	M	L	M	L

S – Strong; M – Medium; L-Low

SKILL ENHANCEMENT COURSES

Semester	Foundation Course	H/W	C
I	COURSE CODE: 23UZOOOF17 Ornamental Fish Farming and Management	2	2

Course Objective (LO):

1	To highlight the importance of ornamental fish culture in relation to entrepreneurship development.
2	To enable the identification, culture and maintenance of commercially important ornamental fishes.
3	To provide the knowledge on the techniques of ornamental fish breeding, rearing, disease control and economics of ornamental fish farming.

Unit I:

Introduction to ornamental fish keeping. Scope and importance of ornamental fish culture. Domestic and global scenario of ornamental fish trade and export potential.
Commercially important ornamental fishes - Indigenous and exotic varieties.

Unit II:

Biology of egg layers and live bearers. Food and feeding in ornamental fishes. Formulated feed and Live feed; Live feed culture. Breeding, hatchery and nursery management of egg layers (eg. Goldfish) and live bearers (eg. Guppy).

Unit III:

Aquarium design and construction; Accessories - aerators, filters and lighting.
Aquarium plants and their propagation. Maintenance of aquarium and water quality management.

Unit IV:

Disease management of Ornamental fishes (symptoms, Life cycle, and their prevention, control and treatment methods. Protozoan diseases, Bacterial diseases, crustacean diseases, Fungal diseases and Helminth diseases

Unit V:

Conditioning, packing, transport and quarantine methods.
Economics, trade regulations, domestic and export marketing strategies.

References:

1. Swain SK., Sarangi N. and Ayyappan S. 2010. Ornamental fish farming. ICAR, New Delhi.
2. Living Jewels – A handbook on freshwater ornamental fish, MPEDA, Kochi.
3. Dey V.K.A. 1997. A handbook on aquafarming ornamental fishes. MPEDA, Kochi.
4. Ahilan, B., Felix N. and Santhanam R. 2008. Text book of aquaculture. Daya Publishing House, New Delhi.

Web links:

1. <http://ecoursesonline.iasri.res.in/course/view.php?id=297>
2. <https://www.ofish.org/>
3. <https://krishijagran.com/agripedia/income-generation-by-ornamental-fish-culture/>
4. <https://99businessideas.com/ornamental-fish-farming/>

Expected Course Outcomes (COs)

1	The students will be able to identify, culture, maintain and market the commercially important ornamental fishes.
2	The knowledge and skills gained on the different aspects of ornamental fish keeping will enable the students to develop entrepreneurship potential and help in self employment.

Outcome Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO 1	S				M			S
CO 2	M	S					S	
CO 3				S		S		
CO 4	M			S	S	M		
CO 5			S				M	S

S-Strong**M-Medium****L-Low**

SEMESTER	ELECTIVE – I	H/W	C
I	COURSE CODE : 23UBOTEPI COURSE TITLE: Botany Practical – I	2	1

Course Objectives

1. To enhance information on the identification of each taxonomical group by developing the skill-based detection of the morphology and microstructure of microorganisms, algae, and fungi
2. To comprehend the fundamental concepts and methods used to identify Bryophytes, Pteridophytes and Gymnosperms through morphological changes and evolution, anatomy and reproduction.
3. To be familiar with the basic concepts and principles of cell biology.
4. Understanding of laws of inheritance, genetic basis of loci and alleles.
5. To learn about the principles and applications of Biotechnology

EXPERIMENTS

1. Make suitable micro preparation of the types prescribed in Algae, Fungi, Bryophytes, Pteridophytes and Gymnosperms.
2. Micro photographs of the cell organelles ultra structure.
3. Simple genetic problems.
4. Spotters - Algae, Fungi, Bryophytes, Pteridophytes, Gymnosperms Cell biology and Biotechnology.

Bonafide record of practical work done should be submitted for the practical examination

Course outcomes:

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

1. To study the internal organization of algae .
2. To study the structure and organization of fungi, bacteria and viruses
3. Develop critical understanding on morphology, anatomy and reproduction of Bryophytes, Pteridophytes and Gymnosperms.
4. To study the cell structure and function.
5. Understand the fundamental concepts of genetics and Biotechnology

Recommended texts

1. Sharma, O.P. 2017. Bryophyta, MacMillan India Ltd, New Delhi.
2. Sharma, O.P. 2012. Pteridophyta, Tata McGraw-Hills Ltd, New Delhi.
3. Subramaniam, N.S. 1996. Laboratory Manual of Plant Taxonomy. Vikas Publishing House Pvt. Ltd., New Delhi.
4. Benjamin, A. Pierce. 2012. Genetics- A conceptual Approach. W.H. Freeman and Company, New York, England.
5. Noggle G.R and G.J. Fritz. 2002. Introductory Plant Physiology. Prentice Hall of India, New Delhi.

Reference books

1. Strickberger, M.W. 2005. Genetics (III Ed). Prentice Hall, New Delhi, India.
2. Nancy Sereadiak and M. Huynh. 2011. Algae identification lab Guide. Accompanying manual to algae identification field guide, Ottawa Agriculture and Agri food Canada publisher.
3. Mohammed Gufran Khan, Shite Gatew and Bedilu Bekele. 2012. Practical manual for Bryophytes and Pteridophytes. Lambert Academic Publishing.
4. AlerGingauz. 2001. Medicinal Chemistry. Oxford University Press & Wiley Publications.
5. Steward, F.C. 2012. Plant Physiology Academic Press, US

Web Resources

1. <https://www.amazon.in/Practical-Manual-Pteridophyta-Rajan-Sundara/dp/8126106883>
2. <https://www.google.co.in/books/edition/Gymnosperms/3YrT5E3Erm8C?hl=en&gbpv=1&dq=gymnosperms&printsec=frontcover>
3. <https://www.amazon.in/Manual-Practical-Bryophyta-Suresh-Kumar/dp/B0072GNFX4>

OUTCOME MAPPING

	PO1	PO2	PO3	PO4	PO5
CO1	2	3	1	3	2
CO2	2	3	2	2	3
CO3	2	1	3	2	3
CO4	1	3	3	2	2
CO5	2	2	3	1	3

BOTANY PRACTICAL I

Time : 3 Hours

Max. Marks : 75

PRACTICAL QUESTION PAPER

1. Make suitable micro preparations of the given specimens A, B and C.

Submit the slides for valuation. Identify the specimens, draw diagrams and give reasons.

(Identification – 1, diagram – 2, Reasons – 2, Slide -2) (7 X 3) (21)

2. Make suitable micro preparations of the given specimens D.

Submit the slides for valuation. Identify the specimens, draw diagrams and give reasons.

(Identification – 1, diagram – 2, Reasons – 2, Slide -2) (08)

3. Identify the given electron micrograph –E, describe and draw diagrams

(Identification – 2, Diagram – 3, description – 3) (08)

4. Spotters – F, G, H, I, J, K and L.

(Identification – 1, diagram – 1, Reasons – 2) (7 X 4) (28)

Total = 65

Record = 10

Grand Total = 75

BOTANY PRACTICAL I

KEY & SCHEME OF VALUATION

1. A – Algae / Fungi :*Sargassum/Agaricus*

B – Bryophytes :*Funaria*

C – Pteridophytes :*Lycopodium*

(Identification – 1, diagram – 2, Reasons – 2, Slide -2) (7 X 3)

(21)

2. Gymnosperms - D :*Cycas* – rachis and leaflet

(Identification – 1, diagram – 2, Reasons – 2, Slide -3)

(08)

3. Cell biology - E – Electron Micrograph of organelles- Chloroplast, Mitochondria, Nucleus, Mitosis, Giant Chromosomes

– (Identification – 2, Diagram – 3, description – 3)

(08)

4. Spotters – F, G, H, I, J and L(any seven of the following)

(Algae, Fungi, Bacteria, Virus, Bryophytes, Pteridophytes and Gymnosperms –permanent slides, book diagrams or wet preserved jar specimens, mentioned in the syllabus)

Cytology – photographs of cell organelles

Genetics – simple genetics problems

Plant biotechnology – tissue culture techniques : explants, callus, hardening

(Identification – 1, diagram – 1, Reasons – 2) (7 X 4)

(28)

Total = 65

Record = 10

Grand Total = 75

Semester	CORE – III	H/W	C
II	Course Code: 23UZOOC23 Course Title: Chordata	5	5

Course Objective

1	To understand the structures and distinct features of Phylum Chordata.
2	To understand and able to distinguish the characteristic features of each subphylum and class.
3	To understand the economic importance of vertebrates
4	To know about the adaptations of vertebrates
5	To understand the evolutionary position of different groups of vertebrates

Unit – 1: General Characters and Classification of Phylum Chordata: Origin of Chordata, Differences between non-chordates and chordates, General characters, Affinities and Systematic position of Hemichordata (*Balanoglossus*), Urochordata (*Ascidia*), Cephalochordata (*Amphioxus*).

Unit - 2: Prochordates and Agnatha: Characteristics of subphylum vertebrata, Classification of Vertebrata upto Class level, Agnatha (*Petromyzon*), - Pisces (*Scoliodon sorrakowah*) General characters and classification, Origin of fishes, Affinities of Dipnoi - Types of scales and fins - Accessory respiratory organs - Air bladder - Parental care - Migration - Economic importance.

Unit - 3: Amphibia : General characters and classification - Origin of Amphibia - Type study - *Rana hexadactyla* - Adaptive features of Anura, Urodela and Apoda - Neoteny in Urodela - Parental care in Amphibia.

Unit - 4: Reptilia : General characters and classification - Type study – (*Calotes versicolor* (endoskeleton of *Varanus*)) - Origin of reptiles and effects of terrestrialisation, Extinct reptiles. Snakes of India. Poison apparatus and biting mechanism of poisonous snakes - Skull in reptiles as basis of classification

Unit - 5: Aves and Mammalia : Aves: General characters and classification – Type study - *Columba livia* - Origin of birds, Flight adaptations, Migration. Mammalia: General characters and classification - Type study - Rabbit - Adaptive radiation in mammals - Egg laying mammals, Marsupials, Flying mammals, Aquatic mammals, Dentition in mammals.

Expected Course Outcomes (CO)

At the end of the course, the student will be able to

1	Classify, Identify and recall the name and distinct features of different subphylum belonging to phylum Chordata.
2	Explain, and relate the origin, structural organization and evolutionary aspects of vertebrates.

3	Analyze, compare and distinguish the developmental stages and describe the important biological process.
4	Correlate the different modes of life and parental care among different vertebrates.
5	Summarise the morphology and ecological adaptations in vertebrates and list out the economic importance.

Text Books (Latest Editions)

1. Ayyar, E.K. and T.N. Ananthakrishnan, 1992. Manual of Zoology Vol. II (Chordata), S. Viswanathan (Printers and Publishers) Pvt Ltd., Madras, 891p.
2. Jordan, E.K. and P.S. Verma, 1995. Chordate Zoology and Elements of Animal Physiology, 10th edition, S. Chand & Co Ltd., Ram Nagar, New Delhi, 1151 pp.
3. Nigam, H.C., 1983. Zoology of Chordates, Vishal Publications, Jalandhar - 144008, 942.
4. Ganguly, Sinha, Bharati Goswami and Adhikari, 2004. Biology of animals Vol.II - New central book Agency (p) Ltd.
5. Kotpal. R.L. A, Modern text book of Zoology Vertebrates- Rastogi publications. 2009

References Books (Latest editions, and the style as given below must be strictly adhered to)

1. Darlington P.J. The Geographical Distribution of Animals, R.E. Krieger Pub. Co.
2. Hall B.K. and Hallgrimsson B. (2008). Strickberger's Evolution. IV Edition. Jones and Bartlett Publishers Inc.
3. Hickman, C.P. Jr., F.M. Hickman and L.S. Roberts, 1984. Integrated Principles of Zoology, 7th Edition, Times Merror/Mosby College Publication. St. Louis. 1065 pp.
4. Newman, H.H., 1981. The Phylum Chordata, Satish Book Enterprise, Agra – 282 003, 477 pp.
5. Parker and Haswell, 1964. Text Book of Zoology, Vol II (Chordata), A.Z.T.B.S. Publishers and Distributors, New Delhi - 110 051, 952 pp.
6. Pough H. Vertebrate life, VIII Edition, Pearson International.
7. Waterman, Allyn J. et al., 1971. Chordate Structure and Function, Mac Millan & Co., New York, 587 pp.
8. Young, J. Z. (2004). The Life of Vertebrates. III Edition. Oxford university press.

Web Resources

1. <http://tolweb.org/Chordata/2499>
2. <https://www.nhm.ac.uk/>
3. <https://bit.ly/3Av1Ejg>
4. <https://bit.ly/3kqTfYz>
5. <https://biologyeducare.com/aves/>
6. <https://www.vedantu.com/biology/mammalia>

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO 1	S							
CO 2	M	S						
CO 3		S	S	S	S	S		S
CO 4			S	S	S	M		
CO 5			S		S			S

S – Strong; M – Medium; L - Low

Semester	CORE – IV: Practical- II	H/W	C
II	Course Code: 23UZOOP24 Course Title: Chordata	4	5

Course Objective

1	To understand the structures and distinct features of phylum chordata.
2	To understand and able to distinguish the characteristic features of each subphylum and class.
3	To understand and compare the structure of various internal organs in different classes of vertebrates.
4	To know about the classification, adaptations and affinities of chordate animals.

Unit - 1: Dissections: Frog (Demo)/Fish: External features, Digestive system, Arterial system, Venous system, 5th Cranial nerve, 9th and 10th cranial nerves, Male and female urinogenital system.

Unit – 2: Mounting: Fish: Placoid and Ctenoid scales, Frog: Hyoid apparatus and Brain (Demo).

Unit – 3: Osteology: Frog: Skull and lower jaw, Vertebral column, Pectoral girdle, Pelvic girdle, Forelimb, Hindlimb. Chelonia-Anapsid skull, Pigeon - skull and lower jaw, synsacrum

Unit - 4: Specimen and Slides: (i) **Hemichordata:** Balanoglossus, Tornaria larva (ii). **Protochordata:** Amphioxus, Amphioxus T.S. through pharynx, (iii). **Urochordata; Asidian,** (iv) **Cyclostomata:** Asidian Petromyzon, Myxine, Ammocoetus larva (v). **Pisces:** Sphyrna, Pristis, Torpedo, Channa, Pleuronectes, Hippocampus, Exocoetus, Echieneis, Labeo, Catla, Clarius, Auguilla, Protopterus, Scales: Placoid, Cycloid, Ctenoid (vi). **Amphibia:** Ichthyophis, Amblystoma, Siren, Hyla, Rachophous, Bufo, Rana, Axolotl larva (vii). **Reptilia :** Draco, Chamaeleon, Gecko, Uromastix, Viperarusselli, Naja, Bungarus, Enhydrina, Typhlops, Testudo, Trionyx, Crocodilus, Ptyas. (viii). **Aves:** Archaeopteryx, Passer, Psittacula, Bubo, Alcedo, Columba, Corvus, Pavo; Collection and study of different types of feathers: Quill, Contour, Filoplume, Down (ix). **Mammalia:** Ornithorhynchus, Tachyglossus, Pteropus, Funambulus, Manis, Loris, Hedgehog

Unit - 5: Embryology: Stages in the development of Amphioxus, Frog and Chick- Placenta in shark and mammals.

Expected Course Outcomes (CO)

At the end of the course, the student will be able to

1	Identify and recall the name and distinct external and internal features of animals belonging to phylum Chordata.
2	Explain the structural organization of various organs and systems in different classes of vertebrates.
3	Analyse, compare and distinguish the morphological features and developmental stages of chordates
4	Dissect and explain various organs and internal systems in different vertebrates and correlate its function.
5	Summarise the morphology and ecological adaptations in vertebrates and list out the economic importance.

Text Books (Latest Editions)

1. Lal S S, 2009. Practical Zoology Vertebrate, Rajpal and Sons Publishing, 484pp.
2. Verma P.S, 2000. A Manual of Practical Zoology: Chordates, S. Chand Limited, 627pp.

References Books (Latest editions, and the style as given below must be strictly adhered to)

1. Robert William Hegner, 2015. Practical Zoology, BiblioLife, 522pp.
2. Young, J.Z., 1972. The life of vertebrates. Oxford Uni. London.

Web Resources

1. https://www.youtube.com/watch?v=b04hc_kOY10
2. <https://bit.ly/3CzTEy8>
3. <http://tolweb.org/Chordata/2499>
4. <https://www.nhm.ac.uk/>
5. <https://bit.ly/3Av1Ejg>

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO 1	S							
CO 2	M	S						
CO 3				S		S		
CO 4				S	S	M		
CO 5			S					S

S-Strong;

M-Medium; L-Low

ELECTIVE II

SEMESTER	ELECTIVE - II	H/W	C
II	COURSE CODE: 23UBOTE25 COURSE TITLE: Botany- II	3	2

Course Objective (LO):

1	To be familiar with the basic concepts and principles of plant systematics.
2	Learn the importance of plant anatomy in plant production systems.
3	Understand the mechanism underlying the shift from vegetative to reproductive phase.
4	To learn about the physiological processes that underlie plant metabolism.
5	To know the energy production and its utilization in plants.

Unit – 1: MORPHOLOGY OF FLOWERING PLANTS

Plant and its parts. Structure and function of root and stem. Leaf and its parts. Leaf types- simple and compound. Phyllotaxy and types. Inflorescence - Racemose, Cymose and Special types. Terminology with reference to flower description.

Unit – 2 :TAXONOMY

Study of the range of characters and plants of economic importance in the following families: Rutaceae, Caesalpiniaceae, Asclepiadaceae, Euphorbiaceae and Cannaceae

Unit – 3: ANATOMY

Tissue and tissue systems: Simple and complex tissues. Anatomy of monocot and dicot roots - anatomy of monocot and dicot stems - anatomy of dicot and monocot leaves.

Unit – 4: EMBRYOLOGY

Structure of mature anther and ovule - Types of ovules, structure of embryo sac, pollination -double fertilization, structure of dicotyledonous and monocotyledonous seeds.

Unit – 5: PLANT PHYSIOLOGY

Absorption of water, photosynthesis - light reaction - Calvin cycle; respiration - Glycolysis - Krebs cycle - electron transport system. Growth hormones - auxins and cytokinins and their applications.

Expected Course Outcomes (CO)

At the end of the course, the student will be able to

1	Understand the fundamental concepts of plant anatomy and embryology.
2	Analyze and recognize the different organs of plants and secondary growth.
3	Understand water relation of plants with respect to various physiological

	processes
4	Classify aerobic and anaerobic respiration.
5	Classify plant systematics and recognize the importance of herbarium and virtual herbarium.

Recommended Texts:

1. Sharma, O.P. 2017. Plant Taxonomy. (II Edition). The McGraw Hill Companies.
2. Bhojwani, S.S. Bhatnagar, S.P and Dantu, P.K. 2015. The Embryology of Angiosperms (6th revised and enlarged edition). Vikas Publishing House, New Delhi.
3. Maheshwari, P. 1963. Recent Advances in Embryology of Angiosperms. Intl. Soc. Plant Morphologists, New Delhi.
4. Salisbury, F. B.C.W. Ross. 1991. Plant Physiology. Wadsworth Pub. Co. Belmont.
5. Ting, I.P. 1982. Plant Physiology. Addison Wesley Pb. Philippines.

Reference books

1. Lawrence, G.H.M. 1985. An Introduction to Plant Taxonomy, Central Book Depot, Allahabad.
2. Bhojwani, S.S and Bhatnagar, S.P. 2000. The Embryology of Angiosperms (4th revised and enlarged edition). Vikas Publishing House, New Delhi.
3. Pandey, B.P. 2012. Plant Anatomy. S Chand Publishing.
4. Jain, V.K. 2006. Fundamentals of Plant Physiology, S. Chand and Company Ltd.
5. Rajni Gupta. 2012. Plant Taxonomy: Past, Present and Future. Vedams (P) Ltd. New Delhi.
6. Jain, V.K. 2006. Fundamentals of Plant Physiology, S.Chand and Company Ltd., New Delhi.
7. Verma, S.K. 2006. A Textbook of Plant Physiology, S.K.Chand & Co., New Delhi.

Web Resources

1. https://books.google.co.in/books/about/Plant_Taxonomy.html?id=0bYs8F0Mb9gC&redir_esc=y
2. https://books.google.co.in/books/about/PLANT_TAXONOMY_2E.html?id=Roi0lwSXFuUC&redir_esc=y
3. <https://archive.org/EXPERIMENTS/plantanatomy031773mbp>
4. <https://www.amazon.in/Embryology-Angiosperms-6th-S-P-Bhatnagar-ebook/dp/B00UN5KPQG>
5. <https://www.crcpress.com/Plant-Physiology/Stewart-Globig/p/book/9781926692692>

Mapping with Programme Outcomes:

Cos	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	S	S	S	S	S	S	S	S	S
CO2	S	S	S	S	S	S	S	S	S	S
CO3	M	S	S	S	S	L	S	S	S	S
CO4	S	S	M	S	S	S	S	M	S	M
CO5	S	M	M	M	M	M	M	L	M	M

S – Strong; M – Medium; L – Low

SEMESTER	ELECTIVE - II	H/W	C
II	COURSE CODE: 23UBOTEP2 COURSE TITLE: Botany Practical -II	2	1

Course Objectives

1. To enhance information on the identification of taxonomical plant
2. To be familiar with the basic concepts and principles of plant systematics.
3. Understanding of reproduction and development of angiosperms
4. To understand the internal organization of Angiosperms
5. To learn about the physiological processes that underlie plant metabolism.

EXPERIMENTS

1. To identify Angiosperm root, stem, leaf, flowers and fruits based on morphology
2. To describe in technical terms, plants belonging to any of the family prescribes and to identify the family.
3. To dissect a flower, construct floral diagram and write floral formula.
4. Demonstration experiments
 - a. Ganong's Light screen
 - b. Ganong's respiroscope
5. To make suitable micro preparations of anatomy materials prescribed in the syllabus.
6. Spotters - Angiosperm morphology, anatomy, Embryology and Physiology

Bonafide record of practical work done should be submitted for the practical examination

Course outcomes:

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

1. Understand external structure of angiosperms
2. To study the classical taxonomy with reference to different parameters.
3. Understand the fundamental concepts of plant anatomy and embryology
4. To study the effect of various physical factors on photosynthesis.
5. Understand simple experiments in plant Physiology

Recommended texts

1. Sharma, O.P. 2017. Bryophyta, MacMillan India Ltd, New Delhi.
2. Sharma, O.P. 2012. Pteridophyta, Tata McGraw-Hills Ltd, New Delhi.
3. Subramaniam, N.S. 1996. Laboratory Manual of Plant Taxonomy. Vikas Publishing House Pvt. Ltd., New Delhi.
4. Benjamin, A. Pierce. 2012. Genetics- A conceptual Approach. W.H. Freeman and Company, New York, England.
5. Noggle G.R and G.J. Fritz. 2002. Introductory Plant Physiology. Prentice Hall of India, New Delhi.

Reference books

1. Strickberger, M.W. 2005. Genetics (III Ed). Prentice Hall, New Delhi, India.
2. Nancy Sereciak and M. Huynh. 2011. Algae identification lab Guide. Accompanying manual to algae identification field guide, Ottawa Agriculture and Agri food Canada publisher.
3. Mohammed Gufran Khan, Shite Gatew and Bedilu Bekele. 2012. Practical manual for Bryophytes and Pteridophytes. Lambert Academic Publishing.
4. AlerGingauz. 2001. Medicinal Chemistry. Oxford University Press & Wiley Publications.

5. Steward, F.C. 2012. Plant Physiology Academic Press, USA

Web Resources

1. <https://www.amazon.in/Practical-Manual-Pteridophyta-Rajan-Sundara/dp/8126106883>
2. <https://www.google.co.in/books/edition/Gymnosperms/3YrT5E3Erm8C?hl=en&gbpv=1&dq=gymnosperms&printsec=frontcover>
3. <https://www.amazon.in/Manual-Practical-Bryophyta-Suresh-Kumar/dp/B0072GNFX4>

OUTCOME MAPPING

	PO1	PO2	PO3	PO4	PO5
CO1	2	3	1	3	2
CO2	2	3	2	2	3
CO3	2	1	3	2	3
CO4	1	3	3	2	2
CO5	2	2	3	1	3

BOTANY PRACTICAL II

Time : 3 Hours

Max. Marks : 75

PRACTICAL QUESTION PAPER

1. Identify the given specimens –A to its respective family, draw MLS of the flower and describe it in technical terms.

(Identification of family – 2, MLS diagram – 3, technical description – 4) (09)

2. Identify the given specimen –B, to its respective family, construct the floral diagram and write the floral formula.

(Identification of family – 2, floral diagram – 3, floral formula – 2) (07)

3. Make suitable micro preparations of the given specimens C.

Submit the slides for valuation. Identify the specimens, draw diagrams and give reasons.(Identification – 1, diagram – 2, Reasons – 2, Slide -2) (07)

4. Comment on the Physiology setup – D Write the aim, materials required , Procedure, Results and Inference

(Aim-1, Materials required -1, Procedure -2 , Results and Inference -3) (07)

4. Spotters – E, F, G, H, I, J, K and L.

(Identification – 1, diagram – 2, Reasons – 2) (7 X 5) (35)

Total = 65

Record = 10

Grand Total = 75

BOTANY PRACTICAL II

KEY & SCHEME OF VALUATION

1. Taxonomy - A – MLS of the flower (from any one family mentioned in the syllabus)

(Identification of family – 2, MLS diagram – 3, technical description – 4)(09)

2. Taxonomy - B – Floral diagram and floral formula (from any one family mentioned in the syllabus)(Identification of family – 2, floral diagram – 3, floral formula – 2) (07)

3.. Anatomy - C : Dicot and monocot – stem, root and leaf.

(Identification – 1, diagram – 2, Reasons – 2, Slide -2) (07)

4. Physiology Set up D - Osmosis – thistle funnel experiment, Photosynthesis – Beaker and Funnel experiment, Ganong's light screen and Ganong's respire scope

(Aim-1, Materials required -1, Procedure -2 , Results and Inference -3) (07)

5. Spotters –E, F, G, H, I, J , and K (any seven of the following) (08)

Morphology – vegetative and reproductive morphological parts

Anatomy – simple and complex tissues, dicot, monocot root and leaf

Embryology – ovules, anther T.S.

Physiology - Osmosis – thistle funnel experiment, Photosynthesis – Beaker and Funnel experiment, Ganong's light screen and Ganong's respire scope experimental setup.

(Identification – 1, diagram – 2, Reasons – 2) (7 X 5) (35)

Total = 65

Record = 10

Grand Total = 75

Elective Courses offered to other Science Department in I and II Semesters

Semester	Elective - I	H/W	C
I	COURSE CODE: 23UZOOE15 Course Title : Zoology – I	3	2

Course Objectives

The main objectives of this course are:

1	To acquire a basic knowledge of diversity and organization of Protozoa, Coelenterata, Helminthes and Annelida
2	To acquire a basic knowledge of diversity and organization of Arthropoda, Mollusca and Echinodermata
3	To comprehend the taxonomic position and diversity among Protochordata, Pisces and Amphibia
4	To comprehend the taxonomic position and diversity among Reptilia, Aves and Mammalia
5	To acquire detailed knowledge of selected invertebrate and chordate forms

Unit - I: Diversity of Invertebrates–I

Principles of taxonomy.Criteria for classification–Symmetry and Coelom–Binomial nomenclature. Classification of Protozoa, **Porifera**, Coelenterata, Helminthes and Annelida upto classes with two examples.

Unit – II: Diversity of Invertebrates–II

Classification of Arthropoda, Mollusca and Echinodermata upto class level with examples.

Unit – III: Diversity of Chordates–I

Classification of Prochordata, Pisces and Amphibia upto orders giving two examples.

Unit – IV: Diversity of Chordates–II

Classification of Reptilia, Aves and Mammalia upto orders giving two examples.

Unit –V :Animal organization

Structure and organization of (i) Earthworm, (ii) Rabbit/Rat, (iii) Prawn/Fish

Expected Course Outcomes

On completion of this course, students will:

1	Recall the characteristic features invertebrates and chordates.
2	Classify invertebrates up to class level and chordates up to order level
3	Explain and discuss the structural and functional organisation of some invertebrates and chordates
4	Relate the adaptations and habits of animals to their habitat
5	Analyse the taxonomic position of animals.

Text Books (Latest Editions)

Ekambaranatha Iyer, - Outlines of Zoology, Viswanathan Publication.

References Books (Latest editions, and the style as given below must be strictly adhered to)

1. Ekambaranatha Iyar and T.N.Ananthakrishnian - A Manual of Zoology Invertebrata– Vol. I: Viswanathan Publishers.
2. Ekambaranatha Iyar and T.N. Ananthakrishnan, - A Manual of Zoology -Invertebrata– Vol. II: Viswanathan Publishers.
3. Ekambaranatha Iyar and T.N.Ananthakrishnan, - A Manual of Zoology: Chordata Viswanathan Publishers.
4. Jordan E.L. and P.S. Verma-Invertebrate Zoology, S. Chand & Co.

Web Resources

1. www.sanctuaryasia.com
2. www.iaszoology.com

Outcome Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO 1	S							
CO 2	M	S						
CO 3				S		S		
CO 4				S	S	M		
CO 5			S					S

S-Strong

M-Medium

L-Low

Semester	Elective - I	H/W	C
I	COURSE CODE: 23UZOOEP1 Course Title : Zoology Practical – I	2	1

Course Objectives

1	To identify the different groups of invertebrate animals by observing their external characteristics.
2	To understand the organs, organ system and their functions in lower animals.
3	To get knowledge about the different modes of life and their adaptation based on the environment.
4	Able to dissect and display the internal organs and mount the mouthparts and scales of invertebrates.

UNIT – I :Major Dissection :

Cockroach: Digestive system. Earthworm: Nervous System, *Pila globosa*: Digestive system. Prawn: Appendages. Digestive system Reproductive of fish.

UNIT – II: Minor Dissection:

Earthworm: Body setae; Pineal setae. *Pila globosa*: Radula. - Honey Bee and Mosquito mouth parts

UNIT – III: Mounting:

Fish : Placoid and Ctenoid scales

UNIT - IV: Spotters :(i).

Protozoa: Amoeba, Paramoecium, Paramoecium Binary fission and Conjugation, *Entamoeba histolytica*, *Plasmodium vivax* **(ii). Porifera:** Sycon, Spongilla, Euspongia, **(iii). Coelenterata:** Obelia – Colony & Medusa, Aurelia, Physalia, Pennatula

(iv). Platyhelminthes: Planaria, *Fasciola hepatica*, *Taenia solium*, **Nemathelminthes:** Ascaris (Male & Female), *Wuchereria* **(vi). Annelida:** Nereis, Chaetopteurs, Hirudinaria, **(vii). Arthropoda:** Palaemon, Limulus, Peripatus, **(viii). Mollusca:** Chiton, Pila, Unio, Sepia, Loligo, Nautilus, **(ix). Echinodermata:** Asterias, Echinus, Cucumaria, Antedon,

UNIT - V: Spotters :(ii).

(i) Hemichordata: Balanoglossus, **(ii). Cephalochordata:** Amphioxus, **(iii). Urochordata:** Asidian, **(iv) Cyclostomata:** Petromyzon, Myxine, **(v). Pisces:** Pristis, Torpedo, Channa, Hippocampus, Exocoetus, Echieneis, Labeo, Catla, Clarius, Anguilla, Protopterus, **(vi). Amphibia:** Ichthyophis, Hyla, Rachophous, Bufo, Rana, **(vii). Reptilia :** Draco, Chamaeleon, Gecko, Viperarusselli, Naja, Bungarus, **(viii). Aves:** Archaeopteryx, Alcedo, Columba, Corvus, **(ix). Mammalia:** Pteropus, and , Rabbit/ Rat/ squirrel.

Expected Course Outcomes

On completion of this course, students will;

1	Identify and label the external features of different groups of invertebrate animals.
2	Illustrate and examine the circulatory system, nervous system and reproductive system of invertebrate animals.
3	Differentiate and compare the structure, function and mode of life of various groups of animals.
4	To compare and distinguish the dissected internal organs of lower animals.
5	Prepare and develop the mounting procedure of economically important invertebrates.

Text Books (Latest Editions)

1. Ekambaranatha Iyyar and T. N. Ananthakrishnan, 1995 A manual of Zoology Vol.I (Part 1, 2) S. Viswanathan, Chennai.
2. Ganguly, Sinha and Adhikari, 2011. Biology of Animals: Volume I, New Central Book Agency; 3rd revised edition. 1008 pp.
3. Sinha, Chatterjee and Chattopadhyay, 2014. Advanced Practical Zoology, Books & Allied Ltd; 3rd Revised edition, 1070 pp.
4. Lal, S. S., 2016. Practical Zoology Invertebrate, Rastogi Publications.
5. Verma, P. S. 2010. A Manual of Practical Zoology: Invertebrates, S Chand, 497pp.

References Books

1. Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2002). *The Invertebrates: A New Synthesis*, III Edition, Blackwell Science.
2. Barnes, R.D. (1982). *Invertebrate Zoology*, V Edition. Holt Saunders International Edition.
3. Barrington, E.J.W and Nelson (1979). *Invertebrate Structure and Functions*. II Edition, E.L.B.S.
4. Boradale, L.A. and Potts, E.A. (1961). *Invertebrates: A Manual for the use of Students*. Asia Publishing Home.
5. Lal, S.S. 2005. A text Book of Practical Zoology: Invertebrate, Rastogi, Meerut

Web Resources

1. <https://nbb.gov.in/>
2. <http://www.agshoney.com/training.htm>
3. <https://icar.org.in/>
4. <http://www.csrtimys.res.in/>
5. <http://csb.gov.in/>
6. <https://iinrg.icar.gov.in/>
7. <https://www.nationalgeographic.com/animals/invertebrates/>

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO 1	S			S	S	S	M	
CO 2	M	S			M		L	

CO 3			M	S		S		
CO 4	S			S	S	M	S	
CO 5			S			S		S

S-Strong(3)

M-Medium (2)

L-Low (1)

Semester	Elective - II COURSE CODE: 23UZOOE25 Course Title: Zoology– II	H/W	C
II		3	2

Course Objectives

1	To enable students to learn basic concepts relating to aspects of respiratory, circulatory, excretory, nervous and sensory physiology.
2	To enable students to comprehend the processes involved during development
3	To enable students to learn basic concepts of immunity and the working of immune organs and familiarize them with the recommended vaccination schedule
4	To enable students to comprehend the basic concepts of human genetics and patterns of inheritance
5	To enable students to learn about aspects of animal behaviour such as foraging, courtship, nest construction, parental care and learning

Unit – I: Respiration- Respiratory pigments and transport of gases. Mechanism of blood clotting. Types of excretory products–Ornithine cycle. Structure of neuron–Conduction of nerve impulse, Mechanism of vision and hearing.

Unit – II: Fertilization, Cleavage, Gastrulation and Organogenesis of Frog; Placentation in mammals

Unit – III: Innate and Acquired - Active and Passive; Antigens and Antibodies; Immunological organs–responses in humans; Vaccination schedule

Unit – IV: Human Genetics: Human Chromosomes – Sex Determination in Humans; Patterns of Inheritance: Autosomal Dominant, Autosomal Recessive, X-linked, Y-linked, Mitochondrial, Multiple Allelic and Polygenic; Genetic Counseling

Unit - V: Animal Behaviour: Foraging, Courtship Behaviour, Shelter and Nest Construction, Parental Care, Learning Behaviour

Expected Course Outcomes

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

1	Recall the parts and working of body organs and developmental stages, name the patterns of inheritance and list different types of animal behaviour
2	Analyse the different developmental stages

3	Analyse the working of body and immune systems
4	Analyse the different patterns of inheritance
5	Relate the behaviour of animals to physiology. Analyse the different types of behavior

Text Books (Latest Editions)

1. Verma P.S. & Agarwal - Developmental Biology, Chordata embryology S. Chand & Co.

References Books (Latest editions, and the style as given below must be strictly adhered to)

1. Owen, J. A., Punt, J. & Stranford, S. A. Kuby Immunology. New York: W.H. Freeman & Company.
2. Klug, W. S., Cummings, M. R. & Spencer, C - Concepts of Genetics. (12th ed.). New Jersey: Pearson Education.
3. Mathur, R. Animal Behaviour. Meerut: Rastogi.
4. Verma P.S. & Agarwal. Developmental Biology, Chordata Embryology. S.Chand& Co.

Outcome Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO 1	S		S		M		S	S
CO 2	M	S						
CO 3		S	M	S		S	M	
CO 4	S			S	S	M		
CO 5			S					S

S-Strong

M-Medium

L-Low

Semester	Elective - II COURSE CODE: 23UZOOEP2 Course Title: Zoology Practical – II	H/W	C
II		2	1

Course Objectives:

1	To learn basic concepts relating to various physiological aspects of animals.
2	To comprehend the processes involved during development
3	To learn basic concepts of immunity and familiarize on immune organs.
4	To know the basic concepts of human genetics and patterns of inheritance
5	To learn about aspects of animal behaviour.

Practicals:

UNIT I: MAJOR

1. Qualitative detection of excretory products (Ammonia, Urea, Uric acid).
2. Identification of ABO blood groups.
3. Polygenic inheritance with respect to body height in human.

UNIT II: MINOR

1. Demonstration of lymphoid organs.
2. Study of behavioural adaptations of animals
3. Vital staining of chick blastoderm.
4. Y – linked inheritance (Hairy Pinna in human)

UNIT III: Spotters

1. Construction and identification of pedigree for the X – linked Dominant inheritance (Ricket), X-linked recessive inheritance (Colour blindness),
2. Identification of Human syndrome- Turner’s syndrome, Klinefelter’s Syndrome and Down’s Syndrome.

UNIT IV: Spotters

1. Frog egg,
2. Frog Cleavage – 2-cell, 4-cell & 8-cell
3. Frog – Blastula, Gastrula
4. Placenta of pig and sheep

UNIT V: Spotters

Immunological organs –Lymph node, Spleen, Thymus and Bone marrow

Expected Course Outcomes

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

1	Recall the parts and working of body organs
2	Analyse the different developmental stages
3	Analyse the functioning of body and immune systems
4	Analyse the different patterns of inheritance
5	Understand the different types of behaviour

Text Book(s)

- 1 Arumugam N. (2013). Developmental Zoology, Saras Publication, Nagercoil, Tamilnadu, India.

- 2 Das S. (2020). Microbiology Practical Manual, CBS Publication, Delhi.
- 3 Jayasurya, Arumugam N, Dulsy Fatima. (2013). Practical Zoology Vol 3, Saras Publication, Nagercoil, Tamilnadu, India.
- 4 Singh HR and Neerajkumar. (2014). Animal Physiology and Biochemistry, Vishal Publishing Co. Jalandhar, Delhi.

Outcome Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO 1	S	M		M	M	S		S
CO 2	M	S	M		S		M	
CO 3	S	M		S		S		M
CO 4	S	S		S	S	M		
CO 5	S	S	S				S	S

S-Strong

M-Medium

L-Low

SKILL ENHANCEMENT COURSES (NME)

Semester	NME – I	H/W	C
I	COURSE CODE: 23UZOON16 COURSE TITLE: Economic Zoology	2	2

Course Objectives

1. To understand the culturing techniques and production methods of different farm animals.
2. To know the life history of animals and disease control methods used in farming.
3. To understand the concept of breeding, cross breeding and the importance of high yield varieties.
4. To know about the marketing strategies.

Unit I: Economic Entomology : Apiculture: Species of honey bees – Social organisation of honey bee – selection of bees and location for apiary – Newton’s bee hive – products of bee keeping – enemies and diseases of honey bees. Sericulture: Species of silkworm – life history of mulberry silkworm – Rearing of silkworm – pests and diseases of silkworm.

Lac Culture: Introduction – Life history – Host plants – cultivation of Lac – Enemies of lac cultivation – Economic importance of Lac.

Unit II: Vermiculture : Introduction: Types of earthworms – ecological classifications of earthworms – Physical, chemical and biological changes caused by earthworms in the soil – Natural enemies of earthworms. Vermicomposting: vermicomposting methods – factors affecting vermicomposting –Vermiculture unit. Harvesting of vermicompost – vermicast – advantages of vermicompost – vermiwash and its applications.

Unit III: Aquaculture : Fresh water aquaculture: Carp culture – types of ponds – preparation – maintenance – harvesting and management. Integrated and composite culture. Prawn culture. Marine Aquaculture: Edible – pearl oyster culture. Ornamental fish culture: Aquarium fishes– Aquarium maintenance in home.

Unit IV: Poultry Farming : Poultry industry in India – Poultry for sustainable food production and livelihood - Commercial poultry farming – Nutritive value of egg and meat- Broiler management (Definition; Housing and equipment; Brooding, feeding and health cover of broilers; Record keeping; Broiler integration) – Layer management (Brooder; Grower and layer management; Culling of layers; Marketing of eggs and meat). Women in backyard poultry farming.

Unit V: Dairy Farming :Dairy farming – advantages of dairying – classification of breeds of cattle – Indigenous and exotic breeds – Selection of dairy cattle. Breeding – artificial insemination – Dairy cattle management – housing – water supply – cattle nutrition feeding standards – Common contagious

diseases. Milk - Composition of milk – milk spoilage – pasteurization – Role of milk and milk products in human nutrition – Dairying as a source of additional income and employment.

Text Books

1. Sastry, N.S.R., C.K.Thomas and R.A.Singh, 2015. Livestock Production Management, 4thEd.Kalyani Publishers, New Delhi.
2. Mary violet Christy, A. 2014. Vermitechnology, MJP Publishers, Chennai.
3. ICAR, 2013. Hand book of Animal Husbandry, 4th Ed., ICAR Publication, Pusa, New Delhi.
4. Awasthi, V.B., 2012. Introduction to General and Applied Entomology, third edition, Scientific publishers, India.
5. Vasanthraj David, B and Ramamurthy, VV., 2012. Elements of Economic Entomology, Seventh edition, Namrutha publications, Chennai.
6. Shukla &Upadhyay, 2014. Economic Zoology, 5th edn. Rastogi Publication, Meerut New Delhi.
7. Gupta, S.M., 2010. Text book of fishery, Ann Backer, Mumbai.
8. ShailendraGhosh, 2009. Fisheries and aquaculture management, Adhyayan, New Delhi.
9. David, B and Ananthakrishnan, T. N., 2006. General and Applied Entomology, Second edition, Tata McGraw hill publishing company Ltd., New Delhi, India.
10. Jagadish Prasad, 2002. Principles and practices of Dairy Farm Management, 3rd Ed. Kalyani Publishers, Ludhiana.
11. Sukumar, D.E., 2002. Outline of Dairy Technology, Oxford University, New Delhi.
12. Rath, R.K., 2000. Freshwater Aquaculture. Scientific Publishers (India), Jodhpur.
13. Ismail, S.A., 1997. Vermitechnology, The biology of earthworms, Orient Longman, India.
14. Prabakaran, R. 1998. Commercial Chicken production. Published by P. Saranya, Chennai.
15. Hafez, E. S. E., 1962. Reproduction in Farm Animals, Lea &Fabiger Publisher.

Suggested Readings

1. Glenn Munroe, 2017. Manual of on-Farm vermicomposting and vermiculture, Holdanca Farms Ltd, Wallace, Nova Scotia.
2. Hanifa, M.A., 2011. Aquatic resources and aquaculture, Dominent, New Delhi.
3. Gupta, P.K., 2008. Vermicomposting for sustainable agriculture, 2nd Edition, Agrobios, India.
4. Talashikar, S.C., 2008. Earthworms in Agriculture, Agrobios, India.
5. Abishek Shukla, D ., 2 0 0 9 . A Hand Book of Economic Entomology, Vedamse Books, New Delhi .
6. Banerjee, G.C., 2006. Text book of Animal Husbandry 8thEd.Oxford and IBH Publishing Company Ltd., New Delhi.
7. Walstra, P. Wouters, J.T.M. and Geurts, T.J. 2006. Dairy Science and Technology. CRC Press, New York.
8. Dunham, R.A., 2004. Aquaculture and Fisheries Biotechnology Genetic Approaches. CABI publications, U.K.
9. Donald.D Bell and William. D. Weaver, 2002. Commercial chicken meat and egg production, Springer, New York.
10. Eckles C.H. and Anthony, E.L., 2001. Dairy Cattle and milk production, Biotech. Tata McGraw Hill Publishing Co.Pvt.Ltd., New Delhi.

11. Edwards, C.A., and Bother, B., 1996. Biology of earthworms, Chapman Hall Publication company.
12. ICAR, 1997. Handbook of Animal Husbandary– The Indian Council of Agricultural Research, New Delhi.
13. Banerjee G.C., 1992. Poultry, Oxford and IBH, New Delhi.
14. Jhingran, AVG, 1991. Fish and Fisheries of India. Hindustan Publishing Co. New Delhi.
15. James. N. Marner, 1975. Principles of dairy processing, wiley eastern limited, New Delhi.
16. Baradach, JE. Ryther. JH. and, MC larney WO., 1972. Aquaculture. The farming and Husbandry of Freshwater and Marine Organisms. Wiley InterScience, NewYork.

Web Resources

1. <https://bit.ly/3tXHjk8>
2. <https://bit.ly/3tUTHBu>
3. <https://bit.ly/3hVv96q>
4. <https://bit.ly/39nztH1>
5. <https://bit.ly/3CzasVO>
6. https://agritech.tnau.ac.in/org_farm/orgfarm_vermicompost.html
7. <https://bit.ly/3nYvgSF>
8. <http://caa.gov.in/farms.html>
9. <http://www.csrtimys.res.in/>
10. <http://www.agshoney.com/training.htm>

Course Outcomes (COs)

1. To identify the breeds and varieties of poultry, fish, bees, and cattle and understand the basic aspects of farming.
2. To assess and integrate the available tools and techniques to increase the productivity in farms.
3. To analyse the pros and cons of different methods of farming and marketing strategies of products.
4. To evaluate the use of available resources in improving the breeds, vermicomposting, farm products etc..
5. To design new methods to improve farm animals with increased productivity and disease resistance and to construct new methods in vermicomposting.

Semester	NME - II	H/W	C
II	COURSE CODE:23UZOON26 Ornamental Fish Farming& Management	2	2

Course Objectives (LOs):

1	To highlight the importance of ornamental fish culture in relation to entrepreneurship development.
2	To enable the identification, culture and maintenance of commercially important ornamental fishes.
3	To provide the knowledge on the techniques of ornamental fish breeding, rearing, disease control and economics of ornamental fish farming.

Unit I: Introduction to ornamental fish keeping. Scope and importance of ornamental fish culture. Domestic and global scenario of ornamental fish trade and export potential. Commercially important ornamental fishes - Indigenous and exotic varieties.

Unit II: Biology of egg layers and live bearers. Food and feeding in ornamental fishes. Formulated feed and Live feed; Live feed culture. Breeding, hatchery and nursery management of egg layers (eg. Goldfish) and live bearers (eg. Guppy).

Unit III: Aquarium design and construction; Accessories - aerators, filters and lighting. Aquarium plants and their propagation. Maintenance of aquarium and water quality management.

Unit IV: Disease management of Ornamental fishes(symptoms, Life cycle, and their prevention, control and treatment methods. Protozoan diseases, Bacterial diseases, crustacean diseases, Fungal diseases and Helminth diseases

Unit V: Conditioning, packing, transport and quarantine methods. Economics, trade regulations, domestic and export marketing strategies.

References:

1. Swain SK., Sarangi N. and Ayyappan S. 2010. Ornamental fish farming. ICAR, New Delhi.
2. Living Jewels – A handbook on freshwater ornamental fish, MPEDA, Kochi.
3. Dey V.K.A. 1997. A handbook on aquafarming ornamental fishes. MPEDA, Kochi.
4. Ahilan, B., Felix N. and Santhanam R. 2008. Text book of aquaculture. Daya Publishing House, New Delhi.

Web links:

1. <http://ecoursesonline.iasri.res.in/course/view.php?id=297>
2. <https://www.ofish.org/>
3. <https://krishijagran.com/agripedia/income-generation-by-ornamental-fish-culture/>
4. <https://99businessideas.com/ornamental-fish-farming/>

Expected Course Outcomes (COs)

1	The students will be able to identify, culture, maintain and market the commercially important ornamental fishes.
2	The knowledge and skills gained on the different aspects of ornamental fish keeping will enable the students to develop entrepreneurship potential and

	help in self employment.
--	--------------------------

Outcome Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO 1	S				M			S
CO 2	M	S					S	
CO 3				S		S		
CO 4	M			S	S	M		
CO 5			S				M	S

S-Strong

M-Medium

L-Low

SECOND YEAR

Semester	CORE – V	H/W	C
III	Course Code: 23UZOOC33 Course Title: CELL AND MOLECULAR BIOLOGY	5	5

Course Objectives :

1	To understand the structures and purposes of basic components of prokaryotic and eukaryotic cells, and technique used to study the cells.
2	To understand the procedure of histological techniques and staining.
3	To understand structure, functions and composition of various cell organelles.
4	To understand molecular concepts Chromosome and Cell Division
5	To understand types, structure and chemical composition of Macromolecule DNA and RNA.

UNIT I

History of Cell Biology: Cell - Prokaryotic and Eukaryotic (General organization).

Methods of cell study: Cell Fractionation, Homogenization, Centrifugation, Isolation of subcellular Components. Microscopy – Dissection, Compound, Phase contrast, Unit of measurement (micrometry).

UNIT II

Micro Technique; Histological techniques - Staining - Vital Stains. – Cytoplasmic and Nuclear Stains. Ultra structure and functions: Plasma membrane.

UNIT III

Cell components - Structure and Function of Endoplasmic reticulum, Golgi Complex, Mitochondria, Ribosomes, Lysosomes, Centrioles, Nucleus and Nucleolus.

UNIT IV

Ultra structure and functions: Chromosome, Polytene and lamp brush chromosomes

Cell Division: Mitosis and Meiosis

Biology of cancer cell: Causes, types and treatment.

Ageing of Cells – Apoptosis and Stem cell studies.

UNIT V

Molecular Biology: Types, structure and chemical composition: DNA and RNA

Replication of DNA: Semi conservative – Unidirectional and Bi-directional replication in eukaryotic chromosome. Genetic code: properties and importance. Protein synthesis: Transcription and Translation in eukaryotes.

Expected Course Outcomes (COs)

At the end of the course, the student will be able to

1	Understand and recall the basic structure, origin and development of cell organelles.
2	Integrate and assess the cytological and histological tools to infer cellular basis of organization.
3	Explain the role of cells and cell organelles in various biological processes.
4	Get the knowledge on the structure of chromosome, cell division and cell cycle.
5	Understand the types, structure and chemical composition of DNA and RNA

Text Books (Latest Editions)

1. Ambrose, E.J. and Dorothy, M. Easty, 1970. Cell Biology, Thomas Nelson & Sons Ltd., 500 pp.
2. Kumar P. and Mina U. (2018) Life Sciences: Fundamentals and Practice, Part-I, 6th Edn., Pathfinder Publication. p.608.
3. VeerBala Rastogi, Molecular Biology. Rastogi Publications, Meerut 250 001.
4. Verma, P.S. and V. K. Agarwal, 1995. Cell and Molecular Biology, 8th Edition, S.Chand & co., New Delhi - 110 055, 567 pp.
5. Verma P.S. and Agarwal V.K. (2016) Cell Biology (Cytology, Biomolecules, Molecular Biology), Paperback, S. Chand and Company Ltd.

References Books (Latest editions, and the style as given below must be strictly adhered to)

1. Albert B., Hopkin K., Johnson A.D., Morgan D., Raff M., Roberts K. and Walter P. (2018). Essential Cell Biology 5th Edn.,(paperback) W.W. Norton & Company p.864.
2. Burke, Jack. D., 1970. Cell Biology, Scientific Book Agency, Calcutta.
3. Challoner J. (2015) The Cell: A visual tour of the building block of life, The University of Chicago Press and Ivy Press Ltd., p.193.
4. Cohn, N. S., 1979, Elements of Cytology, Freeman Book Co., New Delhi – 110007, 495 pp
5. Cooper G.M. (2019) The Cell – A Molecular Approach, 8th Edn., Sinauer Associates Inc., Oxford University Press p.813.
6. DeRobertis, E.D.P. and E.M.F. De Robertis, 1988. Cell and Molecular Biology, 8th Edition, International Edition, Info med, Hong Kong, 734pp.
7. Dowben, R., 1971. Cell Biology, Harper International Edition. Harper and Row Publisher, New York, 565 pp.
8. Giese, A.C., 1979. Cell Physiology, Saunders Co., Philadelphia, London, Toronto, 609 pp.
9. Hardin J. and Bertoni G. (2017) Becker's World of the Cell. 9th Edn (Global Edition). Pearson Education Ltd., p. 923
10. Karp G., Iwasa J. and Masall W. (2015) Karp's Cell and Molecular Biology Concepts and Experiments. 8th Edn. John Wiley and Sons. p.832.
11. Loewy, A.G. and P.Sickevitz, 1969. Cell Structure and Function, Amerind Publishing Co., NewDeihi - 110 020, 516 pp.
12. Mason K.A., Losos J.B. and Singer S.R. (2011) Raven and Johnson's Biology. 9th Edn. Mc Graw Hill publications. p.1406.
13. Powar, C.B., 1989. Essential of Cytology, Himalaya Publishing House, Bombay - 400 004, 368 pp.
14. Swansen, C.P. and P.L.Webster, 1989. The Cell, Prentice Hall of India Pvt. Ltd., New Delhi - 110 001, 373 pp.
15. Urry L.A. Cain M.L., Wasserman S.A., Minorsky P.V., Jackson R.B. and Reece J.B. (2014) Campbell Biology in Focus. Pearson Education. p.1080.

Web Resources

1. <http://www.microscopemaster.com/organelles.html>

2. <https://bit.ly/3tXwDSB>
3. <https://bit.ly/3tWNpRX>
4. <https://bit.ly/3AuYR9M>
5. <https://rsscience.com/cell-organelles-and-their-functions>

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO 1	S							
CO 2		S	S	S	S			S
CO 3		S	S	S	S	S		S
CO 4		S	M			M		
CO 5				S	S	S		S

S-Strong(3) M-Medium (2) L-Low (1)

Semester	CORE – VI	H/W	C
III	Course Code: 23UZOOP34 Course Title: PRACTICAL III : CELL AND MOLECULAR BIOLOGY	3	5

Course Objectives :

1	To understand the structures and purposes of basic components of prokaryotic and eukaryotic cells, and technique used to study the cells.
2	To understand the procedure of histological techniques and staining.
3	To understand structure, functions and composition of various cell organelles.
4	To understand molecular concepts Chromosome and Cell Division
5	To understand types, structure and chemical composition of Macromolecule DNA and RNA.

Unit I: Cytometry

Light and Compound microscope - principles and functions, camera Lucida, Stage and Ocular Micrometers.

Unit II:

Identification of drumstick chromosome from human blood smear preparation.

Identification of Barr body from human buccal epithelial smear preparation.

Squash preparation of Onion root tip for identification of different stages of Mitosis.

Unit III:

Squash preparation of Grass hopper testes/ Onion flower bud for identification of different stages of Meiosis. Squash preparation of Salivary glands of chironomous larva to observe polytene chromosome.

Unit IV: Spotters

Observation of Eukaryotic cell types –Columnar Epithelial cell, Buccal Epithelial cell, Liver, Pancreas and muscle using permanent slides; Observation of meiotic cell division stages using permanent slides;

Unit V: Spotters

Model of DNA chemical composition, DNA double helical structure, DNA replication, RNA structure. Model of Protein Synthesis

Expected Course Outcomes (COs)

At the end of the course, the student will be able to

1	Students will learn the practical knowledge about principle and working procedure of microscope.
2	Identify various stages of cell divisions and giant chromosome structure.
3	Explain the role of cells and cell organelles in various biological processes.

4	Get the knowledge on the structure of chromosome, cell division and cell cycle.
5	Understand the types, structure and chemical composition of DNA and RNA

Text Books

1. Veer Bala Rastogi. (2019). *A Text book of Cell Biology and Genetics*. Kedar Nath Ram Nath Publication, Meerut. U.P.
2. Verma, P.S. and Agarwal, V.K. (2013). *Cell Biology, Genetics, Molecular Biology, Evolution and Ecology*. S. Chand & Company Ltd, New Delhi.
3. Powar, C.B., (2012). *Cell Biology*. Himalaya Publishing house, Mumbai.
4. Gupta P.K. (2009). *Genetics*. Rastogi Publication Ltd., New Delhi
5. Singh. H.G, Y.S. Chauhan, and R.P. Katiyar. (1988). *A manual of Practical genetics*. Kalyani Publishers. New Delhi, Ludhiana

Reference Books

1. Lodish et al., Molecular cell Biology, 4thEdition, W.H. Freeman & Company, 2000.
2. Smith & Wood, Cell Biology, 2ndEdition, Chapman & Hall, London, 1996.
3. Watson et al., Molecular Biology of the gene, 5th Edition, Pearson Prentice Hall. USA, 2003.
4. B. M. Turner, Chromatin & Gene regulation, 1st Edition, Wiley- Blackwell, 2002.
6. Benjamin Lewin, Gene IX, 9thEdition, Jones and Barlett Publishers, 2007.

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO 1	S							
CO 2		S	S	S	S			S
CO 3		S	S	S	S	S		S
CO 4		S	M			M		
CO 5				S	S	S		S

S-Strong(3) M-Medium (2) L-Low (1)

Title of the Course	CHEMISTRY FOR BIOLOGICAL SCIENCES I (FOR BOTANY AND ZOOLOGY STUDENTS)						
Course Code	23UCHEE35						
Category	Generic Elective	Year	II	Credits	2	Course Code	
		Semester	III				
Instructional hours per week	Lecture	Tutorial	Lab Practice		Total		
	3	-	-		3		
Prerequisites	Higher secondary chemistry						
Objectives of the course	This course aims at providing knowledge on - basics of atomic orbitals, chemical bonds, hybridization and fundamentals of organic chemistry - nuclear chemistry and industrial chemistry - importance of speciality drugs and - separation and purification techniques.						
Course Outline	UNIT I Chemical Bonding and Nuclear Chemistry Chemical Bonding: Molecular Orbital Theory-bonding, antibonding and non-bonding orbitals. M. O diagrams for Hydrogen, Helium, Nitrogen; discussion of bond order and magnetic properties. Nuclear Chemistry: Fundamental particles - Isotopes, Isobars, Isotones and Isomers-Differences between chemical reactions and nuclear reactions- group displacement law. Nuclear binding energy - mass defect - calculations. Nuclear fission and nuclear fusion - differences – Stellar energy. Applications of radioisotopes - carbon dating, rock dating and medicinal applications. Unit II Industrial Chemistry Fuels: Fuel gases: Natural gas, water gas, semi water gas, carbureted water gas, producer gas, CNG, LPG and oil gas (manufacturing details not required). Silicones: Synthesis, properties and uses of silicones. Fertilizers: Urea, ammonium sulphate, potassium nitrate NPK fertilizer, superphosphate, triple superphosphate. UNIT III Fundamental Concepts in Organic Chemistry Hybridization: Orbital overlap hybridization and geometry of CH₄, C₂H₄, C₂H₂ and C₆H₆. Polar effects: Inductive effect and						

	consequences on K_a and K_b of organic acids and bases, electromeric, mesomeric, hyper conjugation and steric-examples and explanation. Reaction mechanisms: Types of reactions- aromaticity-aromatic electrophilic substitution; nitration, halogenation, Friedel-Craft's alkylation and acylation. Heterocyclic compounds: Preparation, properties of pyrrole and pyridine. UNIT IV Drugs and Speciality Chemicals Definition, structure and uses: Antibiotics viz., Penicillin, Chloramphenicol and Streptomycin; Anaesthetics viz., Chloroform and ether; Antipyretics viz., aspirin, paracetamol and ibuprofen; Artificial Sweeteners viz., saccharin, Aspartame and cyclamate; Organic Halogen compounds viz., Freon, Teflon. UNIT V: Analytical Chemistry Introduction qualitative and quantitative analysis. Principles of volumetric analysis. Separation and purification techniques: extraction, distillation and crystallization. Chromatography: principle and application of column, paper and thin layer chromatography.
Extended Component (is a part of internal component only, Not to be included in the external Examination question paper)	Professional Questions related to the above topics, from various competitive examinations UPSC/ JAM /TNPSC others to be solved (To be discussed during the Tutorial hours)
Skills acquired from this course	Knowledge, Problem solving, Analytical ability, Professional Competency, Professional Communication and Transferable skills.
Recommended Text	1. V.Veeraiyan, Textbook of Ancillary Chemistry; High mount publishing house, Chennai, first edition,2009. 2. S.Vaithyanathan, Text book of Ancillary Chemistry; Priya Publications, Karur,2006. 3. ArunBahl, B.S.Bahl, Advanced Organic Chemistry; S.Chand and Company, New Delhi, twenty third edition,2012. 4. P.L.Soni, H.M.Chawla, Text Book of Inorganic Chemistry; Sultan Chand & sons, New Delhi, twenty ninth edition, 2007.

Reference Books	1. P.L.Soni, Mohan Katyal, Text book of Inorganic chemistry; Sultan Chand and Company, New Delhi, twentieth edition, 2007. 2. B.K,Sharma, Industrial Chemistry; GOEL publishing house, Meerut, sixteenth edition, 2014. 3. Jayashree gosh, Fundamental Concepts of Applied Chemistry; Sultan & Chand, Edition 2006.
Course Learning Outcomes (for Mapping with POs and PSOs) On completion of the course the students should be able to CO1: state the theories of chemical bonding, nuclear reactions and its applications. CO 2: evaluate the efficiencies and uses of various fuels and fertilizers. CO 3: explain the type of hybridization, electronic effect and mechanism involved in the organic reactions. CO 4: demonstrate the structure and uses of antibiotics, anaesthetics, antipyretics and artificial sugars. CO 5: analyse various methods to identify an appropriate method for the separation of chemical components.	

CO /PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to PSOs	3.0	3.0	3.0	3.0	3.0

Level of Correlation between PSO's and CO's

CO /PO	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15

Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0
--	-----	-----	-----	-----	-----

Level of Correlation between PO's and CO's

Title of the Course	CHEMISTRY PRACTICAL FOR BIOLOGICAL SCIENCES – I (for Botany and Zoology II Year/III Semester)						
Course Code	23UCHEEP3						
Category	Generic Elective	Year Semester	I/ II I/III	Credits	1	Cours e Code	
Instructional hours per week	Lecture	Tutorial	Lab Practice		Total		
	-	-	2		2		
Prerequisites							
Objectives of the course	This course aims to provide knowledge on the - basics of preparation of solutions. - principles and practical experience of volumetric analysis						
Course Outline	VOLUMETRIC ANALYSIS 1. Estimation of sodium hydroxide using standard sodium carbonate. 2. Estimation of hydrochloric acid using standard oxalic acid. 3. Estimation of ferrous sulphate using standard Mohr's salt. 4. Estimation of oxalic acid using standard ferrous sulphate. 5. Estimation of potassium permanganate using standard sodium hydroxide. 6. Estimation of magnesium using EDTA. 7. Estimation of ferrous ion using diphenyl amine as indicator.						
Reference Books	V.Venkateswaran, R.Veerasingam, A.R.Kulandaivelu, Basic Principles of Practical Chemistry; Sultan Chand & sons, Second edition, 1997.						
Course Learning Outcomes (for Mapping with POs and PSOs) On completion of the course the students should be able to CO 1: gain an understanding of the use of standard flask and volumetric pipettes, burette. CO 2: design, carry out, record and interpret the results of volumetric titration. CO 3: apply their skill in the analysis of water/hardness. CO4: analyze the chemical constituents in allied chemical products							

CO /PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
Weightage	12	12	12	12	12
Weighted percentage of Course Contribution to PSOs	3.0	3.0	3.0	3.0	3.0

Level of Correlation between PSO's and CO's

CO /PO	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
Weightage	12	12	12	12	12
Weighted percentage of Course Contribution to POs	3.0	3.0	3.0	3.0	3.0

Level of Correlation between PO's and CO's

Semester	SKILL ENHANCEMENT COURSE - IV	H/W	C
III	Course Code: 23UZOOS36-1 Course Title: APICULTURE	1	1

Course Objectives :

1	To acquire knowledge of different species of honey bees and their biology.
2	To understand the social organization and behaviour of bees.
3	To gain the knowledge of tools required in Bee Keeping and hive maintenance.
4	To obtain the knowledge to protect the bee hives from enemies and diseases.
5	To acquire Knowledge of harvesting bee products from the combs and work out business plan and economics of apiculture.

Unit I : Basics of Beekeeping

History of bee keeping: Scope and advantages of beekeeping.

Honey bee species and identification: Species of honey bees and their identification characters - *Apis dorsata*, *A. florea* and *A. cerana indica*, *A. mellifera*.

Biology and life history of honeybees: Egg, larva, pupa and adult - characteristics.

Unit II: Organization and Behaviour

Social organization of honeybees: Structural and functional differences – Queen bee – Drone bee – Worker bee.

Behaviour of honeybees: Bee dances – types (round and Wag tail) and purposes; nuptial flight and purposes.

Unit III: Basic requirements & Management

Bee keeping Equipments: Newton's and Langstroth bee hive, smoker, bee veil, knife, honey extractor, queen excluder, queen gate, comb foundation, feeder.

Management of bee hive: Seasonal management – summer and winter, dearth and flow seasons; Artificial feeding - sugar solution; Swarming and colony multiplication.

Unit IV: Enemies & Diseases

Natural Enemies: Wax-moth, wasp, ants- their control measures.

Diseases: Brood diseases - Bacterial (American Foul brood), Virus (Sac brood), Fungal (Chalk brood) - their control measures.

Unit V: Bee Products

Bee products: Honey, bee wax, propolis, royal jelly, bee venom, pollen – methods of collection, processing and uses. Economics: Economics of Apiculture.

Expected Course Outcomes (COs)

At the end of the course, the student will be able to

1	Appreciate the importance of beekeeping and understand the basic biology of honey bees.
2	Understand the social life of honey bee and importance of behavior.
3	Select suitable area and species of bees for Bee keeping and maintain the

	Beehives in a scientific way.
4	Maintain the Bee hives in a healthy condition.
5	Understand the methodologies of in extracting, preservation of bee products and establish bee keeping unit and run it profitably.

Text Books

1. Jayashree, Tharadevi and Arumugam. (2018). *Apiculture*. Saras publications, Nagarkoil, India.
2. Tamilselvi, M. and Abdul Ali. (2018). *A text book for Apiculture*. Vijay Nicole publications, Chennai, India.
3. Abrol, D.P. (2013). *Beekeeping: A Comprehensive guide to bee and beekeeping*. Scientific Publishers, India.
4. T.V. Sathe (2006), *Fundamentals of Beekeeping*. Daya publish's house. Delhi

Supplementary Readings

1. Mahindru. S.N. (2014). *Beekeeping*. APH. Publishing Corporation, New Delhi, India.
2. Stuart. F.S, (2010). *Beekeeping practice*, Axis Books, India.
3. Wheeler, W.M. (2006). *Social Insects their origin and evolution*. Discovery publishing house, New Delhi.
4. George. A, Carter, (2004). *Beekeeping*. A guide to the better understanding of Bees, their disease and the chemistry of Beekeeping. Biotech Books. Delhi.
5. Mishra, R. C. and R. Garg. (2002). *Perspectives in Indian Apiculture*. Agrobios Publication, India.
6. Phillips, E.F. (2001). *Beekeeping*. Agrobios Publication, Jodhpur, India.

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO 1	S							
CO 2		S	S	S	S			S
CO 3		S	S	S	S	S		S
CO 4		S	M			M		
CO 5				S	S	S		S

S-Strong(3) M-Medium (2) L-Low (1)

Semester	SKILL ENHANCEMENT COURSE - IV	H/W	C
III	Course Code: 23UZOOS36-2 Course Title: BASICS OF MARINE BIOLOGY	1	1

COURSE OBJECTIVES

1	To understand and learn the physical, chemical and biological aspects of marine environment and to gain knowledge about the management of oceans.
2	To introduce students to the marine environment and its indigenous organisms.
3	To study the principles, concepts and facts through which the student can better understand and appreciate the nature of the sea and its inhabitants.
4	To acquaint the student with the characteristics used to identify and classify marine plants and animals
5	to develop an awareness of the career possibilities available to students in this area.

Unit I: Marine Ecology : Marine environment- ecological factors- light, temperature, salinity, pressure; Classification of marine environment; Pelagic environment – Planktonic and Nektonic adaptations; Benthic environment - intertidal, interstitial and deep sea adaptations; Distribution and ecological role of other coastal environments - coral reefs, estuaries, mangroves, seagrass beds, kelp forests polar seas and hydrothermal vents.

Unit II: Physical Oceanography : Physical Properties of Seawater- density, viscosity, surface tension, conductivity and their relationship; temperature distribution in the sea – heat budget, UV radiation; El Nino/La Nina – global impact; Dynamics of the ocean-general surface circulation, Waves, Currents and Tides, Tsunami.

Unit III: Chemical Oceanography : Chemical composition of seawater- ionic, major and minor constituents, constancy- ionic compositions and factors affecting constancy- major and minor elements, trace elements- their importance, distribution. Chemistry of seawater constituents- concept of chlorinity and salinity - methods of measurements, nutrients - biogeochemical cycles.

Unit IV: Biological Oceanography : Sea as a biological environment- Plankton- classification based on size, mode of life and habitat. Phytoplankton and Zooplankton - methods of collection, estimation of standing crop-wet and dry weight estimation-plankton volume settling and displacement methods. Oxidation as carbon (as organic matter). Primary productivity – estimation and factors affecting primary productivity.

Unit V: Marine Pollution and Ocean Management : Ocean pollution- kinds and quantities of pollutants, toxic effects and control measures – oil spills, plastics, nuclear waste disposal in marine environment, Eutrophication. Role of National and international agencies and organizations in ocean management- FAO, UNEP, DOD, WOCE, WHOI, IOI Malta, IMO INMARSAT- IUCN, SCAR, SCOR, Marpol, Traffic. Ocean policy (India) - research and management.

Expected Course Outcomes (COs)

At the end of the course, the student will be able to

1	Define marine ecosystem, recognize and describe the interrelationship between biology and ocean technology.
2	Articulate and classify the dynamics and physical attributes of the ocean, interpret the factors which affect the global climate.
3	Identify and analyze the physical and biological factors of marine environments, and focus life in the open sea.
4	Evaluate the impact of variations in abiotic factors in marine productivity and justify the role of human activities in the degradation of marine ecosystems.
5	Categorize marine pollutants and develop controlling measures in collaboration with the institutions for ocean management.

Text Books

1. Thurman, Harold., 2001 Introduction to Oceanography, Prentice Hall Inc. New Jersey. 506 pp.
2. Bertness, M.D, S. D. Gaines and M.K. Hay 2000. Marine Community Ecology Sinauer Associates.
3. Grant Gross, M., 1993 Oceanography: A view of the earth (sixth edition). Prentice Hall Inc. New Jersey.
4. Fincham A. A, 1984. Basic Marine Biology. Cambridge University Press, England. 157 pp.
5. John Resch Jr. 1979, Marine Biology. Reston Publishing Company, Virginia. 257 pp.

Suggested Readings

1. Barbara E. Curry, 2016. Advances in Marine Biology, Volume 74, 1st Edition. Academic Press ISBN: 9780128036075
2. Peter Castro, Michael E. Huber, 2015. Marine Biology; Series Botany, Zoology, Ecology and Evolution. McGraw-Hill Education.
3. Philip V. Mladenov, 2013 Marine Biology: A very short introduction, 1st Edition. Oxford University Press.
4. Venkataraman K, Raghunathan C, Raghuraman R, Sreeraj C. R, 2012. Marine diversity in India. Zoological Survey of India, Kolkata. 178 pp.
5. Amy Hill. 2002. Marine Biology: An Introduction to Ocean Ecosystems (Marine Biology Ser) Walch publishing.
6. Pickard, G.L. and W.J. Emery 1995. Descriptive Physical Oceanography. Pergamon Press, London.
7. Gage. J.D. and P.A. Tyler, 1991. Deep Sea Biology, Cambridge University Press, Cambridge
8. Raymont J. E. G., 1980. Plankton and Productivity in the oceans: Volume 1: Phytoplankton, Pergamon Press.
9. Van Der Spoel, S. and Pierrot-Bults, A. C (Eds) 1979. Zoogeography and diversity of plankton. Bungs Scientific Publishers Utrecht, 410pp.
10. Riley, J.P. and Skirrow, 1975-1984. Chemical Oceanography. Vols. 1 to 8. Academic Press, London

Web Resources

1. <https://www.livescience.com>
2. <https://www.icriforum.org>
3. <https://www.cbd.int>

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO 1	S							
CO 2	M	S						
CO 3				S		S		
CO 4				S	S	M		
CO 5			S					S

1. **S-Strong**

M-Medium

L-Low

Semester	SKILL ENHANCEMENT COURSE - V Course Code: 23UZOOS37-1 Course Title: ANIMAL BEHAVIOUR	H/W	C
III		2	2

COURSE OBJECTIVES

1	To learn the origin and development of animal behaviour and to understand the influence of genetics, environment on animal behaviours.
2	To understand the biological properties of animal behavior, with an evolutionary and ecological emphasis.
3	To Compare innate and learned behavior and differentiate between various mating system.
4	To impart the knowledge about visual and auditory communication; courtship, mate choice, and mating systems; social behavior and social systems; and animal personality.
5	To discuss how movement and migration behaviors are a result of natural selection

Unit I: Genetics and Behaviour : Genetic material, Genes and chromosomes, Genetic variation, Single and Polygenic inheritance of behaviour, Heritability of behaviour, Natural selection and behaviour, Frequency distribution of phenotypes, Darwinian fitness.

Unit II: Evolution and Social Behaviour : Sexual selection, Altruism, Sexual strategy and social organisation, Animal perception, Neural control of behaviour, Sensory processes and perception, Visual adaptations to unfavourable environments.

Unit III: Animal and the Environment: Coordination and Orientation, Homeostasis and Behaviour, Physiology and Behaviour in changing environments, Animal Learning, Conditioning and Learning, Biological aspects of learning, Cognitive aspects of learning.

Unit IV: Understanding Complex Behaviour : Instinct and learning, Displacement activities, Ritualization and Communication, Decision making behaviour in Animals, Complex behaviour of honey bees, Evolutionary optimality, Mechanism of Decision making. The mentality of Animals : Languages and mental representation, non-verbal communication in human, mental images, Intelligence, tool use and culture, Animal awareness and Emotion.

Unit V: Chronobiology : Organization of circadian system in multicellular animals; Concept of central and peripheral clock system; Circadian pacemaker system in invertebrates with particular reference to Drosophila; Photoreception and photo- transduction; The physiological clock and measurement of day length; Molecular bases of seasonality; The relevance of biological clocks for human welfare - Clock function (dysfunction); Human health and diseases - Chronopharmacology, chronomedicine, chronotherapy.

Expected Course Outcomes (COs)

At the end of the course, the student will be able to

1	Recall and record genetic basis and evolutionary history of behaviour.
---	--

2	Classify movement and migration behaviors and explain environmental influence upon behaviour.
3	Analyze and identify innate, learned and cognitive behavior and differentiate between various mating systems.
4	Assess complexity involved in behavioural traits and evaluate hormones and their role in aggression and reproduction
5	Discuss the rhythmicity of behavioural expressions and the scientific concepts in behavior and behavioral ecology

Text Books

1. David McFarland, 1985. Animal Behaviour, Longman Scientific & Technical, UK. 576pp.
2. Harjindra Singh, 1990. A Text Book of Animal Behaviour, Anomol Publication, 293pp.
3. Hoshang S. Gundevia and Hare Govind Singh, 1996. Animal Behaviour, S. Chand & Co, 280pp.
4. Shukla, J. P 2010, Fundamentals of Animal Behaviour, Atlantic, 587pp.
5. Vinod Kumar, 2002. Biological Rhythms. Narosa Publishing House, Delhi.

Suggested Readings

1. Michael D. Breed and Janice Moore, 2012. Animal Behaviour, Academic Press, USA, 359pp.
2. Aubrey Manning and Martin Stamp Dawkins, 2012. An Introduction to Animal Behaviour, 6th Edition, Cambridge University Press, UK. 458pp.
3. Davis E. Davis, 1970. Integral Animal Behaviour, Mac Millan Company, London, 118pp.
4. Jay, C. Dunlap, Jennifer, J. Loros, Patricia J. De Coursey (ed). 2004. Chronobiology Biological time Keeping, Sinauer Associates Inc, Publishers, Sunderland, MA.

Web Resources

1. <https://www.ncbs.res.in/content/animal-behaviour>
2. <https://bit.ly/3i6wUxR>
3. <https://www.behaviour.univie.ac.at/>
4. <https://www.ru.nl/bsi/>

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO 1	S							
CO 2	M	S						
CO 3				S		S		
CO 4				S	S	M		
CO 5			S					S

2. S-Strong M-Medium L-Low

Semester	SKILL ENHANCEMENT COURSE - V	H/W	C
III	Course Code: 23UZOOS37-2 Course Title: NANO BIOLOGY	2	2

COURSE OBJECTIVES

1	This course provides knowledge about the basic concepts of nanobiology.
2	Learners will be able to acquire skills about the assembly, design and types of nanomaterials and nanoparticles.
3	To study the Composition and functional properties of nanostructures
4	To know the Strategies to design biologically active nanostructure-based biomaterials
5	They will be able to appreciate the applications of nanobiology in diverse fields.

Unit-I: Nanobiology- Definition-concepts and scope. History of nanotechnology and nanoscience in nature; Structure and Properties of nanomaterials: size, surface charge, conductivity, optical properties, and biocompatibility.

Unit-II: Synthesis and characterization of nanomaterials, Fabrication of nanostructures, Metallic nanoparticles, semiconductor, biopolymeric nano-structures and nanoparticles.

Unit-III: Composition and functional properties of nanostructures: Protein and peptide-based nanostructures, carbohydrate and nucleic acid-based nanomaterials; Use of gold, silver and other metallic nanoparticles.

Unit-IV: Strategies to design biologically active nanostructure-based biomaterials. Interaction of nanoparticles with biomolecules to study their conformational and functional properties.

Unit-V: Biological Applications of Nanomaterials and nanoparticles – therapeutics – biomaterials - Immobilized enzymes - drug delivery systems – Biosensors - Cellular imaging tools and diagnostics.

Expected Course Outcomes (CO)

At the end of the course, the student will be able to

1	Understand basics of Nano-science and Nano-biology.
2	Gain knowledge on nanomaterials and nanoparticles.
3	Know the biological applications of nanomaterials and nanoparticles.
4	Apply their knowledge in their career development in higher education, research, and development.
5	Understand the Biological Applications of Nanomaterials and nanoparticles

References

1. Pradeep, T. (2017) The Essentials: Understanding Nanoscience and Nanotechnology: McGraw-Hill Education.
2. Phoenix, D.A. and Ahmad, W (2014) Nanobiotechnology. One Central Press Ltd.

Additional Readings:

1. Mekuye, B. & B. Abera. 2023. An overview of synthesis, classification, characterization, and applications. Nano, 4: 486-501. [https:// doi.org/ 10.1002/ nano.202300038](https://doi.org/10.1002/nano.202300038)

2. El-Kady et al., 2023. Nanomaterials: A comprehensive review of applications, toxicity, impact, and fate to environment. Journal of Molecular Liquids, 370: <https://doi.org/10.1016/j.molliq.2022.121046>
3. Joudeh, N. & D. Linke. 2022. Nanoparticle classification, physicochemical properties, characterization, and applications: a comprehensive review for biologists. Journal of Nanobiotechnology, 20: <https://doi.org/10.1186/s12951-022-01477-8>

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO 1	S							
CO 2	M	S						
CO 3				S		S		
CO 4				S	S	M		
CO 5			S					S

1. S-Strong M-Medium L-Low

SEMESTER IV

Semester	CORE – VII	H/W	C
IV	Course Code: 23UZOOC43 Course Title: GENETICS	5	5

COURSE OBJECTIVES

1	To enable the students to understand the basic principles of inheritance.
2	To understand different types of inheritance.
3	To comprehend the importance of genetic variation in evolution.
4	To know about the harmful effects of genetic variations in humans, their cumulative effect in human population.
5	To acquire knowledge of the microbial and molecular structure of gene.

UNIT I : Mendelism and Gene Interaction:

Mendelism: Mendel's Laws of inheritance - Monohybrid – Dihybrid cross - Back Cross -Test Cross. Interaction of genes: Allelic gene interactions: - Incomplete dominance - Inheritance of flower colour in 4 O' clock plant, Codominance - Coat colour in short horn cattle; Non- allelic gene interactions: - Dominant epistasis - Colouring pattern of plumage in domestic fowls, Complementary genes – Inheritance of flower colour in sweet pea. Pleiotrophism; Penetrance and Expressivity; lethal genes and atavism.

UNIT II : Inheritance and Sex determination:

Polygenic inheritance: Skin colour in human. Multiple allele Inheritance: ABO blood groups in human. Sex - Linked inheritance: – Eye colour in *Drosophila*, X-linked - Colour blindness, Y-linked – Harry pinna in man. Cytoplasmic inheritance: Shell coiling pattern in snail. Sex determination: Chromosomal theory of Sex Determination in man and butterfly, genic balance, environmental and hormonal basis of sex determination.

UNIT III : Linkage & Crossing over, Mapping and Mutation:

Linkage & Crossing over: Principle, types and mechanism with *Drosophila* as example.

Chromosome mapping: Principles and methods - Construction of chromosome map in *Drosophila* – Three Point Test cross experiment. Mutation: Mutagens – physical, chemical; chromosomal aberrations – structural – numerical. Gene mutation: types, molecular basis of mutation, mutational hot spots, reversion - Detection of mutation - CLB method and muller-5 method.

UNIT IV : Human Genetics:

Human Chromosome; Karyotype and ideogram; chromosomal abnormalities in humans, Pedigree analysis; diagnosis of genetic abnormalities. Population genetics and evolution: Hardy-Weinberg law of equilibrium - Factors affecting Hardy-Weinberg equilibrium (gene pool, gene frequency and genotype) frequency; Inbreeding, Outbreeding and Heterosis. Genetic Counseling: Eugenics, Euphenics, and Euthenics.

UNIT V : Microbial and Molecular Genetics:

Bacterial genetics: Conjugation, transformation, transduction. Molecular Genetics: Fine Structure of Gene - Cistron – Recon – Muton. Gene expression and regulation: Operon model- Lac operon - tryptophanoperon, role and relative positions of promoters and operators, feedback mechanism. Elements of Molecular Genetics: Insertion elements, transposable elements, retroelements; integrons and antibiotic resistance cassettes.

Expected Course Outcomes (CO)

At the end of the course, the student will be able to

1	Understand the basis of inheritance and expression of genes.
2	Correlate changes in genetic makeup and phenotypic changes in progeny.
3	Analyse the causes of variations in genetic material and predict the effect in a population using different techniques.
4	Explain the role of chromosomes and different genetic elements in the expression of genes.
5	Compile the factors which contribute to changes in gene expression and specify the changes which contribute to evolution.

Text Books

1. David E Sadava, 1993. Cell Biology - Organelle Structure and Function, Jones Bartlett Publishers.
2. Guptha G. K., 2013. Genetics Classical to Modern, Rastogi publishers, Meerut.
3. Lewin B., 2008. Genes IX, Jones and Bartlett publishers.
4. Veer Bala Rastogi., 2019. Text Book of Genetics, Medtech
5. Verma P.S and Agarwal V.K., 2006. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, S. Chand & Company Ltd.
6. Verma P. S. and V. K. Agarwal., 2018. Genetics, S. Chand & Company Pvt Ltd

References Books

1. Cooper, Geoffrey M., 2018. The cell: A Molecular Approach, Eighth Edition, Oxford University Press.
2. De Robertis, E. D. P and E.M.F Robertis, 2017. Cell and Molecular Biology 8th Edition, LWW.
3. Dobzhansky T., 1982. Genetics and The Origin of Species, Columbia University.
4. Fletcher H and Hickey I., 2015. Genetics, IV Edition. GS, Taylor and Francis Group, New York and London.
5. Gardner, Anne. 2009. Human Genetics, Scion Publishing Ltd.
6. Klug, W. S., Cummings, M. R., Spencer, C. A., 2012. Concepts of Genetics. X Edition. Benjamin Cummings.
7. Lodish, Harvey, Arnold Berk et al .,2007. Molecular cell biology. 6th edition,
8. W. H. Freeman, Russel, Peter J. 2013. iGenetics: A Molecular Approach, Pearson.
9. Strickberger M. W., 1995. Genetics, Prentice Hall India Learning Private Limited

Web Resources

1. <https://go.nature.com/2XE8V1q>
2. <https://bit.ly/3zoTt6B>
3. <https://bit.ly/2XAm7oa>
4. <https://bit.ly/2XEbhxi>
5. <https://bit.ly/3AB4bso>
6. <https://bit.ly/39pZSE4>
7. <https://www.genome.gov/genetics-glossary/Sex-Linked>
8. <https://www.vedantu.com/biology/mutagens>

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO 1	S							
CO 2		S	S		S			M
CO 3			S	S	S	S		S
CO 4		S						
CO 5		S	S	S	S	S		S

S-Strong(3)

M-Medium (2)

L-Low (1)

Semester	CORE – VIII	H/W	C
IV	Course Code: 23UZOO44 Course Title: PRACTICAL IV : GENETICS	5	5

COURSE OBJECTIVES

1	To impart training on the principle of genetics, the role of genes and their inheritance in the organisms.
2	To inculcate good laboratory practice in students and to train them about to basic gene interaction pattern of inheritance in organisms.
3	To train the students to identify their blood group and construction of chromosome map.
4	To emphasize the knowledge about certain phenotypic characters of human genetic and to train the students to statistical approach.
5	To train the students to prepare the pedigree chart of various characters.

UNIT I :

1. Culture of *Drosophila* and identification of sex and Mutant.
2. Monohybrid cross, Test cross.
3. Dihybrid cross, Test of hypothesis of law of independent assortment by Chi-square test.

UNIT II :

Gene interaction – Allelic gene interaction –

1. Incomplete dominance (flower colour in *Antirrhinum*/ *Mirabilis* / 4 O' Clock plant)
2. Co-dominance (in short horn cattle)

Non-allelic gene interaction –

1. Complementary gene (Flower colour in Sweet Pea – 9:7)
2. Supplementary gene (Coat colour in Mice - 9 : 3 : 4)
3. Dominant epistasis (Poultry variety - 13:3)

UNIT III:

1. Polygenic / Quantitative inheritance using human height
2. Multiple allele inheritance – Blood grouping in human.
3. Construction of Chromosomal map in *Drosophila* using three point test cross.

UNIT IV:

1. Calculation of gene frequency and genotype frequency of autosomal traits in human.
2. Statistical Approaches to Genetic data: Biometrical Computation of Mean, Median and Mode and Standard Deviation

UNIT V:

Spotters

1. Observation on genetic traits in pea plants *Pisum sativum* through model.
2. Human Karyotyping (with the help of photographs) – normal male and female
3. Study of karyotypes of different genetic syndromes (Turner's syndrome, Klinefelter's Syndrome, Down's Syndrome)

4. Construction of Pedigree with chart / models
5. Identification of Pedigree
 - a. Autosomal dominant inheritance – Polydactyly in human
 - b. Autosomal recessive inheritance – Sickle cell anemia in human
 - c. X- linked dominant inheritance – Ricket in human
 - d. X- linked recessive inheritance – Colour blindness in man
 - e. Y-linked inheritance – Hairy pinna in man
6. Cytoplasmic inheritance – Identification of Shell coiling pattern in snail.

Expected Course Outcomes (COs)

At the end of the course, the student will be able to

1	Describe, examine and interpret the organization of genomic material and to research theories of genetic inheritance.
2	Prepare samples of genetic molecules and to determine their purity, structure and characteristics.
3	Experiment with genomic preparations and devise techniques to distinguish genetic material in different organisms to survey biodiversity.
4	Assess the changes in genetic material and to predict and consider the consequences of those changes.
5	Report and justify the results of molecular and genetic experiments in an accurate and meaningful manner.

Text Books

1. Sharmila, G., Sankari, A., Abbiramy, K. S., Duraimurugan, V., Chitrapriya, K. and Asokan, S. 2024. Lab Manual for Genetics. Vishal Publishing Co., Jalandhar, India.
2. Surya Nandan Meena, Milind Naik, 2019. Advances in Biological Science Research: A Practical Approach, Academic Press, New York, USA.
3. Michael Perlin, William Beckerson, Adarsh Gopinath, 2017. Cell, Genetics, and Molecular Biology: A Lab Manual (First Edition), Cognella Inc., USA

References Books

1. Sarah Stauffer, Aaron Gardner, Wilko Duprez, Dewi Ayu Kencana Ungu, Philip Wismer, 2018. Labster Virtual Lab Experiments: Basic Genetics, Springer Publishers, NY, USA.

Web Resources

1. <https://www.jove.com/>
2. <https://vlab.amrita.edu/?sub=3&brch=77>
3. <http://cbii-au.vlabs.ac.in/>
4. https://media.hhmi.org/biointeractive/vlabs/transgenic_fly/index.html
5. <https://www.ibiology.org/biology-techniques/>

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO 1	S							
CO 2	M	S						
CO 3				S		S		
CO 4				S	S	M		
CO 5			S					S

S-Strong(3)

M-Medium (2)

L-Low (1)

Title of the Course	CHEMISTRY FOR BIOLOGICAL SCIENCES II (FOR BOTANY AND ZOOLOGY STUDENTS)						
Code	23UCHEE45						
Category	Generic Elective	Year Semester	II IV	Credits	2	Course Code	
Instructional hours per week	Lecture	Tutorial	Lab Practice		Total		
	3	-	-		4		
Prerequisites	Chemistry for Biological Sciences I						
Objectives of the course	This course aims to provide knowledge on • nomenclature of coordination compounds and carbohydrates. • Amino Acids and Essential elements of biosystem • understand the concepts of kinetics and catalysis • provide fundamentals of electrochemistry and photochemistry						
Course Outline	UNIT I Co-ordination Chemistry and Water Technology Co-ordination Chemistry: Definition of terms - IUPAC Nomenclature - Werner's theory - EAN rule - Pauling's theory – Postulates - Applications to $[\text{Ni}(\text{CO})_4]$, $[\text{Ni}(\text{CN})_4]^{2-}$, $[\text{Co}(\text{CN})_6]^{3-}$ Chelation - Biological role of Hemoglobin and Chlorophyll (elementary idea) - Applications in qualitative and quantitative analysis. Water Technology: Hardness of water, determination of hardness of water using EDTA method, zeolite method-Purification techniques – BOD and COD. Unit II Carbohydrates Classification, preparation and properties of glucose and fructose. Discussion of open chain ring structures of glucose and fructose. Glucose-fructose interconversion. Preparation and properties of sucrose, starch and cellulose.						

UNIT III

Amino Acids and Essential elements of biosystem

Classification - preparation and properties of alanine, preparation of dipeptides using Bergmann method - Proteins-classification – structure - Colour reactions – Biological functions – nucleosides -nucleotides – RNA and DNA – structure. Essentials of trace metals in biological system-Na, Cu, K, Zn, Fe, Mg.

	UNIT IV Electrochemistry Galvanic cells - Standard hydrogen electrode - calomel electrode - standard electrode potentials -electrochemical series. Strong and weak electrolytes - ionic product of water -pH, pKa, pKb. Conductometric titrations - pH determination by colorimetric method – buffer solutions and its biological applications - electroplating - Nickel and chrome plating – Types of cells -fuel cells-corrosion and its prevention.	
	UNIT V Photochemistry Grothus - Drapper's law and Stark-Einstein's law of photochemical equivalence, Quantum yield - Hydrogen -chloride reaction. Phosphorescence, fluorescence, chemiluminescence and photosensitization and photosynthesis (definition with examples).	
Extended Professional Component (is a part of internal component only, Not to be included in the external examination question paper)	Questions related to the above topics, from various competitive examinations UPSC/ JAM /TNPSC others to be solved (To be discussed during the Tutorial hours)	
Skills acquired from this course	Knowledge, Problem solving, Analytical ability, Professional Competency, Professional Communication and Transferable skills.	
Recommended Text	1. V.Veeraiyan, Textbook of Ancillary Chemistry; High mount publishing house, Chennai, first edition, 2009. 2. S.Vaithyanathan, Text book of Ancillary Chemistry; Priya Publications, Karur, 2006. 3. Arun Bahl, B.S.Bahl, Advanced Organic Chemistry; S.Chand and Company, New Delhi, twenty third edition, 2012. 4. P.L.Soni, H.M.Chawla, Text Book of Organic Chemistry; Sultan Chand & sons, New Delhi, twenty ninth edition, 2007.	

Reference Books	1. Arun Bahl, B.S.Bahl, Advanced Organic Chemistry; S.Chand and Company, New Delhi, twenty third edition, 2012. 2. P.L.Soni, H.M.Chawla, Text Book of Organic Chemistry; Sultan Chand & sons, New Delhi, twenty ninth edition, 2007. P.L.Soni, Mohan Katyal, Text book of Inorganic chemistry; Sultan Chand and Company, New Delhi, twentieth edition, 2007. 4. B.R.Puri, L.R.Sharma, M.S.Pathania, Text book Physical Chemistry; Vishal Publishing Co., New Delhi, forty seventh edition, 2018. 5. B.K,Sharma, Industrial Chemistry; GOEL publishing house, Meerut, sixteenth edition, 2014.
------------------------	---

CO /PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to PSOs	3.0	3.0	3.0	3.0	3.0

CO /PO	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to POs	3.0	3.0	3.0	3.0	3.0

Level of Correlation between PO's and CO's

Title of the Course	CHEMISTRY PRACTICAL FOR BIOLOGICAL SCIENCES – II (For Botany and Zoology II year/IV semester)						
Subject Code	23UCHEEP4						
Category	Generic Elective	Year Semester	II IV	Credits	1	Course Code	
Instructional hours per week	Lecture	Tutorial	Lab Practice		Total		
	-	-	2		2		
Prerequisites							
Objectives of the course	This course aims to provide knowledge on identification of organic functional groups different types of organic compounds with respect to their properties. determination of elements in organic compounds..						
	SYSTEMATIC ANALYSIS OF ORGANIC COMPOUNDS The analysis must be carried out as follows: Functional group tests [phenol, acids (mono & di) aromatic primary amine, amides (mono & di), aldehyde and glucose]. Detection of elements (N, S, Halogens). To distinguish between aliphatic and aromatic compounds. To distinguish – Saturated and unsaturated compounds.						
Reference Books	V.Venkateswaran, R.Veerasingam, A.R.Kulandaivelu, Basic Principles of Practical Chemistry; Sultan Chand & sons, Second edition, 1997.						
Course Learning Outcomes (for Mapping with POs and PSOs) On completion of the course the students should be able to CO 1: gain an understanding of the use of standard flask and volumetric pipettes, burette. CO 2: design, carry out, record and interpret the results of volumetric titration. CO 3: apply their skill in the analysis of water/hardness. CO4: analyze the chemical constituents in allied chemical products							

CO /PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
Weightage	12	12	12	12	12
Weighted percentage of Course Contribution to PSOs	3.0	3.0	3.0	3.0	3.0

Level of Correlation between PSO's and CO's

CO /PO	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3

CO4	3	3	3	3	3
Weightage	12	12	12	12	12
Weighted percentage of Course Contribution to POs	3.0	3.0	3.0	3.0	3.0

Level of Correlation between PO's and CO's

Semester	SKILL ENHANCEMENT COURSE - VI	H/W	C
IV	Course Code: 23UZOOS46-1 Course Title: MEDICAL LAB TECHNOLOGY	2	2

COURSE OBJECTIVES

1	To understand the different protocols and procedures to collect clinical samples.
2	To explain the characteristics of clinical samples.
3	To demonstrate skill in handling clinical equipment.
4	To evaluate the safety precautions while handling clinical samples.
5	To summarise the control measures to avoid contamination of clinical samples.

Unit I: Laboratory Safety and Human Health and Hygiene : Laboratory safety –toxic chemicals and biohazardous waste- biosafety level- good laboratory practice – hygiene and health issue – physiological effect of alcohol, tobacco, smoking & junk food & its treatment - biomedical waste management.

Unit II: Haematology : Composition of blood and their function- collection of blood & lab procedure-haemopoiesis- types of anaemia- mechanism of blood coagulation- bleeding time- clotting time- determination of hemoglobin-erythrocyte sedimentations rate- packed cell volume- Total count of RBC & WBC- Differential count of WBC- blood grouping and typing- haemostasis- bleeding disorder of man - Haemolytic disease of newborn, Platelet count, reticulocytes count, Absolute Eosinophil count.

Unit III: Medical Microbiology and Instrumentation Techniques : Definition and scope of microbiology - structure and function of cells - parasites – Entamoeba - Plasmodium- Leishmania and Trypanosoma - Computer tomography (CT scan) – Magnetic Resonance Imaging (MRI) – flowcytometry – treadmill test – PET.

Unit IV: Medical Physiology : Cardiovascular system- Blood pressure - Pulse – regulation of heart rate, cardiac shock. Heart sounds, Electrocardiogram (ECG) – significance – ultra sonography- Electroencephalography (EEG).

Unit V: Diagnostic Pathology : Handling and labelling of histology specimens – Tissue processing - processing of histological tissues for paraffin embedding, block preparation. Microtomes – types of microtome- sectioning, staining –staining methods- vital staining - mounting- problems encountered during section cutting and remedies - Frozen section techniques- freezing microtome.

Expected Course Outcomes (COs)

At the end of the course, the student will be able to

1	Understand protocols and procedures to collect clinical samples for blood analysis and to study human physiology.
2	Explain the characteristics of clinical samples.
3	Demonstrate skill in handling clinical equipment.
4	Evaluate the hematological and histological parameters of biological samples.
5	Elaborate the role of medical laboratory techniques in health care industry.

Text Books

1. Godker, P. B. and Darshan, P, Godker, 2011. Text book of medical Laboratory Technology, Mumbai.
2. Guyton and Hall, 2000. Text Book of Medical Physiology, 10 th edition, Elseiner, New Delhi.
3. Mukerjee, K.L, 1999. Medical Laboratory Technology- Vol, I, II, III. Tata MC Graw Hill, New Delhi.
4. Sood, R, 2009. Medical Laboratory Technology, Methods and Interpretation.

Suggested Readings

1. Manoharan,A, and Sethuraman, 2003. Essential of Clinical Heamatology, Jeypee brothers, New Delhi.
2. Richard, A, McPherson, Mathew, R, Pincus, 2007. Clinical and management by laboratory methods, Elsevier, Philadelphia. Published by Tata McGraw-Hill Education Pvt. Ltd.,
3. Ochei. J., A. Kolhatkar (2000). Medical Laboratory science: Theory and practice, Published by Tata McGraw-Hill Education Pvt. Ltd, First edition.

Web Resources:

1. <https://bit.ly/3tUs8In>
2. <https://bit.ly/2XKu7mT>
3. <https://bit.ly/3hNS1EP>
4. <https://bit.ly/2ZgrLga>
5. <https://bit.ly/3hTBO1b>

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO 1	S							
CO 2		S	S		S			M
CO 3			S	S	S	S		S
CO 4		S						
CO 5		S	S	S	S	S		S

S-Strong(3) M-Medium (2) L-Low (1)

Semester	SKILL ENHANCEMENT COURSE - VI	H/W	C
IV	Course Code: 23UZOOS46-2 Course Title: AQUACULTURE	2	2

Course Objectives :

1	To acquire knowledge about the importance of aquaculture.
2	To know the different types of culture and pond management.
3	To obtain knowledge about cultivable species and aquarium keeping.
4	To gather information about poly culture
5	To learn the role of organizations and funding agencies involved in aquaculture.

Unit I : Importance of aquaculture

Definition - Scope and importance – status of aquaculture in India, Role of aquaculture on economic development. Types of aquaculture - Freshwater, coastal and marine water aquaculture.

Unit II: Fish ponds and Management

Definition, breeding ponds, nursery ponds, rearing ponds, culture ponds (stocking ponds). Preparation of pond for fish culture, management of fish ponds, water quality management of fish ponds. Importance and composition of feeds; types of feed, wet and dry feeds, Artificial and live feeds.

Unit III: Cultivable species

Cultivable species of fish, crustaceans, molluscs and algae; Different types of cultures, Monoculture, Poly culture, composite fish culture, cage culture, pen culture, race way culture- extensive, intensive and semi intensive culture; Common species for ornamental fish farming.

Unit IV: Fish disease management

Common bacterial, viral, fungal, protozoan and crustacean diseases, their symptoms and treatment. Aquatic pollution –Definition, causes, ecological effects and control of water pollution.

Unit V: Marketing the products

Marketing the fish to local markets and for export - Harvesting and transport of fish and its products - Fish preservation and fish processing technology; Organizations involved and their role of aquaculture - ICAR, CMFRI, CIFRI, CICFRI, CIFA, CIBA, CIFT & MPEDA.

Expected Course Outcomes (COs)

At the end of the course, the student will be able to

1	Students will be able to describe the history and development of aquatic life.
2	Students will be able to theoretical and practical aspects of fisheries across different species.
3	Students will be able to explain how the management of aquatic ponds and to analyze biological samples of Aquaculture ponds.
4	Students can make knowledge of how the difference of cultivable forms evolved in the earth.
5	To take up jobs in Aquaculture farms.

Text Books

- 1) Pillay, T.V.R. 1995. *Aquaculture principles and practices*. Fishing News Books, Blackwell Science Ltd., Oxford.
- 2) Shanmugam, K. 1990. *Fishery biology and Aquaculture*. Leo Pathipagam, Madras.
- 3) Santhanam, Sugumaran and Natarajan, P. 1997. *A Manual of freshwater aquaculture*. Oxford and IBHPub. Co. Ltd., New Delhi.

Supplementary Readings

1. Arumugam, N. 2008. *Aquaculture*. Saras Publications, Nagercoil.
2. Baradach, JE, JH Ryther and WO McLarney (1972) *Aquaculture. The farming and Husbandry of Freshwater and Marine Organisms*. Wiley Interscience, New York.
3. Chadar, S.L. 1980. *Hypophysation of Indian major carps*. Satish Book Enterprise, Agra, PP.146. Exporters manual and Documentation. 1999. Jain Book Agency. New Delhi.
4. Jhingran, V.C. 1991. *Fish and fisheries of India*, Hindustan Pub. Cord. New Delhi.
5. Kurian, C.V and Sebastin. 1992. *Prawn and prawn fisheries of India*, Hindustan Pub. Cord. New Delhi.
6. Rath, R.K. (2000) *Freshwater Aquaculture*. Scientific Publishers, (India), PO.Box.91, Jodhpur

OUTCOME MAPPING

PO/CO	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	3	1
CO2	3	3	3	3	1
CO3	3	3	3	3	1
CO4	3	3	3	3	1

Semester	SKILL ENHANCEMENT COURSE - VII	H/W	C
IV	Course Code: 23UZOOS47-1 Course Title: FOOD , NUTRITION AND HEALTH	2	2

Course Objectives:

1	To understand the Basic concepts of Food
2	To study the macro and micro nutrient
3	To study the Malnutrition and nutrient deficiency diseases
4	To study the Life style dependent diseases
5	To study the Diseases caused by microorganisms

Unit I: Nutrition and dietary nutrients:

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

Unit II: Macro nutrients and micronutrients:

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

Unit III: Malnutrition and nutrient deficiency diseases:

Definition and concept of health: Common nutritional deficiency diseases- Protein Malnutrition (e.g., Kwashiorkor and Marasmus), Vitamin A deficiency, Iron deficiency and Iodine deficiency disorders- their symptoms, treatment, prevention and government initiatives.

Unit IV:

Life style dependent diseases- hypertension, diabetes mellitus, and obesity their causes and prevention. Social health problems- smoking, alcoholism, narcotics. Acquired Immuno Deficiency Syndrome (AIDS): causes, treatment and prevention.

Unit V: Diseases caused by microorganisms:

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

Expected Course Outcomes (COs)

At the end of the course, the student will be able to

1	Understand the role of food and nutrients in health and disease.
2	Gain knowledge about hygiene, food safety, disease transmission
3	Perform food system management and leadership functions that consider sustainability in business, healthcare, community and institutional areas.
4	Understanding the Life style dependent diseases
5	Understanding the Diseases caused by microorganisms

Text Books

1. SrilakshmiB(2017): Nutrition Science, 6th Multicolour Ed. New Age International (P) Ltd.
2. Mann J and TruswellS(2017) : Essentials of Human Nutrition, 5th Ed. Oxford University Press.

- Swaminathan M(2007): Essentials of Food and Nutrition(Vol. I & II), 2nd Ed. Bappco
- Geissler C and Powers H (2005): Human Nutrition, 11th Ed. Churchill Livingston
- Ritchie, JAS(1979): Learning Better Nutrition , Nutritional Studies number 20, FAO, Rome.
- Hughes O and Bennion, M (1970): Introductory Foods, 5th Ed. Macmillan & Co., New York.
- Anita FP and Abraham P: Clinical Dietetics and Nutrition, 4th Ed. Oxford University Press, Delhi.
- Jay JM (2005): Modern Food Microbiology, 3rd Ed. CBS Publishers & Distributors.

References

- Mudambi, S.R. and Rajagopal, M.V. (2007). Fundamentals of Foods, Nutrition and Diet Therapy; Fifth Ed; New Age International Publishers.
- Srilakshmi, B. (2007). Food Science; Fourth Ed; New Age International (P) Ltd.
- Swaminathan, M. (1986). Handbook of Foods and Nutrition; Fifth Ed; BAPPCO.
- Bamji, M.S.; Rao, N.P. and Reddy, V. (2009). Text Book of Human Nutrition; Oxford & IBH Publishing Co. Pvt Ltd.
- Lakra, P. and Singh M.D. (2008). Textbook of Nutrition and Health; First Ed; Academic Excellence.
- Gibney, M.J. et al. (2004). Public Health Nutrition; Blackwell Publishing.

Web Resources

- <https://nios.ac.in/media/documents/srsec321newE/321-E-Lesson-4.pdf>
- <https://ddceutkal.ac.in/Syllabus/MBA-BOOK/FND.pdf>
- <https://gmch.gov.in/sites/default/files/documents/Nutrition%20and%20Health.pdf>
- https://www.dairyknowledge.in/sites/default/files/food_nutrition_and_health.pdf
- <https://ncert.nic.in/textbook/pdf/lehe103.pdf>

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO 1	S							
CO 2	M	S						
CO 3				S		S		
CO 4				S	S	M		
CO 5			S					S

S-Strong

M-Medium

L-Low

Semester	SKILL ENHANCEMENT COURSE - VII	H/W	C
IV	Course Code: 23UZ00S47-2 Course Title: AGRICULTURAL ENTOMOLOGY	2	2

Course Objectives :

1	Explain the basic concepts of entomology and observe the pest status of agriculture.
2	Illustrate and examine the systemic and functional morphology of various group of agricultural insect pests.
3	Differentiate and classify the various groups of insect animals and estimate biodiversity.
4	To compare and distinguish the general and specific characteristics integrated pest management.
5	Infer and integrate the economic importance of insect species.

Unit I: Outline classification of insects - Causes for insect assuming pest status - Methods of collection, mounting and preservation of insect pests.

Unit II: Insect vectors of plant diseases, Insect pests of stored grains, their preventive and curative methods. Most common insect pests of the following plants and their control measures: Paddy, Sugarcane, Groundnut, Coconut and Cotton. Locust and its control. Insect pollinators and scavenger.

Unit III: Apiculture: Introduction, types of honey bees, hive, apiary, selection of bees for apiary, Newton's bee hive, enemies and diseases of honey bees. Sericulture: Introduction, types of silk worms, silk worm races, life history of mulberry silk worm, features of sericulture industry, pests and diseases of silk worm. Lac Culture.

Unit IV: IPM, physical, mechanical, chemical and biological control methods, Pesticide application equipment. First Aid & Precautions in handling pesticides. Residual effects of pesticides on non-target organisms.

Unit V: Introduction and steps towards IPM, Pheromones, anti feedents, repellents and biopesticide. Pesticide industry-production and marketing.

Expected Course Outcomes (CO)

At the end of the course, the student will be able to

1	Examine and identify the systemic and functional morphology of various group of agricultural insect pests.
2	Differentiate and classify the various groups of insects and estimate the biodiversity.
3	Explain the pest status in agriculture and control measures.
4	To compare the methods and outcomes of integrated pest management.
5	List the economic importance of agricultural insect species.

Text Books

1. David, Band Ananthakrishnan, T.N. 2006. General and Applied Entomology, Second edition, Tata McGraw hill publishing company Ltd., New Delhi, India.
2. Vasanthraj David, B. and Ramamurthy, VV. 2012. Elements of Economic Entomology, Seventh edition, Namrutha publications, Chennai.
3. Pruthi, H.S. 1969. Textbook on Agricultural Entomology, I.C.A.R. Publication, New Delhi.

4. Awasthi, V.B. 2012. Introduction to General and Applied Entomology, third edition, Scientific publishers.

Suggested Readings

1. Abishek Shukla, D. 2009. A Hand Book of Economic Entomology, Vedamse, Books, New Delhi.
2. Ministry of Agriculture, Government of India, 1995. Manual on Integrated Pest Management in Rice and Cotton.
3. John William S. 1995. Management of Natural Wealth, Loyola College Publications, Chennai.

Web resources

1. <http://www.fao.org>
2. <http://flybase.bio.indiana.edu/>
3. <http://www.ipm.ucdavis.edu>
4. <http://www.ent.iastate.edu/list/>
5. www.entsoc.org

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO 1	S							
CO 2	M	S						
CO 3				S		S		
CO 4				S	S	M		
CO 5			S					S

S-Strong

M-Medium

L-Low

SEMESTER V

Semester	CORE – IX	H/W	C
V	Course Code: 23UZOOC51 Course Title: DEVELOPMENTAL BIOLOGY	5	4

Course Objectives :

1	To create an awareness to the students about the theories, concepts and basics of Developmental Biology.
2	To provide students about the idea of sex cells, fertilization, cleavage, differentiation and development of organs.
3	To make an awareness of the induction, organizers and development of extra embryonic structures.
4	To provide adequate explanation to students about the late embryonic developments and post embryonic development and ageing
5	To give an idea about teratogenesis, invitro fertilization, stem cells and amniocentesis to the students

UNIT I: Gametogenesis & Fertilization

Basic concepts of developmental biology. Gametogenesis - Spermatogenesis – Oogenesis - structure & types of Spermatozoa, types of egg - Mammalian egg - Egg membranes. Fertilization – mechanism, theories and significance – Parthenogenesis

UNIT II: Blastulation & Gastrulation

Cleavage - Planes and Patterns, Factors controlling cleavage - Fate map and its construction. Blastulation – types of blastula. Morphogenetic movements - Gastrulation of frog & chick.

UNIT III: Organogenesis

Development of Brain, Eye and Heart in frog. Foetal membranes in chick. Development of Pro, Meso, Metanephric kidneys. Placentation in Mammals.

UNIT IV: Applied Embryology

Organizer concept – Structure – mechanism of induction and competence. Nuclear transplantation – teratogenesis – agents and mechanisms – Regeneration: types - events and factors. Embryonic stem cells & significance. Methods to culture embryo

UNIT V: Human embryology

Reproductive organs, Menstrual cycle and menopause - Pregnancy – development. Erythroblastosis foetalis - Twins – types. Infertility – causes - Test tube baby and Assisted Reproductive Technology – Embryo transfer – Amniocentesis

Expected Course Outcomes (COs)

At the end of the course, the student will be able to

1	To describe and illustrate the significance of cellular processes in embryonic development.
2	To relate the factors that contribute to the developmental process, construct fate maps and illustrate the steps in morphogenesis and organogenesis.
3	To correlate the involvement of specific cell types in the formation of specific organs and explain the importance of morphogens.
4	To distinguish between the different types of developmental mechanisms in various organisms and appraise the species-based differences in development.
5	To justify and validate the role of environment and genetics in influencing

	embryonic development
--	-----------------------

Text Books

1. Lewis Wolpert 2007. Principles of development, 3rd edition, Oxford University Press, New Delhi, India
2. Subramoniam, T. 2003. Developmental Biology, Narosa Publishing House, New Delhi, India.
3. Verma, P.S., Agarwal, V. K. 2010. Chordate Embryology: Developmental Biology, S. Chand & Company, New Delhi., India

Reference Books

1. Gilbert S.F. 2010. Developmental Biology, Sinauer Associates, Massachusetts, USA.
2. Balinsky, B.I. 1970. Introduction to Embryology, Philadelphia & London, UK.
3. Berril, N.J. 1971. Developmental Biology, McGraw Hill, New York, USA.
4. Russ Hodge 2010. Developmental Biology, Facts on File, Inc., New York, USA.
5. Carlson, Bruce, M. 2009. Human embryology and Developmental Biology, Elsevier, Philadelphia, USA.

Web Resources

1. <https://www.ncbi.nlm.nih.gov/books/NBK10052/>
2. <https://www.cdc.gov/ncbddd/developmentaldisabilities/facts.html>
3. <https://anatomypubs.onlinelibrary.wiley.com/doi/full/10.1002/dvdy.20468>
4. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5293490/>

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO 1	S							
CO 2	M	S						
CO 3				S		S		
CO 4				S	S	M		
CO 5			S					S

S-Strong(3) M-Medium (2) L-Low (1) B N

Semester	CORE – X	H/W	C
V	Course Code: 23UZOOC52 Course Title: ANIMAL PHYSIOLOGY	5	4

Course Objectives :

1	To familiarize students with the principles and basic facts of Animal Physiology
2	To give students an insight about the molecular and cellular basis of physiological functions in animals.
3	To give an idea about the regulation of organ system functions in a whole animal using a conceptual model of feedback to explain homeostasis.
4	To make the students aware about how the structure-function relationships and its synchronization with the molecular signals.
5	To familiarize students with the principles and basic facts of Animal Physiology

UNIT I : Nutrition & Respiration

Nutrition: Digestion and absorption of carbohydrates proteins and lipids. Minerals& Vitamins–their deficiency. Hormonal control of digestion. Types of Respiration, Respiratory pigments-structure of Haemoglobin, Transportation of gases –Bohr effect-Regulation of respiration- bronchitis, asthma –Physiological effects of smoking

UNIT II : Circulation & Excretion

Blood- composition and functions, Mechanism of clotting. Types of Hearts – Heartbeat and its regulation -pace maker – Cardiac cycle, Cardiac Rhythm – ECG - Pulse and blood pressure. Nephron structure & mechanism of urine formation, Regulation of acid base balance, Excretory products, Kidney failure and Transplantation, Osmoregulation in fishes.

UNIT III : Muscle& Nerve Physiology

Types of muscles – Ultra structure of striated muscle, Muscle contraction & properties, Neurons–structure & types Impulse propagation, synaptic transmission, neurotransmitters - Reflex action, Nerve disorders – epilepsy, Alzheimer’s disease, Parkinson’s disease.

UNIT IV : Sense Organs

Structure of eye, physiology of vision, visual elements and pigments, photo chemistry of vision - Eye defects – myopia, hyperopia, presbyopia, astigmatism, cataract - Structure of ear and mechanism of hearing - Hearing impairments – deafness, labyrinthine disease - Olfactory, gustatory and tactile sense organs

UNIT V : Reproductive Physiology

Endocrine glands in man - Hormones, action and disorders - Feed-back mechanism, Outlines of mechanism of hormonal activity. Puberty, adolescence, pregnancy, parturition, lactation and birth control.

Expected Course Outcomes (COs)

At the end of the course, the student will be able to

1	Be able to explain how the various organ systems are coordinated and controlled.
2	Be able to list the functions of various organs in relation to physiological process.
3	Be able to develop the idea of multi level controlling and feedback mechanism in relation to various physiological functions.
4	Be able to understand the basic physiological process related to adaptation , metabolism and major requirements.

5	Be able to correlate and understand human physiology.
---	---

Text Books

1. Agarwal R A., Anil K Srivastava., Kaushal Kumar.,1978. Animal Physiology and Biochemistry, S. Chand & Co. Ltd., New Delhi Publishing., 377 pp.
2. Ambika Shanmugam, 2001. Fundamentals of Biochemistry for Medical students, Karthik Offset Printers, Chennai, 590pp
3. Berry A.K.1998. A text book of Animal Physiology and Biochemistry. Emkay Publications, New Delhi, 320 pp.
4. Parameswaran, Ananta krishnan and Ananta Subramanian, 1975. Outlines of Animal Physiology, S. Viswanathan (Printers & Publishers) Pvt. Ltd., 329 p p.
5. Verma P.S., Tyagi B.S & Agarwal V.K., 2010. Animal Physiology, S. Chand & Co. Ltd., New Delhi Publishing., 417 pp.

Reference Books

1. Guyton, A.C. and Hall, J.B., 2011. Text Book of Medical Physiology, 9th Edition, W.B. Sanders Company, Prism Books (Pvt.) Ltd., Bangalore., 1064 pp.
2. Ganong, W.F., 2019. Review of Medical Physiology, McGraw Hill, New Delhi., 340 pp.
3. Hill, W.R., Wyse, G.A and Anderson, M. 2016. Animal Physiology (4th edn). Sinauer Associates is an imprint of Oxford University Press; USA, 828 pp.
4. Hoar, W.S. 1983. General and Comparative Physiology. Prentice Hall of India, New Delhi, 928 pp.
5. Prosser C.L., 1985. Comparative Animal Physiology, Satish Book Enterprise, Agra - 282 003, 966 pp.
6. Sarada Subrahmanyam, Madhavan Kutty, K., & Singh H.D., 2018. Text Book of Human Physiology, S. Chand & Co, New Delhi.
7. Singh, H.R and Kumar, N. 2017. Animal physiology and biochemistry, Vishal publishing company, Jalandhar, 864 pp.
8. Sreekumar, S. 2010. Basic physiology, PHI learning private ltd., New Delhi.210 pp
9. Tortora G.J. & Derrickson B., 2016. Principles of Anatomy and Physiology, John Sons, Inc. 1232 pp.
10. Wood, D.W., 1968. Principles of Animal Physiology, Edward Arnold Ltd, London., 342 pp.

Web Resources

1. <https://microbenotes.com/category/biochemistry/>
2. <https://www.stem.org.uk/resources/collection/3931/animal-physiology>
3. <https://animalphys4e.sinauer.com>
4. <https://nptel.ac.in/courses/102/104/102104042/>
5. <https://biochem.oregonstate.edu>

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO 1	S							
CO 2	M	S						
CO 3				S		S		
CO 4				S	S	M		
CO 5			S					S

S-Strong

M-Medium

L-Low

Semester	CORE – XI COURSE CODE:	H/W	C
V	COURSE TITLE: PRACTICAL V : 23UZOOP53 DEVELOPMENTAL BIOLOGY & ANIMAL PHYSIOLOGY	5	4

Course Objectives :

1	To understand the mechanisms of reproduction in mammals and to understand the types of eggs and Blastulation and Gastrulation in frog
2	To understand the developmental stages of chick and to understand the various embryonic placentations in mammals.
3	To demonstrate an understanding of core principles, and define scientific principles in metabolism of fish
4	To understand the physiological processes that regulate body functions.
5	To explain the various physiological instruments related to heart and lungs function

UNIT I : Estimation of Oxygen consumption in a fish with reference to body weight. Activity of human salivary amylase in relation to pH, Enzyme concentration and Temperature.

UNIT II : Estimation of haemoglobin in human blood. Estimation of Bleeding time and clotting time of blood. Detection of nitrogenous waste products in fish tank water, frog tank water, bird excreta and mammalian urine/ Kidney.

UNIT III : Detection of nitrogenous waste products in fish tank water, frog tank water, bird excreta and mammalian urine/ Kidney.

UNIT IV: Use of Kymograph Unit, Sphygmomanometer, Stethoscope and Haemoglobinometer. Slides showing transverse section of testis and Ovary in Mammals. Study of cleavage stages 2 Cell, 4 Cell, 8 Cell - Blastula and gastrula of Frog.

UNIT V : Slides of different stages of chick embryo - 18 hours, 24 hours, 48 hours, 72 hours and 96 hours. Placenta of Sheep and Pig

Expected Course Outcomes (COs)

At the end of the course, the student will be able to

1	The student will be able to understand the process of Oxygen consumption by fish depending upon the body weight
2	The student will be able to understand the level of haemoglobin present in their own blood and to observe bleeding and Clotting time in their blood
3	The student will be able to understand the various instruments and its applications related to human beings
4	The student will be able to study human reproduction and reproductive process in mammals and will observe various egg types and stages of cleavage in frog.
5	The student will be able to study embryonic adaptations in human and various developmental stages in chick.

Text Books

1. Sambasivaiah, Kamalakara rao and Augustine chellappa 1990. A Text book of Animal physiology and ecology, S. Chand & co., Ltd., New Delhi - 110 055.
2. Prosser, C.L. Brown, 1985, Comparative Animal Physiology, Satish Book Enterprise, Agra - 282 003

3. Burtis, C.A. and Ashwood, E.R. 2008. Tietztext book of Fundamentals of clinical chemistry and molecular diagnostics, Elsevier, Philadelphia.
4. Parameswaran, Anantakrishnan and Ananta Subramanyam, 1975. Outlines of Animal Physiology, S. Viswanathan [printers & Publishers] Pvt. Ltd.
5. Wood.D.W, 1983, Principles of Animal Physiology 3rd Ed.

Reference Books

1. Berril & Corp Developmental Biology. McGraw Hill Book Company, MC.,New York.
2. M.S.Jayaraj An Introduction to embryology Veer Bala Rastogi Publication.
3. Dubey 2006 Text book of Biotechnology S. Chand and Co., New Delhi.
4. Verma, P.S., V.K. Agarwal and Tyagi, 1995. Chordate embryology. S. Chand & co., New Delhi.

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO 1	S							
CO 2	M	S						
CO 3				S		S		
CO 4				S	S	M		
CO 5			S					S

S-Strong(3)

M-Medium (2)

L-Low (1)

SEMESTER V	23UZOOD54 PROJECT WITH VIVA-VOCE	H/W	C
CORE – XII		5	4

(Refer to the Regulations)

Semester	ELECTIVE - V	H/W	C
V	Course Code: 23UZOOE55-1 Course Title: BIO PHYSICS & BIOSTATISTICS	4	3

Course Objectives :

1	To understand the concepts of diffusion, osmosis, centrifugal force, surface tension.
2	To understand the techniques for the separation of biomolecules.
3	To understand radiology, sonography, Laser techniques for biological and medical application.
4	To know to collect and Classify Data
5	To know to calculate standard deviation, correlation coefficient, chi-square analysis and student 't' test using the formula

Unit I: Biophysical Principles: Physical laws in living system:diffusion–Factors affecting diffusion- types of diffusion – Biological significance of diffusion–Osmosis–Osmotic pressure(endocytosis, pinocytosis, phagocytosis, exocytosis plasmolysis and haemolysis) Principles of viscosity–Brownian movement–surface tension–Centrifugation:Principle–types–applications.

Unit II: Applications of Biophysics: Principle and applications of colorimeter – electrophoresis –principle, instrumentation – applications of gel electrophoresis. Radioactivity: Types of radioactive decay – Radioactive isotopes. Medical and biological uses of X-rays, Ultrasound and Laser.

Unit III: Collection and Classification of Data: Introduction to biostatistics: Definition – characteristics, importance and applications of biostatistics. Collection of data: Primary – secondary data. Statistical population and sampling in biological studies. Types of Classification: Qualitative – quantitative and Tabulation of biological data. Variables: discrete – continuous. Frequency distributions.

Unit IV: Presentation of Data: Tabulation: Types – Components – advantages. Diagrammatic and graphical representations of data: Bar diagrams (Simple, multiple, subdivided and percentage) – Pie diagram – Frequency diagram: histograms – frequency polygon – frequency curve – line graphs.

Unit V: Descriptive & Inferential Statistics: Measure of central tendency: Arithmetic mean – median– mode. Measures of dispersion: Standard deviation – Standard error– Coefficient of variance. Hypothesis testing: Correlation and regression. Test of significance: Chi-square test for goodness of fit – Student 't' test. Analysis of Variance – types – One way ANOVA.

Expected Course Outcomes (COs)

At the end of the course, the student will be able to

1	Understand and recall the basic biophysical concepts, statistical data and formula.
2	Apply suitable physical techniques and statistical methods to solve biological problems.
3	Identify and relate the bioanalytical techniques and statistical principles for the application of biological experiments.

4	Select suitable biophysical techniques to study the biological process and statistical approach to assess the experimental results.
5	Integrate the bioanalytical techniques and statistical methods to validate research investigations.

Text Books

1. Das,D.,1996.Biophysics and Biophysical Chemistry for Medical and Biology students, Academic, Calcutta. 302pp.
2. Subramanian,M.A.,2016.Biophysics–Principles and Techniques, MJP, Chennai. 324pp.
3. Gurumani,N.,2005.AnintroductiontoBiostatistics,MJP,Chennai, 250pp.
4. Palanichamy,SandM.Shanmugavelu,1991.PrinciplesofBiostatistics.Palani Paramount.India. 350pp
5. Roy, R.N. 1996. A Text Book of Biophysics, New Central Book Agency Ltd, Calcutta. 992pp.

Suggested Readings

1. Antonisamy, B., Solomon Christopher and P. Prasanna Samuel, 2011. Biostatistics: Principles and practices. Mac Graw Hill Education Pvt.Ltd. New Delhi. 349pp.
2. BettyKarasek,2015.Advanced concepts of biophysics, Callistro Reference, 198pp.
3. Daniel, W.W., 2000. Biostatistics: A foundation for analysis in the health sciences, 7thEd. John Wiley & Sons Ltd. New York. 328pp.
4. EdwardK.Yeagers,2018.Basic Biophysics for Biology, CRCPress,USA.195pp
5. Gurumani, N., 2006. Research methodology for biological sciences, MJP, Chennai. 753pp.
6. Harvey Motulsky, 2015. Essentials of Biostatistics. A non mathematical approach. Oxford University Press. New York. 208pp.
7. Michael C., Whit lock and Dolph Schluter, 2009. The analysis of biological data, 2ndEd.MacMillanPublishers,NewYork,USA.818pp.
8. Narayanan, R., 2010. Essentials of biophysics, II Ed., New age International publishers, Chennai. 546pp.
9. Pranab Kumar Banerjee, 2014. Introduction to biostatistics (A Text Book of Biometry, S. Chand & Company Ltd. New Delhi, India. 208pp.
10. Rodney M.J, Cotterill, 2002. Biophysics : An introduction, John Wiley & Sons Ltd. New York. 400pp.
11. Ronser,B.,2006. Fundamentals of Biostatistics, Thomson Brooks/ Cole, 6thEd. Duxbury press,Singapore.784pp
12. Sail Bose, 2000, Elementary Biophysics, Vijaya printers, Maduari.

Web Resources:

1. <https://bit.ly/2XGFuML>
2. <http://www.life.uiuc.edu/molbio/geldigest/electro.html>
3. http://users.stat.ufl.edu/~winner/sta6934/st4170_int.pdf
4. <http://www.biostathandbook.com/analysissteps.html>
5. <https://bit.ly/3nXUIrD>
6. https://onlinecourses.nptel.ac.in/noc19_bt19

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO 1	S							
CO 2	M	S						
CO 3				S		S		
CO 4				S	S	M		
CO 5			S					S

S-Strong

M-Medium

L-Low

Semester	ELECTIVE – V	H/W	C
V	Course Code: 23UZOOE55-2 Course Title: WILD LIFE CONSERVATION & MANAGEMENT	4	3

Course Objective :

1	To understand and discuss the importance of wildlife, its values, modern concepts in wildlife management, and relevant conservation policies.
2	To assess and instill strong foundations on wildlife policies and be familiar with a variety of laws and regulations.
3	To analyse and design appropriate approaches to turn conflict into tolerance and coexistence, with an emphasis on the human dimensions of human-wildlife interactions.
4	To evaluate and integrate all the related areas like Fundamentals in Ecology, Forestry, Natural Resource Conservation approaches and develop the role PVA models for protection of Endangered species.
5	To explain the advanced scientific basis for wildlife management and discuss National and International Efforts for successful wildlife conservation.

Unit I :Biodiversity Extinction and Conservation Approaches :

Perspectives and Expressions. Identification and prioritization of Ecologically sensitive area (ESA). Coarse filter and fine filter approaches. Regional and National approaches for biodiversity conservation.

Unit II: Theory and Analysis of Conservation of Populations :

Stochastic perturbations - Environmental, Demographic, spatial and genetic stochasticity. Population viability analysis-conceptual foundation, uses of PVA models. Management Decisions for small populations using PVA models. Minimum viable populations & recovery strategies for threatened species.

Unit III: National and International Efforts for Conservation :

International agreements for conserving marine life, Convention on wetlands of International Importance (Ramsar convention), Conservation of Natural Resources. Overview of conservation of Forest & Grassland resources. CITES, IUCN, CBD National Forest Policy, 1988, National Wildlife Action Plan 2017-2031, Wildlife Protection Act 1972.

Unit IV: Wildlife in India :

Wildlife wealth of India & threatened wildlife, Reasons for wildlife depletion in India, Wildlife conservation approaches and limitations. Wild life Habitat: Characteristic, Fauna and Adaptation with special reference to Tropical forest. Protected Area concept: National Parks, Sanctuaries and Biosphere Reserves, cores and Buffers.

Unit V: Management of Wildlife :

Distribution, status. Habitat utilization pattern, threats to survival of Slender Loris, Musk deer, Great Indian Bustard, Olive Ridley turtle. Wild life Trade & legislation, Assessment, documentation, Prevention of trade, Wild life laws and ethics.

Expected Course Outcomes (COs)

At the end of the course, the student will be able to

1	To understand and recall the importance of wildlife, extinction and Conservation Approaches of wildlife.
2	To integrate and assess the National, international approaches for biodiversity conservation.
3	To analyse and differentiate threats to wildlife, various action plans, conservation strategies on wildlife of India to turn conflict into tolerance and coexistence.
4	To explain the role PVA models, Wildlife conservation approaches, and limitations.
5	To construct and simulate National and International strategies for Conservation, Wild life laws and ethics.

Text Books:

1. Robinson W L and Eric G Bolen, 1984. Wildlife Ecology and Management, Maxmillan Publishing Company, New York, p 478.
2. Aaron, N.M.1973 Wildlife ecology, W.H. Freeman Co. San Francisco, U.S.A.
3. Dasmann R F, 1964. Wildlife Biology, John Wiley & Sons, New York, p 231.
4. Justice Kuldip Singh 1998. Handbook of Environment, Forest and Wildlife Protection Laws in India, Natraj Publishers, Dehradun.
5. Hosetti, B.B. 1997 Concepts in Wildlife Management, Daya Publishing House, Delhi.
6. Sutherland, W.J 2000. The conservation handbook: Research, Management and Policy. Blackwell Science.
7. Caughley.G and Sinclair, A.R.E 1994 Wildlife ecology and management. Blackwell Science.
8. Woodroffe R, Thirgood, S. and Rabinowitz A. 2005.People and Wildlife, Conflict or Co existence? Cambridge University.
9. Sinha, P.C. 1998. Wildlife and Forest Conservation, Anmol Publishing Pvt. Ltd., New Delhi.
10. Singh, S.K, 2005. Text Book of Wildlife Management. IBDC, Lucknow.

Suggested Readings

1. Gilas R H Jr.(ed.), 1984. Wildlife Management Techniques, 3rd ed. The Wildlife Society, Washington D.C., Nataraj Publishers, Dehra Dun, p 547.
2. Rodgers W A, 1991. Techniques for Wildlife Census in India - A Field Manual: Technical Manual - T M - 2. WII.
3. Saharia V B, 1982. Wildlife of India, Natraj Publishers, Dehra Dun.
4. Goutam Kumar Saha and SubhenduMazumdar, 2017. Wildlife Biology: An Indian Prospective, PHI Publisher, Delhi.
5. Katwal/Banerjee, 2002. Biodiversity conservation in managed and protected areas, Agrobios, India.
6. Gopal, Rajesh,1992. Fundamentals of Wildlife Management, Justice Home, Allahabad, India.
7. Sharma, B.D, 1999. Indian Wildlife Resources Ecology and Development, Daya Publishing House, Delhi.
8. Stephen, H.B. and V.B. Saharia,1995. Wildlife research and management. Asian and American Approaches, Oxford University Press, Delhi.
9. Negi, S.S. 1993. Biodiversity and its conservation in India, Indus Publishing Co., New Delhi.
10. Moulton, M. P. & J. Sanderson, 1997. Wildlife Issues in a Changing World. St. Lucie Press.

Web resources

1. <https://bit.ly/39oPj44>
2. <https://bit.ly/3IHdEYJ>
3. <https://bit.ly/3CwBCfY>
4. <https://bit.ly/3EDYr3a>

5. <https://bit.ly/3tVtG4U>

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO 1	S							
CO 2	M	S						
CO 3				S		S		
CO 4				S	S	M		
CO 5			S					S

1. S-Strong M-Medium L-Low

Semester	ELECTIVE – VI	H/W	C
V	Course Code: 23UZOOE56-1 Course Title: BIO COMPOSTING FOR ENTREPRENEURSHIP	4	3

Course Objectives :

1	To highlight the importance of Biocomposting for entrepreneurship in waste management.
2	To enable students for setting up Biocompost units and bins for waste reduction.
3	To create knowledge on Self - Employment opportunity
4	To understand the potential of vermicompost as an alternative to chemical fertilizer
5	To understand the role of vermiculture in protecting the environment and managing the waste

Unit – I: Biocomposting – Definition, types and ecological importance.

Unit – II: Types of Biocomposting technology – Field pits/ground heaps/ tank/large-scale/batch and continuous methods.

Unit – III : Preparation of Biocompost pit and bed using different amendments.

Unit – IV: Applications of Biocompost in soil fertility maintenance, promotion of plant growth, value added products, waste reduction, etc.

Unit – V: Economics of establishment of a small biocompost unit – project report proposal for Self Help Group (Income and employment generation).

Expected Course Outcomes (COs)

At the end of the course, the student will be able to

1	Learn about the characteristics and biology of earthworm
2	Get an in depth knowledge about the culture techniques
3	Understand about the methods of composting
4	Learn the factors for proper maintenance of the vermicomposting beds
5	Learn about the application and marketing of the compost.

Text Books (In API Style)

1. Edwards, C.A., and Bother, B. 1996: Biology of Earthworms - Chapman Hall Publ. Co., London
2. Ismail, S.A. 1997: Vermitechnology - the Biology of Earthworms - Orient Longman Publ. - India.
3. Ranganathan, L.S. 2006: Vermibiotechnology from soil health to Human health - Agrobios - India.
4. Bikas R. Pati & Santi M. Mandal (2016). Recent trends in composting technology.
5. Van der Wurff, A.W.G., Fuchs, J.G., Raviv, M., Termorshuizen, A.J. (Editors) 2016. Handbook for Composting and Compost Use in Organic Horticulture. BioGreenhouse COST Action FA 1105, www.biogreenhouse.org

Supplementary Readings

1. Talashikar, S.C. 2008: Earthworms in Agriculture - Agrobios - India
2. Gupta, P.K. 2008: Vermicomposting for sustainable agriculture [2nd edition] - Agrobios -

India.

3. Rajeev Prathap Singh. 2012: Organic Fertilizers: Types, Production and Environmental Impact
Nova Science Inc. New York

Outcome Mapping

PO/CO	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	3	1
CO2	3	3	3	3	1
CO3	3	3	3	3	1
CO4	3	3	3	3	1
CO5	3	2	3	3	1

Semester	ELECTIVE – VI	H/W	C
V	Course Code: 23UZOOE56-2 Course Title: BASIC COURSE IN ORNITHOLOGY	4	3

Course Objectives :

1	To equip students with the required knowledge to understand the taxonomic position and role played by birds in the ecosystem, their importance to humans and their evolution
2	To enable students to comprehend the biological evolution of birds and their structural adaptations
3	To enable students to understand and learn aspects of bird behaviour
4	To enable students to learn about the breeding biology of birds
5	To equip students with a knowledge of macroecology of birds, bird populations and communities, bird diseases, bird conservation and on the role of citizen science in ornithology

Unit I: Introduction to Ornithology; Bird Lore; Birds and Humans; Classification of Birds, Bird Evolution and Speciation; Endemism

Unit II: External Morphology of the Bird; Structure of bird feather, Internal Structure of the Bird; Adaptations to Flight

Unit III: Bird Behaviour: Foraging, Roosting, Vocalization, Imprinting, Feather care, Bird Intelligence, Social Behaviour, Mixed Species Flocks, Migration

Unit IV: Breeding Biology: Differential investment of sexes; territoriality, courtship and display behaviour, nesting, eggs, incubation and care of young, brood parasitism

Unit V: Studying bird populations and communities, sampling methods; Macro ecology; Molecular Techniques in Ornithology; Avian Disease; Citizen Science and Ornithology; Threats faced by birds; Bird Conservation with case studies

Expected Course Outcomes (COs)

At the end of the course, the student will be able to

1	Recall the taxonomic position of birds, their external morphology and internal parts, types of bird behaviour, sampling methods and types of avian diseases.
2	Identify the external parts of the bird, internal structures of the bird and different types of bird behaviour
3	Differentiate birds based on their morphology, foraging strategies and other behaviour
4	Explain and discuss how birds evolved, bird adaptations to flight, different aspects of bird behaviour, threats to birds and the role of citizen science in ornithology
5	Discuss and analyse case studies relating to bird conservation

Reference Books

1. Lovette, I.J and Fitzpatrick, J.W. (2016). *Handbook of Bird Biology*, 3rd ed. Wiley.
2. Birkhead, T. (2013). *Bird Sense: What it's like to be a bird?* Bloomsbury, NY.

3. Birkhead, T., Wimpenny, J., and Montgomerie, B. (2014). *Ten Thousand Birds: Ornithology since Darwin*. Princeton University Press, Princeton, NJ.
4. Gill, F.B, and Prum, R.O. (2019). *Ornithology*, 4th ed. Macmillan.

Web Sources

1. <https://txmn.org/elcamino/files/2010/03/Ornithology-Basic-Concepts.pdf>
2. <https://www.freebookcentre.net/biology-books-download/Ornithology-Lecture-Notes.html>
3. https://onlinecourses.nptel.ac.in/noc22_ge10/preview
4. https://www.researchgate.net/publication/356285288_Bird_identification_and_basic_ornithology_technical_report
5. https://www.academia.edu/43837886/Green_Skill_Development_Programme_A_Course_on_Basic_Ornithology_and_Bird_Identification

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO 1	S							
CO 2	M	S						
CO 3				S		S		
CO 4				S	S	M		
CO 5			S					S

S-Strong

M-Medium

L-Low

SEMESTER V	23UZOOI58 SUMMER INTERNSHIP	H/W	C
CORE – XIII		-	2

(Refer to the Regulations)

SEMESTER VI

Semester	CORE – XIII	H/W	C
VI	Course Code: 23UZOOC61 Course Title: ENVIRONMENTAL BIOLOGY	6	4

Course Objectives :

1	To understand the structure and functions of the ecosystem.
2	To explain the relationship between biotic and abiotic factors in an ecosystem.
3	To know the causes and effects of climate change and habitat loss.
4	To bring awareness about the impact of socio-economic development on the environment and the solutions put forward by the government to reduce environmental damage.
5	To bring awareness about Biodiversity Conservation

UNIT I : Ecosystem : Concept of an ecosystem-Structure and function of an ecosystem- Producers, consumers and decomposers-Energy flow in the ecosystem-Ecological succession-Food chains, food webs and ecological pyramids-Introduction, types, characteristic features, structure and function of the following ecosystem : Forest ecosystem-Grassland ecosystem-Desert ecosystem-Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries).

UNIT II : Population And Biological Cycles : Structure and distribution – Growth curves - Groups, natality, Mortality -Density indices, Life study tables - factors affecting population growth -Carrying capacity. Population regulation and human population control. Complete and incomplete biogeochemical cycles - Sedimentary cycle.

UNIT III : Environmental Stresses And Management :Global climatic pattern, global warming, atmospheric ozone, acid and nitrogen deposition. Uptake, biotransformation, elimination and accumulation of toxicants. Factors influencing bioaccumulation from food and trophic transfer. Pesticides and other chemical in agriculture, industry and hygiene and their disposal. Bio indicator and biomarkers of environmental health. Biodegradation and bioremediation of chemicals.

UNIT IV : Environmental Pollution: Definition- cause, effects and control measures of: - Air pollution - Water pollution -Soil pollution -Marine pollution - Noise pollution - Thermal pollution -Nuclear hazards.Solid Waste Management:-Causes, effects, control measures and disposal of wastes-Disaster management:-Floods, earthquakes, cyclone, landslides and tsunami

UNIT V : Biodiversity Conservation: Biodiversity crisis – habitat degradation, poaching of wild life. Socio economic and political causes of loss of biodiversity. - In situ and ex situ conservation of biodiversity -Hot spots of Biodiversity. Green peace movement - Chipko Movement - Role of government agencies: Central and State Pollution Control Boards - Ministry of Environment and Forests- National Biodiversity Authority. Awareness, Programme, NGOs, Natural Disaster Management, Legislations for environmental Protection, Bio villages – sustainable utilization and development, Environmental ethics.

Expected Course Outcomes (COs)

At the end of the course, the student will be able to

1	Understand the fundamental structure and functions of the ecosystem.
2	Assess the inter-relationship between organisms and between biotic and abiotic factors in an ecosystem.
3	Analyze the factors that cause pollution, climate change, loss of biodiversity and depletion of resources.
4	Evaluate the impact of human population growth and socio-economic development on the structure and function of the ecosystem.
5	Design plans to scientifically solve environmental problems using biological tools, technologies and government policies.

Text Books

1. Matthew R. Fisher, 2018. Environmental Biology. Open Oregon Educational Resources. James Madison University.
2. Asthana, D.K. and Meera, A. 2009. A text book of environmental studies, S. Chand, New Delhi.
3. Sanyal, K. Kundu, M. and Rana, S. 2009. Ecology and environment, Books and allied, Kolkata.
4. Grant, W.E. and Swannack, T.M., 2008, Ecological Modelling, Blackwell

Reference Books

1. Odum E.P. 1983. Basic Ecology, Saunders, New York
2. Wilkinson, D.M., 2007, Fundamental Processes in Ecology: An Earth system Approach, Oxford University Press, UK.
3. Saha, T.K. 2010. Ecology and Environmental biology, Books and Allied, Kolkata.

Web Resources

1. <https://bit.ly/2VYWOM5>
2. <https://bit.ly/2VZQFiT>
3. <https://bit.ly/3kqdXYA>
4. <https://bit.ly/39rvvgt>

Mapping with Programme Outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO 1	S							
CO 2	M	S						
CO 3				S		S		
CO 4				S	S	M		
CO 5			S					S

S-Strong(3)

M-Medium (2)

L-Low (1)

Semester	CORE – XIV	H/W	C
VI	Course Code: 23UZOOC62 Course Title: EVOLUTION	6	4

Course Objectives :

1	Evolutionary biology is a branch of the biological sciences concerned with the origin of life and the diversification and adaptation of life forms over time.
2	This course helps to understand the important processes, principles, and concepts on evolution.
3	To provide adequate information on the Lamarckism - Neo Lamarckism – Darwinism, Neutral Theory of Molecular Evolution, and Human Genome Project.
4	To explain the importance of the fossil records in evolutionary studies, and the role of phylogenetic studies in the wider context of biodiversity and conservation.
5	In this course, we will apply the knowledge of human evolutionary history to simulate how genetic variation within and among human populations affects risk, diagnosis, and treatment of modern diseases.

UNIT I : Inorganic and organic evolution-History of evolutionary thought, , Chemical origin of life: Synthesis of organic molecules, Urey-Miller experiment, Origin of prokaryotes and eukaryotes; Evidences Morphological, physiological and biochemical, embryological, Taxonomical and geographical evidences -Palaeontological evidences

UNIT II : Lamarckism - Neo Lamarckism - Darwinism - Neo Darwinism and modern synthetic theory - DeVrie's Mutation theory – modern concepts of mutation – colouration and mimicry Natural selection and Variation.

UNIT III : Isolation - Isolating mechanisms - speciation- Law of Adaptive Radiation- Adaptive radiation in reptiles and mammals - Animal colouration and Mimicry.

UNIT IV : Geological time scale; Nature of fossils- Dating of fossils - Fossil records of man and fossil records of horse – living fossils; Distribution of animals.

UNIT V : Eugenics, Euphenics and Euthenics- Adaptation of animals- Evolution of Man and Horse.

Expected Course Outcomes (COs)

At the end of the course, the student will be able to

1	Analyse the evolutionary history of biological organisms
2	Critically assess the evolutionary relationship among various phyla
3	Identify the role of natural selection in the survival of the species
4	Understand the various mechanisms involved in evolution.
5	Students will be able to explain how speciation occur and reasons for extinction.

Text Books

1. Ridley, M., 2004. Evolution. III Edition. Blackwell Publishing.
2. Lull, R.S. 2010. Organic evolution, The Macmillan, New York.
3. Minkoff, E. C. (1983). Evolutionary biology. Reading, MA: Addison-Wesley Publishing Company
4. Sober, E. (1994). Conceptual issues in evolutionary biology. Cambridge, MA: MIT Press.
5. Dr. Kishore R. Pawar, Dr. Ashok E. Desai, 2019. A text book of Organic Evolution, Nirali Prakashan,
6. Rastogi VB. 1991. Organic Evolution. Kedar Nath Ram Nath Publications, Meerut, Uttar Pradesh, India.
7. Strickerger, M.W., 1996. Evolution. Jones& Bartlett, USA
8. Colbert, E.H. Morales, M. and Minkoff, E.C. 2011. Colbert's Evolution of The Vertebrates: A History of the Backboned Animals Through Time, Wiley, India

Reference Books

1. Burns GW. 1972. The Science of Genetics. An Introduction to Heredity. Mac Millan Publ. Co.Inc.
2. Gardner EF. 1975. Principles of Genetics. John Wiley & Sons, Inc. New York.
3. Harth and Jones EW. 1998. Genetics – Principles and Analysis. Jones and BarHett Publ. Boston.
4. Levine L. 1969. Biology of the Gene. Toppan.
5. Pedder IJ. 1972. Genetics as a Basic Guide. W. Norton & Company, Inc.
6. Rastogi VB. 1991. A Text Book of Genetics. Kedar Nath Ram Nath Publications, Meerut, Uttar Pradesh, India.
7. White MJD. 1973. Animal Cytology and Evolution. Cambridge Univ.Press

Web Sources

1. <https://bit.ly/3nPD09m>
2. <https://bit.ly/3CHOdgL>
3. <https://bit.ly/2XvcCXl>
4. <https://bit.ly/2XAL1Vh>
5. <https://bit.ly/3zoU9Jl>

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO 1	S							
CO 2	M	S						
CO 3				S		S		
CO 4				S	S	M		
CO 5			S					S
S-Strong(3)			M-Medium (2)			L-Low (1)		

Semester	CORE – XV	H/W	C
VI	Course Code: Course Title: PRACTICAL VI : 23UZOOP63 ENVIRONMENTAL BIOLOGY & EVOLUTION	6	4

Course Objectives :

1	To demonstrate an understanding of core ecological principles, and define scientific principles and concepts as related to environmental studies
2	To study the ecological principles, and define scientific principles and concepts as related to chemical factors
3	To study various instruments related to environmental factors.
4	To study various paleontological studies in Invertebrates and Vertebrates instruments related to environmental factors.
5	To study various Mimicry and Colouration in Insects

UNIT I : Estimation of Dissolved oxygen, salinity, Ph and CO₂, in water samples.

UNIT II: Estimation of Carbonates and BiCarbonates in water samples

UNIT III: Plankton study : Freshwater and marine plantons and their environmental significance

UNIT IV: Use of rain Gauge, Maximum and Minimum Thermometer, Hygrometer and Anemometer..Study of Fossils- Trilobite, Archaeopteryx Study of living fossils- Limulus, sphenodon Connecting link – peripatus Evolutionary significance – Exocoetus, Draco, Sea Horse, Rhinoceros beetle -Mimicry and colouration Warning Mimicry-Viceroy and Monarch butterfly

UNIT V : Study of natural Ecosystem and field report

Expected Course Outcomes (COs)

At the end of the course, the student will be able to

1	The student will be able to understand the presence dissolved oxygen, salinity, pH in water samples.
2	The student will be able to understand the presence CO ₂ , Silicate and Iron in water samples.
3	The student will be able to understand the usage of various instruments to observe climatic conditions
4	The student will be able to study the Fossils of Animals
5	The student will be able to study the Mimicry and colouration of insect to protect themselves

Text Books

1. Kotpal. R.L, and N.P. Bali, 1986. Concepts of Ecology, Vishal Publications, New Delhi – 7
2. Rastogi V.B, and M.S. Jayaraji, 1988 – 1989. Animal Ecology and Distribution of animals,
3. Kedar nath, Ram Nath Meerut – 250 001

- Clark, G.L. 1954, Elements of Ecology, John Wiley & Sons Inc., New York, London.
- Eugene P. Odum, 1971. Fundamentals of ecology, Saunders International Student Edition, W.B. Saunders Company, Philadelphia London, Toronto.
- Verma, P.S and Agarwal 1986, Environmental Biology, S. Chand & Co Ltd. Richard, Manual of wild life conservation.
- T.K.Ranganathan, Evolution. 1994 Rainbow Printers, Palayankottai.
- Arumugam.N. Organic Evolution, 2009 Saras. Publ. Nagarcoil, anyakumar Dt.
- Vermas, P.S and V.K.Agarwal, 2015 Cell Biology, Genetics and Molecular Biology, Evolution and Ecology, S.Chand & Company, New Delhi

Web Resources

- http://pustaka.unp.ac.id/file/abstrak_kki/EBOOKS/A%20Comprehensive%20Laboratory%20Manual%20for%20Environmenta%20Science%20and%20Engineering.pdf
- https://www.researchgate.net/publication/324586214_Environmental_science_-_A_practical_manual
- <https://www.nile-center.com/uploads/DTGB3E32CW9G6H8.pdf>
- <https://eclearn.emmanuel.edu/courses/1768319/files/79906065/download?verifier=nlwecNlAMAbL0ujw6TYJQIWVxrdZjuyJ1nWPcDc&wrap=1>
- https://sos.cg.nic.in/E-Books/12th/English/eng-book%20314%20Biology/Lab_Manual.pdf

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO 1	S							
CO 2	M	S						
CO 3				S		S		
CO 4				S	S	M		
CO 5			S					S
S-Strong(3)			M-Medium (2)			L-Low (1)		

Semester	ELECTIVE – VII	H/W	C
VI	Course Code: 23UZOOE64-1 Course Title: BIOINSTRUMENTATION	5	3

Course Objectives :

1	To induce interest in the use of various biological instrumentation and employ them for the study of cells, tissues and genetic material.
2	To help students to map the use of specific bioinstrumentation for specific biological experiments and infer the results of such experiments.
3	To study the working principle of different bioinstrumentation and their applications.
4	To enable students to design experiments and justify them with the underlying principles of bioinstrumentation.
5	To study the working principle of Molecular Techniques

Unit I: Good Laboratory Practices: Guide lines, Laboratory symbols; Cleaning and sterilization of lab ware and reagents; Safety and ethical issues in laboratory settings; handling and care of laboratory animals. Laminar flow hood: types and use; Concepts of molecular weight, atomic weight, preparation of solutions of a particular molarity and percentage; pH meter.

Unit II: Microscopy - Light microscope, SEM, TEM, Atomic force microscope; Fluorescence activated cell sorting; X-ray crystallography.

Unit III: Centrifugation - working principle and types of centrifugation; Spectrophotometry; Mass spectrometry; Chromatography - principle and types of chromatography

Unit IV: Biomedical Instrumentation : ESR measurement, haemoglobin measurement, blood pressure, blood flow, ECG, cardiac pacemakers; X- ray imaging, CT scan and NMR imaging; Biosensors - glucose biosensor, alcohol biosensor, artificial retina, environmental biosensors, cantilever-based biosensors, DNA biosensor.

Unit V: Molecular Techniques : Isolation of DNA, RNA and proteins; Electrophoresis of DNA and proteins; Polymerase chain reaction; ELISA.

Expected Course Outcomes (COs)

At the end of the course, the student will be able to

1	To describe and explain the steps in the use of various biological instrumentation that are used in the study of different animal specimens.
2	To relate the applications of biological techniques and employ them for the study of cells, tissues and genetic material.
3	To correlate and appraise the use of specific bioinstrumentation for specific biological experiments and infer the results of such experiments.
4	To compare the working principle of different bioinstrumentation and to summarize their applications.
5	To devise experiments and justify them with the understanding of the underlying principles of bioinstrumentation that are ecofriendly, ethical and

	have national and global relevance.
--	-------------------------------------

Text Books

1. SabariGhosal and Anupama Sharma Avasthi, 2018. Fundamentals of Bioanalytical Techniques and Instrumentation, 2nd Ed., Phi Learning Pvt. Ltd., New Delhi, India.
2. Veerakumari L., 2015. Bioinstrumentation, MJP Publishers, Chennai, India.
3. Prakash Singh Bisen, Anjana Sharma, 2012. Introduction to Instrumentation in Life Sciences, CRC Press, Taylor & Francis Group, New York, USA.
4. Gupta P.C., 2010. Biological Instrumentation and Methodology (Tools & Techniques), S. Chand & Company Limited, New Delhi, India.
5. Ghatak K. L., 2010. Techniques and Methods in Biology, Phi Learning Pvt. Ltd., New Delhi, India.

Suggested Readings

1. Sue Carson, Heather Miller, Melissa Srougi and Scott Witherow, 2019. Molecular Biology Techniques: A Classroom Laboratory Manual, Academic Press, New York, USA.
2. Aysha Divan, Janice Royds, 2013. Tools and Techniques in Biomolecular Science, Oxford University Press, UK.
3. Gordon M.H., Macrae R., 2012. Instrumental Analysis in the Biological Sciences, Blackie & Son Ltd., UK
4. Leonard Davis, Mark Dibner and James Battey, 2012. Basic Methods in Molecular Biology, Elsevier Science Publishing Co., New York, USA.
5. Wilson, K.M. and Walker, J.M., 2010. Principles and Techniques of Biochemistry and Molecular Biology, Cambridge University Press, UK.

Web Resources

1. <https://bit.ly/3i5flym>
2. <https://pbiol.rsb.org.uk>
3. <https://www.nature.com/subjects/biological-techniques>
4. <https://www.ibiology.org>

Semester	ELECTIVE – VII	H/W	C
VI	Course Code: 23UZOOE64-2 Course Title: BIOTECHNOLOGY	5	3

Course Objectives :

1	To impart the skills required to explain the protocols for genetically manipulating cells and produce transgenic animals.
2	To encourage the use of the apt molecular techniques to evaluate and analyze animal traits and diseases at the genomic level and employ methods for easy taxonomical identification and classification for biodiversity and environmental studies.
3	To study methods of transgenesis and to consider their use in improving animal husbandry and animal health.
4	To motivate students to review the ethics and speculate on the environmental implications of animal biotechnological methods
5	To impart the skills required to explain the protocols for genetically manipulating cells and produce transgenic animals.

UNIT I : Fundamentals of Biotechnology : Animal cell culture: Basic requirements and techniques of cell culture, natural and synthetic culture media, primary culture and cell lines; Stem cells: types, culture and applications; r-DNA technology: Enzymes; Vectors – pBR322, Phage lambda, Cosmid, HAC, BAC, YAC; Host cells; Gene cloning: steps in cloning, selection of clones – chromogenic substrate, antibiotics.

UNIT II : Techniques in Animal Biotechnology :

Isolation and purification: DNA and mRNA; Blotting techniques: Methods of different types of blotting; DNA sequencing: Sanger method, DNA chips, microarray; PCR: principle, types and application; Gene library: screening with probes; Site directed mutagenesis: principle and application; Gene transfer in animal cells: transfection, liposomal, viral mediated, electroporation, biolistic, direct DNA injection.

UNIT III : Transgenic Animal Technology :

Transgenesis: Concept, transgenes, transgenic animal models – knock out mice, sheep; Applications of transgenesis: Molecular farming, Transgenic fishes, transgenic livestock, and animals as bioreactors.

UNIT IV : Animal Biotech and Health Care :

Medical biotechnology: Monoclonal antibodies, recombinant vaccines –hepatitis B, hormones – insulin. DNA diagnostic systems: tuberculosis, AIDS, genetic diseases; Gene therapy: Ex vivo and in vivo, role in cancer treatment; CRISPR gene editing. Molecular markers: RFLP, RAPD, DNA fingerprinting and application.

UNIT V : Applications and Ethics :

Human genome project: Mapping of human genome, applications, ethics; Industrial biotechnology: Bioreactors - Basic concepts of fermentation, bioreactor design, production of ethanol and streptomycin; Ethics: Socio ethical problem, recent trends in animal biotechnology, ethical implications.

Expected Course Outcomes (COs)

At the end of the course, the student will be able to

1	To describe the methodologies for handling animal cells based on their diverse characteristics and identify the correct biotechnological tools to obtain the desired products from the cells.
2	To develop and explain the protocols for genetically manipulating cells and produce transgenic animals
3	To select the apt molecular techniques to evaluate and analyze animal traits and diseases at the genomic level and devise methods for easy taxonomical identification and classification for biodiversity and environmental studies.
4	To choose the correct methods of transgenesis and to consider their use in improving animal husbandry nationally and globally
5	To speculate on the environmental implications of animal otechnological methods and design responsible, ethical solutions to livestock production and health issues.

Text Books

1. Singh B. D., 2015. Biotechnology: Expanding horizon, Kalyani publishers.
2. Sasidhara, R., 2015. Animal biotechnology, MJP publishers.
3. Dubey R. C., 2014. A text Book of Biotechnology, S. Chand & Co Ltd, Ram Nagar, New Delhi.
4. Dubey S. K., Bandana Ghosh, 2012. Fish biotechnology, Wisdom Press.
5. Dubey R.C., 2014. Advanced Biotechnology, S. Chand Publication.
6. Ruby, R.C., 2012. A text book of biotechnology, S. Chand Company, New Delhi.
7. Sambamurthy K., Ashutosh Kar., 2009. Pharmaceutical Biotechnology, New Age International (P) Ltd.
8. Ramdoss P., 2009. Animal Biotechnology- Recent concepts and developments, MJP publishers.
9. Sathyanarayan U., 2008. Biotechnology, Books and Allied, Kolkata.
10. Ignacimuthu, S., 2008. Basic Biotechnology, Tata McGraw hill, New Delhi.
11. Rastogi S. C., 2007. Biotechnology: Principles and applications, Alpha Science publishers
12. Ranga, M.M., 2003. Animal biotechnology, Agrobios, New Delhi.

References

1. Veer Bala Rastogi, 2016. Principles of Molecular biology, Medtech, Maine, USA.
2. Michael Crichton, 2014. Essentials of Biotechnology, Medtech, Maine, USA.
3. Godbey W.T., 2014. An Introduction to Biotechnology, Academic press, New York, USA.
4. Peters, P., 2009. Biotechnology – A guide to genetic engineering, WMC brown publisher, UK.
5. Ramawat, K.G and Shailey Goyal, 2009. Comprehensive biotechnology, S.Chand company, New Delhi, India.
7. Primrose S.B., R. M. Twyman and R. W. Old, 2001. Principles of gene manipulation, Wiley- Blackwell, UK.
8. Primrose S. B., 2001. Molecular Biotechnology, Panima Publishing Corporation, New Delhi, India.
9. Hames B.D. and Higgins S.J. 1995. Gene Probes: A Practical Approach, Oxford University Press, UK

Web Resources

1. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3612824/>
2. <https://www.isaaa.org/resources/publications/pocketk/40/default.asp>
3. <https://www.ncbi.nlm.nih.gov/books/NBK207574/>
4. <https://iopscience.iop.org/article/10.1088/1755-1315/492/1/012035/pdf>
5. <https://go.nature.com/3zAZmO9>

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO 1	S							
CO 2	M	S						
CO 3				S		S		
CO 4				S	S	M		
CO 5			S					S
S-Strong(3)			M-Medium (2)		L-Low (1)			

Semester	ELECTIVE – VIII	H/W	C
VI	Course Code: 23UZOOE65-1 Course Title: MICROBIOLOGY	5	3

Course Objectives :

1	To become familiar with the foundation concepts of history of Microbiology
2	To understand the structure and functions of a typical prokaryotic cell
3	To gain the knowledge of microscopy and staining concepts
4	To understand and implement disposal and safety measures
5	To gain the knowledge of Virus Structure and Classification

UNIT I : Introduction to microbiology

History, scope, branches of microbiology. Contribution of Leeuwenhoek, Jenner, Pasteur, Koch, Fleming, Iwanowsky, Waksman, Luria, M. J. Thirumalachar, Subba Rao, Sambhu Nath De. Evolution of Microbial diversity. Systematic position: 5 kingdom classification of Whittaker and 3 kingdom classification of Carl Woese. Comparison of Bacteria, Archaea, Eukarya (tabular and diagrammatic). Controlling microbes.

UNIT II : Microscopy

Principles of microscopy ii. Compound microscope (Monocular and Binocular microscopes) – construction and function of parts, ray diagram of path of light, objectives, oculars, condensers, sources of illumination and uses iii. Dark field, Phase contrast and Fluorescence microscopes, , - principle, construction, ray diagram and applications iv. Electron microscopy – TEM and SEM – principle, construction, ray diagram and uses.

UNIT III : Introductory Mycology

General characteristics and outline classification of fungi, Morphology of some common fungi - Mucor, Rhizopus, Aspergillus, Penicillium and Fusarium. Yeasts: General characteristics and outline classification of yeasts, General characteristics of Lichens and Mycorrhiza.

UNIT IV : Introductory Bacteriology

Classification of bacteria. Anoxygenic photosynthetic bacteria: general characteristics of purple bacteria and green bacteria. Oxygenic photosynthetic bacteria: General characteristics of Cyanobacteria – external and internal features, physiology and ecology. Magnetotactic bacteria- General characteristics, Magnetosomes, Enrichment and isolation of Magnetotactic bacteria. Types of staining.

UNIT V : Introductory Virology

Virus Structure and Classification. Virus Entry and Viral Pathogenesis. Positive-strand RNA viruses: Picornaviruses, Flaviviruses, Togaviruses, Coronaviruses. Negative-strand and double-strand RNA viruses: Paramyxoviruses, Rhabdoviruses, Filoviruses, Bunyaviruses, Orthomyxoviruses and Reoviruses. DNA viruses: Parvoviruses, Polyomaviruses, Papillomaviruses, Adenoviruses and Baculoviruses, Herpes viruses and Poxviruses.

Expected Course Outcomes (COs)

At the end of the course, the student will be able to

1	To understand history, relevance of microbiology and classification of bacteria
2	To understand the working of various microscopes and their application

3	To gain knowledge of various (physical and chemical) methods of control of microorganisms and safety measures to be followed while handling microbes
4	To understand the structure of bacterial cells, its organelles, physiology and behaviour.
5	To learn different methods of staining bacteria and demonstrate proficiency in handling aseptic bacteriological specimen.

Text Books

1. Aneja K.R., Experiments in Microbiology, plant pathology, Tissue culture and Mushroom Cultivation, New Age International, New Delhi.
2. Atlas R.M., Microbiology – fundamentals and applications, Macmillan Publishing Company, New York.
3. Ravindra Nath, Fundamentals of Biology Courses for Biotechnology, - Vol.1, Special Bangalore University edition, Kalayani Publishers.
4. Greenwood D, Richard CD, John S and Peuther F (1992). Medical Microbiology, 16th edition. ELBS, Churchill living stone.

References

1. Alexopoulos C.J. and Mims C.W., Introductory Mycology, New Age International, New Delhi.
2. Thomas M. Bell, 1965. An Introduction to General Virology, William Heinemann Medical books, London.
3. Stanier R.Y., Ingraham J.L., General Microbiology, Prentice Hall of India Private Limited, New Delhi.
4. Salle A.J., Fundamental Principles of Bacteriology, Tata McGraw – Hill Publishing Company Limited, New Delhi.
5. Pelczar .J. Chan E.C.S. and Krieg N.R., Microbiology, McGraw Hill Book Company, New York.
6. Benson Harold J, Microbiological Applications, WCB McGraw – Hill, New York.
7. Brock T.D. and Madigan M.T., Biology of Microorganisms, Prentice Hall of India Private Limited.
8. Collins CH, Patricia M, and Lyne JM (1995). Collins and Lynes Microbiological Methods 7th edition. Grange, Butter Worth, Oxford.
9. Cappucino JG and Sherman N (1996). Microbiology, A Laboratory Manual 4th edition. Benjamin Cumings Inc. California.
10. Pelczar MJ, Chan ECS and Krieg NR (1993). Microbiology 5th edition, Tata McGraw Hill.
11. Madigan MT, Martinko JM and Parker J (2012). Brock Biology of Microorganism, 11th edition Prentice Hall International Inc. London.

Web Resources

1. <https://vlab.amrita.edu/?sub=3&brch=73>
2. <https://learn.chm.msu.edu/vibl/>
3. <https://mvi-au.vlabs.ac.in/>
4. <https://virtuallab.tlc.ontariotechu.ca/intro.php>
5. <https://www.merlot.org/merlot/viewMaterial.htm?id=79694>

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO 1	S							
CO 2	M	S						
CO 3				S		S		
CO 4				S	S	M		
CO 5			S					S
S-Strong(3)			M-Medium (2)		L-Low (1)			

Semester	ELECTIVE – VIII	H/W	C
VI	Course Code: 23UZOOE65-2 Course Title: RADIATION BIOLOGY	5	3

Course Objectives :

1	The course covers basic knowledge on different types of radiation
2	To study the biological effects of radiation and risks on cellular level to humans
3	To acquire a deeper knowledge on radiation protection for ionizing and non-ionizing radiation, both in legislation and practical radiation protection technology
4	To understand the Radiation safety measures
5	To know the Applications of Radioisotopes in biology

UNIT-I: Scope of Radiation Biology – Sources of Natural Radiation: Terrestrial and cosmic sources - Man made radiations - Medical (occupational and diagnostic). Types of radiation – Ionizing and non-ionizing radiation.

UNIT-II : Properties of Radiation – Radiation Units (Becquerel, RAD, Gray & Curie, Sievert). Measurement of Radiation in the Environment - Alpha and Beta counters and Scintillometer.

UNIT-III: Biological effects of Radiation - Cellular level – Organ and system level – Genetic effects (chromosomal aberrations), radiation induced mutations – Radiation sickness – Syndromes – Cancer induction – Dosimetry.

UNIT-IV : Radiation safety measures - Safety standards disposal of radioactive waste management, administrative & legislative aspect of radiation protection. Nuclear reactors – Nuclear energy programme in India. Regulatory authorities– AERB, BARC, DAE, IAEA & ICRP.

UNIT-V: Applications of Radioisotopes in biology- Auto radiography, Radioimmunoassay; Agriculture -insect, pest and disease management- Sterile Insect Technology (SIT); Medicine - (Therapy & diagnosis); Food preservation

Expected Course Outcomes (COs)

At the end of the course, the student will be able to

1	To describe the various types of ionizing radiation
2	To define the radiation units used in measurement/calculations of “dose”.
3	To describe the biological impact of radiation on living cells and tissues
4	To highlight the applications of radiation in different fields
5	To create awareness about safety precautions when using radioactive isotopes

References

1. Rao, B.M. (2002), Radioactive Materials, Himalayas publishing House.
2. Sood, D.D. Reddy, A.V.R. and Ramamoorthy, N. (2000) Fundamentals of Radiochemistry, Indian Association of Nuclear Chemists and Allied Scientists, Radiochemistry Division, Mumbai.
3. Sharma, B.K., (1990) Environmental Chemistry, Goel Publishing House, Meerut.
4. Kiefer, J. (1990) Biological Radiation Effects, Springer-verlag.
5. Radiation Biology: A Handbook for Teachers and Students International Atomic Agency (IAEA), 2010 - Training Course Series42.

Web Resources

1. https://www-pub.iaea.org/MTCD/Publications/PDF/TCS-42_web.pdf
2. <https://www.utoledo.edu/med/depts/radther/pdf/Lecture%20%20-%20Survey%20Radiobiology%20handouts.pdf>
3. https://www.irsn.fr/sites/default/files/documents/professionnels_sante/documentation/syllabus_chapitre_14.pdf
4. <https://www.nrc.gov/docs/ML1201/ML12010A134.pdf>
5. https://link.springer.com/chapter/10.1007/978-3-031-18810-7_2

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO 1	S							
CO 2	M	S						
CO 3				S		S		
CO 4				S	S	M		
CO 5			S					S

S-Strong

M-Medium

L-Low

Semester	PROFESSIONAL COMPETENCY SKILL COURSE CODE: 23UZ00F66 COURSE TITLE: ENVIRONMENTAL BIOTECHNOLOGY AND HERBAL SCIENCE	H/W	C
VI		2	2

COURSE OBJECTIVES

1. To impart the knowledge about biotechnology and its use in environment.
2. To understand the knowledge about agricultural biotechnology.
3. To Learn about the techniques of mushroom cultivation.
4. To impart knowledge about the herbal science and traditional system of medicine.
5. To Study the role of Medicinal plants under conservation.

Unit -1: SCOPE OF ENVIRONMENTAL BIOTCHNOLOGY

Environmental Biotechnology: Basic concept, Aim and Scope. Pollution Monitoring- Biotechnological Methods- Biosensors- Biological Treatment of Wastewater.

Unit – I: I AGRICULTURAL BIOTECHNOLOGY

Agricultural Biotechnology- Micropropagation- Techniques - Applications- Biofertilizers- Mass cultivation techniques of rhizobium , Azolla and Phospho bacteria, bio pesticides, petroleum plants.

Unit – I: II TECHNOLOGY OF MUSHROOM CULTURE

Mushrooms Technology - Nutritive value of Edible mushrooms- Medicinal value of mushrooms- Advantages of mushroom cultivation- Cultivation of oyster mushrooms.

Unit – IV: HERBAL SCIENCE

Herbal science- traditional system of medicine – Siddha- Ayurveda – Homeopathy- common medicinal plant – Zingiber officinale – Aloe vera - Ocimum sanctum – Asafoetida – Honey.

Unit – V: CONSERVATION OF MEDICINAL PLANTS

Conservation methods for Herbal plants.- Insitu and Exsitu conservation- Biotechnology in conservation of medicinal plants- Adulteration of herbal products - Reason- Types- Disadvantages.

Expected Course Outcome:

After completion of this course, students will be able to gain knowledge in

1. The environmental biotechnology and its value.

2. The agricultural biotechnology and bio pesticide.
3. The cultivation of mushroom and its value.
4. The value of herbal science and traditional system of medicine.
5. The conservation of medicinal plants and herbal products.

TEXTBOOKS

1. N. Arumugam, V. Kumaresan, Applied Plant Biotechnology. 2016, saras Publication, Nagarcoil.
2. V.kumaresan , Herbal biotechnology & pharmacography, 2015., Saras Publication Nagarcoil.
3. Gupta B.K. Elements of Biotechnology ,1997, Tata McCraw Hill publication. New Delhi.

SUPPLEMENTARY READING

1. https://www.researchgate.net/publication/341157139_Environmental_Biotechnology_For_Sustainable_Future
2. <https://www.mushroomoffice.com/mushroom-cultivation/>
3. <https://medcraveonline.com/APAR/bio-diversity-and-conservation-of-medicinal-and-aromatic-plants.html>

Outcome Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	3	3
CO2	3	2	3	3	3
CO3	2	3	3	2	3
CO4	3	3	3	3	3
CO5	3	3	2	3	3

*3 - Strong; 2 - Medium; 1- Low

SEMESTER V	Course Code: 23UZOOX67	H/W	C
CORE – XIII	Course Title: EXTENSION ACTIVITY	-	2

(Refer to the Regulations)