LEARNING OUTCOMES BASED CURRICULUM FRAMEWORK (LOCF) FOR UNDERGRADUATE PROGRAMMES

(BSc Advanced Zoology and Biotechnology)

Department of Advanced Zoology and Biotechnology

LOYOLA COLLEGE (AUTONOMOUS)
CHENNAI 600034

PREFACE

Zoology deals with the study of animal kingdom specially the structural diversity, biology, embryology, evolution, habits and distribution of animals, both living and extinct. As it covers a fascinating range of topics, the modern zoologists need to have insight into many disciplines.

The learning outcomes-based curriculum framework for a B.Sc. degree in Zoology is designed to cater to the needs of students in view of the evolving nature of animal science as a subject. The framework is expected to assist in the maintenance of the standard of Zoology degrees/programmes across the country by reviewing and revising a broad framework of agreed expected graduate attributes, qualification descriptors, programme learning outcomes and course-level learning outcomes.

The Learning Outcomes based approach to Curriculum Planning intends to deliver in terms of concepts, mechanisms, biological designs & functions and evolutionary significance cutting across organisms at B.Sc. level. These courses should be studied by students of all branches of biology. The students should do the dissertation/ project work under practical of different courses, wherever possible.

The students are expected to learn the courses with excitements of biology along with the universal molecular mechanisms of biological designs and their functions. They should be able to appreciate shifting their orientation of learning from a descriptive explanation of biology to a unique style of learning through graphic designs and quantitative parameters to realize how contributions from research and innovation have made the subjects modern, interdisciplinary and applied and laid the foundations of Zoology, Animal Sciences, Life Sciences, Molecular Biology and Biotechnology.

These courses and their practical exercises will help the students to apply their knowledge in future course of their career development in higher education and research. In addition, they may get interested to look for engagements in industry and commercial activities employing Life Sciences, Molecular Biology and Biotechnology. They may also be interested in entrepreneurship and start some small business based on their interest and experience.

The curriculum has been designed in such a way that the students are exposed to modern tools and techniques in Life Sciences. More emphasis has been given to content related to environment, sustainability, skills acquisition and entrepreneurship.

The curriculum, teaching pedagogy and assessment methods are assigned with appropriate cognitive levels as per BLOOM’s Taxonomy. The OBE based evaluation methods will pave way for the assessment of cognitive levels of the students and evaluate the expected course outcome attainment.

CONTENTS

VISION AND MISSION OF LOYOLA COLLEGE

VISION

Towards holistic formation of youth, grounded in excellence, through accompanimentto serve the humanity.

MISSION

- To provide inclusive education through an integral and holistic formative pedagogy.
- To promote skills that prepare them for the future.
- To kindle in young minds the spirit of social and environmental justice with a blendof academic excellence and empathy.
- To stimulate critical and conscientious scholarship leading to meaningful andinnovative human Capital.

CORE VALUES

- Cura Personalis
- Pursuit of Excellence
- Moral Rectitude
- Social Equity
- Fostering solidarity
- Global Vision
- Spiritual Quotient

VISION AND MISSION OF THE DEPARTMENT

VISION

To offer quality science education to inculcate respect for nature and human life and to promote scientific practices based on strong ethical principles.

MISSION

- To introduce modern trends in life sciences emphasizing conservation.
- To develop and hone skills of students to meet the local and global needs.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)
(School of Life sciences)

PEO 1	**Academic excellence and Core Competency** To provide access to quality education and enhance the core competencies in Life Sciences through training using modern tools and techniques.
PEO 2	**Globally Relevant Curriculum and Learning Environment** To constantly innovate and upgrade the curriculum and teaching methodologies to make Life Sciences teaching and learning relevant to the global context.
PEO 3	**Effective Communication, Teamwork and Leadership skills** To provide an academic environment to students which is conducive for academic excellence, creativity, leadership and life-long learning.
PEO 4	**Environmental sustainability, social responsibility and ethics** To instill responsibility and concern towards environment, biodiversity, bioethics, and sustainable development into the curriculum of Life Sciences.
PEO 5	**Skill Development, Entrepreneurship and Lifelong learning** To prioritize experiential learning through specialized professional skill training for a better career with a professional attitude.
PEO 6	**Scientific temperament** To kindle inquisitiveness and creativity to develop innovative protocols for solving issues related to the environment and conservation through research.

PROGRAMME OUTCOMES (POs)
(School of Life sciences)

PO1	**Disciplinary knowledge** Students will apply the scientific knowledge acquired in Life Sciences and become skilled professionals adhering to the values of sustainable living.
PO2	**Communication Skills, Teamwork and leadership qualities** Students will enhance their communication skills to develop an attitude to work as a team and hone leadership qualities.
PO3	**Critical thinking, problem-solving and analytical reasoning** Students will demonstrate analytical reasoning, problem-solving, scientific reasoning, and reflective thinking as professionals in all frontiers of life sciences.
PO4	**Research-related skills and Scientific reasoning** Students will develop and popularize scientific temper to make conceptual contributions in life sciences and promote environmental consciousness.
PO5	**Skill development, entrepreneurship and lifelong learning** Students will develop skills, tools and techniques to explore prospective avenues of entrepreneurship in emerging areas of life sciences and pursue lifelong learning.
PO6	**Environment and ethical awareness** Students will understand and contextualize environmental and ethical issues and contribute towards the betterment of the environment and sustainable growth.
PO7	**Digital literacy and self-directed learning** Students will engage in self-paced and self-directed lifelong learning through digital literacy for personal development and professional accomplishment.

PROGRAMME SPECIFIC OUTCOMES (PSOs)
(Department of Advanced Zoology and Biotechnology)

PSO 1	Acquire knowledge about the diversity and distribution of animals and their interaction with the environment.
PSO 2	Understand the structural, functional and molecular properties of cells and organelles.
PSO 3	Realize the complexity of evolution, embryology, genetics, animal behaviour and bioethics.
PSO 4	To play an active role in the protection of the environment and biodiversity.
PSO 5	Understand the physiological processes and principles of genetics in the animal kingdom.
PSO 6	Perform laboratory procedures in biology and apply ethical principles
PSO 7	Acquire skills and necessary training to initiate start-ups in the realm of life sciences.

B. Sc Advanced Zoology and Biotechnology Restructured CBCS curriculum with effective from June, 2019

PART	SEMESTER I	SEMESTER II	SEMESTER III	SEMESTER IV	SEMESTER V		SEMESTER VI	CREDITS
I	G. Language (3h/3c)	G. Language (3h/3c)	G. Language (3h/3c)	G. Language (3h/3c)				12
II	General English (6h/3c)	General English (6h/3c)	General English (5h/3c)	General English (5h/3c)				12
MC	Invertebrata I (4h/4c)	Chordata (4h/4c)	Animal Physiology and Biochemistry (4h/4c)	Environmental Biology (4h/4c)	Molecular Biology (4h/4c)		Environmental Biotechnology & Toxicology (5h/4c)	84
	Invertebrata II (4h/4c)	Chordata Lab (4h/4c)	Animal Physiology & Biochemistry Lab (2h/2c)	Environmental Biology Lab (2h/2c)	Genetics (4h/4c)		Environmental Biotechnology & Toxicology Lab (3h/4c)	
	Invertebrata Lab (4h/4c)	Cell Biology (4h/4c)	Developmental Biology (3h/3c)		Animal Biotechnology (4h/4c)		Wildlife Biology (5h/5c)	
			Evolutionary Biology (3h/3c)		Immunology (4h/4c)		Reproductive Biology and Endocrinology (5h/5c)	
					Genetics, Molecular Biology & Animal Biotech. Lab (2h/4c)			
					Bioinformatics Lab (2h/2c)			
					Behavioural Biology (4h/2c)			
AR/AO	Plant Diversity (4h/2c)	Chemistry for Biology (4h/2c)	Biochemistry (3h/2c) /Applied Microbiology (3h/2c)	Food Chemistry (3h/2c) /Plant Biotechnology and Biostatics (3h/2c)				12
	Plant Diversity Lab course (2h/1c)	Chemistry Practical for Biology (2h/1c)	Biochemistry Lab course (2h/1c) /Applied Microbiology Lab course (2h/1c)	Food chemistry Lab Course (2h/1c) / Plant Biotechnology and Biostatistics lab course (2h/1c)				
ME				Essentials of Marine Biology (4h/4c)	Medical Lab Techniques (4h/4c)			12
				Essentials of Marine Biology Lab (2h/2c)	Medical Lab. Tech. Lab (2h/2c)			
				Biophysics and Biostatistics (4h/4c)	Bio. Instrumentation Science(4h/4c)			
				Biophysics and Biostatistics lab (2h/2c)	Bio. Instrument. Sci. Lab (2h/2c)			
MS							UAZ 6701 Economic Zoology Theory (6h/5c), UAZ 6706 Economic Zoology Lab (6h/5c), UAZ 6705 Internship (5c)	15 (MS & TP)
BT/AT/ NME					MOOC/SSP			
			Conservation Biology/Public Health and Hygiene (3h/2c)	Green Technologies/ Natural Hazards and Disaster Management (3h/2C)				4
FC	FC (3/1)	FC (3/2), EVS	FC (2/1)	FC 2(1)				5
CCA	CC	CCA(90/1)						1
ORA			OR	OR (120/2)				2
Hr/C	**30h/22c**	**30h /(23+1c)**	**30/24c**	**30h (24+2c)**	**30h/30c**		**30h/33c**	**180 (159)**

UAZ 6705 Economic Zoology : Internship (5c) (4 weeks during Christmas Holidays (30 Days)

MC-Major Core; **AR**-Allied Required; **AO**-Allied Optional; **ME**-Major Elective; **MS**-Major Skill; **NME**-Non Major Elective; **FC**-Foundation Course; **CCA**- Co-curricular Activities; **ORA**-Outreach

LOYOLA COLLEGE (AUTONOMOUS), CHENNAI
DEPARTMENT OF ADVANCED ZOOLOGY AND BIOTECHNOLOGY
(2019 - Restructured Curriculum)

OVERALL COURSE STRUCTURE

Sem	Sub. Code	Course Title	T/L	Category	Cr	Hrs
I	UTL 1101	General Tamil – I (Arts & Science)	T	GL	3	3
I	UFR 1101	French for Beginners-I	T	GL	3	3
I	UFR 1102	French for Communication - I	T	GL	3	3
I	UFR 1104	Français Niveau - I	T	GL	3	3
I	UFR 1107	Beginner's French - I	T	GL	3	4
I	UFR 1108	Advanced French - I	T	GL	3	4
I	UOL 1101	Hindi-Prose - I	T	GL	3	3
I	UOL 1102	General Hindi - I	T	GL	3	3
I	UOL 1104	General Sanskrit - I	T	GL	3	3
I	UEL 1201	General English I - Advanced	T	GE	3	6
I	UEL 1202	General English I - Intermediate	T	GE	3	6
I	UEL 1203	General English I - Basic	T	GE	3	6
I	UEL 1208	English for Professional Skills - I	T	GE	3	3
I	UEL 1209	English for Professional Skills - II	T	GE	3	3
I	UAZ 1504	Invertebrata I	T	MC	4	4
I	UAZ 1505	Invertebrata II	T	MC	4	4
I	UAZ 1502	Invertebrata Lab Course	L	MC	4	4
I	UPB 1301	Plant Diversity	T	AR	2	4
I	UPB 1302	Plant Diversity Lab	L	AR	1	2
I	UHE 1001	Personality Development	T	FC	1	3
II	UTL 2101	General Tamil – II (Arts & Science)	T	GL	3	3
II	UFR 2101	French for Beginners - II	T	GL	3	3
II	UFR 2102	French for Communication - II	T	GL	3	3
II	UFR 2103	Français Niveau - II	T	GL	3	3
II	UFR 2106	Beginner's French-II	T	GL	3	4
II	UFR 2107	Advanced French -II	T	GL	3	4
II	UOL 2101	Hindi-Prose - II	T	GL	3	3
II	UOL 2102	General Hindi - II	T	GL	3	3
II	UOL 2103	General Sanskrit - II	T	GL	3	3
II	UEL 2201	General English II - Advanced	T	GE	3	6
II	UEL 2202	General English II - Intermediate	T	GE	3	6
II	UEL 2203	General English II - Basic	T	GE	3	6
II	UEL 2208	English for Professional Skills - II	T	GE	3	3
II	UEL 2209	English for Professional Skills - II	T	GE	3	3
II	UAZ 2501	Chordata	T	MC	4	4
II	UAZ 2502	Chordata Lab	L	MC	4	4
II	UAZ 2503	Cell Biology	T	MC	4	4

II	UCH 2301	Chemistry for Biology	T	AR	2	4
II	UCH 2302	Chemistry Practical for Biology	L	AR	1	2
II	UHE 2001	Life Issues and Coping Strategies	T	FC	2	3
III	UTL 3101	General Tamil – III (Arts & Science)	T	GL	3	3
III	UFR 3101	French for Beginners - III	T	GL	3	3
III	UFR 3102	Français Niveau - III	T	GL	3	3
III	UOL 3101	Hindi Poetry - III	T	GL	3	3
III	UOL 3102	General Sanskrit - III	T	GL	3	3
III	UEL 3201	General English Advanced - III	T	GE	3	5
III	UEL 3202	General English - Intermediate - III	T	GE	3	5
III	UEL 3203	General English - Basic - III	T	GE	3	5
III	UAZ 3501	Animal Physiology and Biochemistry	T	MC	4	4
III	UAZ 3502	Animal Physiology and Biochemistry Lab	L	MC	2	2
III	UAZ 3503	Developmental Biology	T	MC	3	3
III	UAZ 3504	Evolutionary Biology	T	MC	3	3
III	UCH 3403 UPB 3401	Biochemistry for Biology/ Applied Microbiology	T	AO	2	3
III	UCH 3404 UPB 3402	Biochemistry Lab for Biology/ Applied Microbiology Lab	L	AO	1	2
			T	NME	2	3
	UHE 3001	Social Awareness	L	FC	1	2
				ORA		
IV	UTL 4101	General Tamil – IV (Arts & Science)	T	GL	3	3
IV	UFR 4101	French for Beginners - IV	T	GL	3	3
IV	UFR 4102	Français Niveau - IV	T	GL	3	3
IV	UOL 4101	Hindi Poetry - IV	T	GL	3	3
IV	UOL 4102	General Sanskrit - IV	T	GL	3	3
IV	UEL 4201	Introduction to Technical Translation (CBGEP)	T	GE	3	5
IV	UEL 4202	Soft Skills for Professional Development (CBGEP)	T	GE	3	5
IV	UEL 4203	Professional Content Writing (CBGEP)	T	GE	3	5
IV	UEL 4204	English for Technical Writing (CBGEP)	T	GE	3	5
IV	UEL 4205	English for Employability Skills (CBGEP)	T	GE	3	5
IV	UEL 4206	Essential Skills For Group Communication (CBGEP)	T	GE	3	5
IV	UEL 4207	Theatre Performance and Film Review (CBGEP)	T	GE	3	5
IV	UAZ 4501	Environmental Biology	T	MC	4	4
IV	UAZ 4502	Environmental Biology Lab	L	MC	2	2
IV	UCH 4403 UPB 4401	Food Chemistry/ Plant Biotechnology and Biostatistics	T	AO	2	3
IV	UCH 4404 UPB 4402	Food Chemistry Lab Course/ Plant Biotechnology and Biostatistics Lab Course	L	AO	1	3
IV	UAZ 4601	Essentials of Marine Biology	T	ME	4	4
IV	UAZ 4602	Essentials of Marine Biology Lab	L	ME	2	2
IV	UAZ 4603	Biophysics and Biostatistics	T	ME	4	4

IV	UAZ 4604	Biophysics and Biostatistics Lab	L	ME	2	2
IV	UHE 4001	Environmental Studies	T	FC	1	2
IV			T	NME	2	3
IV				ORA		
V	UAZ 5501	Molecular Biology	T	MC	4	4
V	UAZ 5502	Genetics	T	MC	4	4
V	UAZ 5503	Animal Biotechnology	T	MC	4	4
V	UAZ 5504	Immunology	T	MC	4	4
V	UAZ 5505	Genetics, Molecular Biology & Animal Biotechnology Lab	T	MC	4	2
V	UAZ 5506	Bioinformatics Lab	T	MC	2	2
V	UAZ 5507	Behavioural Biology	L	MC	2	4
V	UAZ 5601	Medical Lab Techniques	T	ME	4	4
V	UAZ 5602	Medical Lab Techniques Lab	L	ME	2	2
V	UAZ 5603	Bioinstrumentation Science	T	ME	4	4
V	UAZ 5604	Bioinstrumentation Science Lab	L	ME	2	2
VI	UAZ 6501	Environmental Biotechnology and Toxicology	T	MC	4	5
VI	UAZ 6502	Environmental Biotechnology and Toxicology Lab	L	MC	4	3
VI	UAZ 6503	Wildlife Biology	T	MC	5	5
VI	UAZ 6504	Reproductive Biology and Endocrinology	T	MC	5	5
VI	UAZ 6701	Economic Zoology- Theory	T	MS	5	6
VI	UAZ 6706	Economic Zoology- Lab	L	MS	5	6
VI	UAZ 6703	Internship	I	MS	5	

COURSES OFFERED TO OTHER DEPARMENTS

I	UAZ 1301	Animal Diversity	T	AR	2	4
I	UAZ 1302	Animal Diversity Lab	L	AR	1	2
III	UAZ 3401	Agricultural Entomology	T	AO	2	3
III	UAZ 3402	Agricultural Entomology Lab	L	AO	1	2
III	UAZ 3801	Conservation Biology	T	NME	2	3
III	UAZ 3802	Public Health and Hygiene	T	NME	2	3
IV	UAZ 4401	Animal Biotechnology and Bioinformatics	T	AO	2	3
IV	UAZ 4402	Animal Biotechnology and Bioinformatics lab	L	AO	1	2
IV	UAZ 4801	Green Technologies	T	NME	2	3
IV	UAZ 4802	Natural Hazards and Disaster Management	T	NME	2	3

COURSE DESCRIPTORS

Course Code	UAZ 1504
Course Title	Invertebrata I
Credits	04
Hours/Week	04
Category	Major core (MC) – Theory
Semester	I
Regulation	2019

Course Overview

1. To understand the basic classification structure on invertebrate animals
2. The aim of the course is to give basic knowledge about the lower animals.
3. To acquire knowledge of diversity, adaptations, organization and taxonomic status of Invertebrates and to study the host - parasites interactions.
4. The other important aspect of invertebrata to study the various type of animals for their economic importance.

Course Objectives

1. To understand the basic concepts of lower animals 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 animal modes of life and to estimate the biodiversity.
4. To compare and distinguish the general and specific characteristics of reproduction in lower animals.
5. To infer and integrate the parasitic and economic importance of invertebrate animals

Prerequisites	Basic knowledge on animals / Invertebrates

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Level
I	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*, *Trypanasoma* & *Leishmania*) - Economic importance Nutrition in protozoa - Host-parasitic interactions in *Entamoeba* and *Plasmodium*-Locomotion in protozoa	12	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
II	Porifera: General characters and classification up to Classes. Type study - Ascon & Sycon - Canal system in sponges - Economic importance, Canal system in sponges - Reproduction in sponges.	10	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
III	Coelenterata : General characters and classification up to classes – Type study - *Obelia* and *Aurelia* - Corals and coral reefs - Polymorphism - Economic importance -	12	CO 1 CO 2 CO 3	K1, K2, K3, K4, K5, K6

	Mesenteries in Anthozoa - Economic importance of corals and coral reefs - Polymorphism in Hydrozoa.		CO 4 CO 5	
IV	Platyhelminthes: General characters and classification of up to classes. Type study – *Fasciola hepatica*. Nemathelminthes: *Taenia solium* – Parasitic adaptations. Host- parasitic interactions of Helminth parasites. Nematode Parasites and diseases - *Wuchereria bancrofti*, *Enterobius vermicularis*, *Ancylostome duodenale*. Aschelminthes : General characters and classification of up to classes - Type study - *Ascaris lumbricoides*	12	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
V	Annelida: General characters and classification up to Classes. Detailed study –*Hirudinaria granulosa*. Nephridium and coelomoducts - Modes of life in Annelids.	6	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6

Text Books

1. Ekambaranatha Iyer, 2000. A Manual of Zoology, 10th edition, Viswanathan, S., Printers & Publishers Pvt Ltd
2. Jordan, E.L. and Verma P.S, 1995. Invertebrate Zoology, 12th edn. S. Chand& Co.
3. Kotpal, R.L, 1992. Protozoa, Porifera, Coelenterata, Annelida, Arthropoda.

Suggested Readings

1. Ruppert and Barnes, R.D. (2006). Invertebrate Zoology, VIII Edition. Holt Saunders International Edition.
2. 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.
3. Barrington, E.J.W. (1979). Invertebrate Structure and Functions. II Edition, E.L.B.S. and Nelson
4. Jordan, E.L. and Verma P.S, 1995. Invertebrate Zoology, 12th edn. S. Chand& Co.
5. Kotpal, R.L, 1992. Protozoa, Porifera, Coelenterata, Annelida, Arthropoda, Mollusca, Echinodermata- - Rastogi Publication.
6. Kotpal, R.L., Agarwal, R.P.R., Khertarpa. I. 1989. Modern text book of Zoology - - Rastogi Publications.
7. Parker, J. and Haswell , 1978. A text book of Zoology Vol. I - Williams and Williams.
8. Srivastava, M.D.L and Srivastava, 1969. A text book of Invertebrate Zoology, U.S-Central Book Depot, Allahabad.
9. Hyman L.H, 1955. The invertebrates - Vol. I to Vol. VII – Mc Graw Hill Book Co

Web Resources

1. https://www.nationalgeographic.com/animals/invertebrates/
2. https://bit.ly/3kABzKa
3. https://www.nio.org/
4. https://greatbarrierreef.org/

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	Understand the basic concepts of invertebrate animals and recall its structure and functions.	**K1, K2**
CO 2	Illustrate and examine the systemic and functional morphology of various groups of invertebrata.	**K3**
CO 3	Differentiate and classify the animal's mode of life in various taxa and estimate the biodiversity.	**K4**
CO 4	To compare and distinguish the various physiological processes and organ systems in lower animals.	**K5**
CO 5	Infer and integrate the parasitic and economic importance of invertebrate animals.	**K6**

Course Code	UAZ 1505
Course Title	Invertebrata II
Credits	04
Hours/Week	04
Category	Major core (MC) – Theory
Semester	I
Regulation	2019

Course Overview

1. Invertebrata II is the part of the Invertebrate zoology which includes Phylum Arthropoda, Mollusca, Echinodermata and Economic entomology
2. This course aims to give broad knowledge about the general characteristics, classification and structural organization of the invertebrate phyla.
3. It covers taxonomy, morphology, reproduction, development and larval forms of major invertebrate phyla.
4. This course explores the invertebrate diversity and evolutionary relationships, economic importance, and ecological adaptations of invertebrates.
5. In addition, this course also emphasizes the interaction of invertebrates as vectors, parasites associated with human diseases and Insect pests that cause damage to the plants.

Course Objectives

1. To understand the structures and distinct features of invertebrate phyla.
2. To understand and able to distinguish the characteristic features of each phylum
3. To understand the economic importance of invertebrates
4. To understand the interaction of invertebrates with the environment.

Prerequisites	Basic knowledge in Biology or Zoology

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Level
I	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.	12	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
II	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.	12	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
III	General characters and classification of Phylum Echinodermata up to Classes. Detailed study: *Asterias*. Water vascular system in Echinodermata – Larval forms of Echinoderms.	12	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6

IV	Detailed study: *Periplaneta americana*. Insect pollinators-predators – parasites. Insects associated with human diseases: Mosquitoes, housefly, bed bug, human head louse. Insects associated with household materials: Ants, Termites, Silver fish.	12	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
V	Insect pests, life cycle and types of damage to plants. Pest of rice: Rice stem borer (*Scirpophaga incertulas*) – Pest of Sugarcane: The shoot borer (*Chilo infuscatellus*) – Pest of coconut: The rhinoceros beetle (*Oryctes rhinoceros*) Pest of cotton: The spotted bollworm (*Earias insulana*) – Pests of vegetables: Brinjal-The shoot and fruit borer (*Leucinodes orbonalis*) – Cauliflower: The diamond black moth(*Plutella xylostella*)Pests of fruits: Citrus butterfly(*Papilio demoleus*) – Pest of stored products: The rice weevil(*Sitophilus oryzae*). Principles of Integrated Pest Management.	12	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6

Text Books

1. Ekambaranatha Ayyar, and T. N. Ananthakrishnan, 2000. A Manual of Zoology. Vol 1 (Invertebrata). Part II – Viswanathan Pvt. Ltd, 842pp
2. Jordan E.L. and Verma P.S., Invertebrate Zoology,1995. 12th Ed., S. Chand & Co. 1152pp.
3. Kotpal R.L. 2019. Modern Text Book of Zoology, Invertebrtes 9th Ed., Rastogi Publications, Gangotri, Shivaji Road, Meerut, 1004 pp.
4. Vasantharaj David, B. 2001. Elements of Economic Entomology, Popular Book Depot, Chennai. 400pp.
5. Ruppert and Barnes, R.D. 2006. Invertebrate Zoology, VIII Edition. Holt Saunders International Edition, Belmont, CA : Thomson-Brooks/Cole, 928pp.

Suggested Readings

1. Barrington, E.J.W., 2012, Invertebrate structure and function. Boston – Houghton. Miffin and ELBS, London.
2. Bhamrah,H.S. and Kavitha Junea, 2002. A text book of Invertebrates. Alilnol Publications Private Limited, 4374/4B.Ansari Road, Dayaganj, New Delhi.
3. Hyman L.H, 1955. The invertebrates – Vol. I to Vol. VII – McGraw Hill Book Co.
4. Kotpal, 1992. Protozoa, Porifera, Coelenterata, Annelida, Arthropoda, Mollusca, Echinodermata, R.L- Rastogi Publication.
5. Kotpal, R.L., Agarwal, R.P.R., Khertarpa. I. 1989. Modern text book of Zoology, Rastogi Publications.
6. Parker, J. and Haswell, 1978. A text book of Zoology Vol. I – Williams and Williams.
7. Shukla G.S and Updhyay V. B. 2004. Economic Zoology, Rastogi Publications.
8. Srivastava, M. D. L and Srivastava, U. S, 1969. A text book of Invertebrate Zoology, Central Book Depot, Allahabad.
9. Verma, A. Invertebrates: Protozoa to Echinodermata. Narosa Publishing House Private Limited.35-36 Greams Road, Thousand Lights, Chennai

Web Resources

1. https://bit.ly/3kqtO9i
2. https://on.natgeo.com/3kofFtg
3. https://bit.ly/3lEbJ7o

4. https://bit.ly/39rIKh7
5. https://bit.ly/3lJdUX0
6. https://microbenotes.com

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	Classify, Identify and recall the name and distinct features of invertebrate groups.	K1, K2
CO 2	Explain, and relate the origin, structural organization and evolutionary aspects of invertebrates.	K3
CO 3	Analyze, compare and distinguish the developmental stages and describe the important biological process.	K4
CO 4	Correlate the interaction of invertebrates with humans and critique its economic importance.	K5
CO 5	Summarize the physiology, ecological adaptations to stimulate and integrate the significance of invertebrates to the environment, humans, and agriculture.	K6

Course Code	UAZ 1502
Course Title	Invertebrata Lab course
Credits	04
Hours/Week	04
Category	Major core (MC) – Lab
Semester	I
Regulation	2019

Course Overview

1. To understand the basic structure on invertebrate animals through dissection
2. The aim of the course is to give basic knowledge about the structure and functions of different organs.
3. To acquire knowledge of the reproductive system, nervous system, circulatory system and respiratory system.
4. The other important aspect of this course is to study the various type of animal's internal and external organs.

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.

Prerequisites	Basic knowledge on handling animals and dissection

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Level
I	Major Dissection : Cockroach: Circulatory system, Nervous system, Reproductive system. Leech : Nervous System, Reproductive system Earthworm: Nervous System, Reproductive system. *Pila globosa*: Nervous system. Prawn: Nervous system (including Appendages).	16	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
II	Minor Dissection: Cockroach: Digestive system. Earthworm: Viscera, Lateral hearts. *Pila globosa*: Digestive system (Including radula). Freshwater Mussel: Digestive system.	8	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
III	Mounting: Earthworm: Body setae; Pineal setae. *Pila globosa*: Radula. Freshwater muscle: Pedal ganglia.	8	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6

IV	Mounting : Cockroach: Salivary apparatus, Mouth parts - Honey Bee, House fly and Mosquito mouth parts.	8	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
V	Spotters : Protozoa : *Amoeba, Euglena, Paramecium, Paramecium* conjugation, *Entamoeba*.. Porifera :Sycon, Spicules, Gemmule. Coelenterata: *Obelia* colony, *Physalia*, Sea anemone, Aurelia, Fungia, Meandrina, Tubipora. Platyhelminthes : *Fasciola*, Redia and Cercaria larva of *Fasciola*, Tapeworm, Scolex of Tapeworm. Nemathelminthes : *Ascaris*: male and female, *Enterobius vermicularis, Wuchereria bancrofti, Anclyostoma duodenale*. Annelida : *Hirudinaria*, Nereis, Heteronereis, Parapodium of Nereis, Arthropoda: Millipede, Centipede, *Penaeus*, Nauplius and Zoea larva of *Penaeus, Peripatus*, Scorpion, *Limulus*. Mollusca : Fresh water mussel, Pearl oyster, *Chiton*, *Dentalium*, Sepia, Glochidium larva. Echinodermata: Starfish, Bipinnaria larva of Starfish, Pedicellaria, Sea cucumber, Sea urchin, Economically Important Insects: Honey bee, *Bombyx mori*, Termites, Silver fish, *Oryctes rhinoceros*, *Leucinodesorbonalis*, *Papilio demoleus*, *Sitophilus oryzae*.	12	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6

Text Books

1. Ekambaranatha Iyyar and T. N. Ananthakrishnan, 1995 A manual of Zoology Vol.I (Part 1, 2) S. Viswanathan, Chennai
2. Ganguly, Sinha an d A dhikari , 2 0 11 . Biology of Animals: Volume I, New Central Book Agency; 3rd revised edition. 1008 pp.
3. Sinha, Chatterjee and Chattopadhyay, 2 0 1 4. Advanced Practical Zoology, Books & Allied Ltd; 3rd Revised edition, 1 07 0 pp.
4. Lal ,S. S, 2016 . Practical Zoology Invertebrate, Rastogi Publications.
5. Verma, P. S. 2010. A Manual of Practical Zoology: Invertebates, S Chand, 4 97pp.

Suggested Readings

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

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/

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	Identify and label the external features of different groups of invertebrate animals.	K1, K2
CO 2	Illustrate and examine the circulatory system, nervous system and reproductive system of invertebrate animals.	K3
CO 3	Differentiate and compare the structure, function and mode of life of various groups of animals.	K4
CO 4	To compare and distinguish the dissected internal organs of lower animals.	K5
CO 5	Prepare and develop the mounting procedure of economically important invertebrate animals.	K6

Course Code	UAZ 2501
Course Title	Chordata
Credits	04
Hours/Week	04
Category	Major core (MC) – Theory
Semester	II
Regulation	2019

Course Overview

1. This course includes classification of phylum Chordata, into subphylum, and class.
2. This course aims to give broad knowledge about the general characteristics, classification and structural organization of the Phylum Chordata.
3. It covers taxonomy and type study of animals from different classes in subphylum vertebrata.
4. This course explores the evolutionary relationships, economic importance and ecological adaptations of vertebrates.
5. In addition, this course also emphasizes on the affinities, origin and adaptations of each subphylum and class.

Course Objectives

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 origin, adaptations and affinities.

Prerequisites	Basic knowledge in Biology or Zoology / Vertebrates

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Level
I	General Characters and Classification of Phylum Chordata: Origin of Chordata, Differences between non-chordates and chordates, General characters, Affinities and Systematic position of Hemichodata (Balanoglossus), Urochordata (Ascidian), Cephalochordata (Amphioxus).	12	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
II	Prochordates and Agnatha: Characteristics of subphylum vertebrata, Classification of Vertebrata upto Class level, General characters and affinities of Prochordates (Petromyzon), Agnatha - 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.	12	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6

III	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.	12	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
IV	Reptilia : General characters and classification - Type study – *Calotes versicolor* (endoskeleton of Varanus instead of *Calotes*) - 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	12	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
V	Aves and Mammalia : Ayes: 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.	12	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6

Text Books

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
3. Physiology, 10th edition, S. Chand & Co Ltd., Ram Nagar, New Delhi, 1151 pp.
4. Nigam, H.C., 1983. Zoology of Chordates, Vishal Publications, Jalandhar - 144008, 942.
5. Chordate Zoology - Jordan E.L, Verma P.S, S. Chand & Company Ltd. 2008
6. Modern text book of Zoology Vertebrates- Kotpal. R.L. A, Rastogi publications. 2009.
7. Ganguly, Sinha,. Bharati Goswami and Adhikari, 2004. Biology of animals Vol.II - New central book Agency (p) Ltd.

Suggested Readings

1. Young, J. Z. (2004). *The Life of Vertebrates*. III Edition. Oxford university press.
2. Pough H. *Vertebrate life*, VIII Edition, Pearson International.
3. Darlington P.J. *The Geographical Distribution of Animals*, R.E. Krieger Pub. Co.
4. Hall B.K. and Hallgrimsson B. (2008). *Strickberger's Evolution*. IV Edition. Jones and Bartlett Publishers Inc.
5. 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.
6. Newman, H.H., 1981. The Phylum Chordata, Satish Book Enterprise, Agra – 282 003, 477 pp.
7. 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.
8. Waterman, Allyn J. et al., 1971. Chordate Structure and Function, Mac Millan & Co., New York, 587 pp.

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

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	Classify, Identify and recall the name and distinct features of different subphylum belonging to phylum Chordata.	K1, K2
CO 2	Explain, and relate the origin, structural organization and evolutionary aspects of vertebrates.	K3
CO 3	Analyse, compare and distinguish the developmental stages and describe the important biological process.	K4
CO 4	Correlate the different modes of life and parental care among different vertebrates.	K5
CO 5	Summarise the morphology and ecological adaptations in vertebrates and list out the economic importance.	K6

Course Code	UAZ 2502
Course Title	Chordata Lab Course
Credits	04
Hours/Week	04
Category	Major core (MC) – Lab
Semester	II
Regulation	2019

Course Overview

1. This course includes classification of phylum Chordata, into subphylum, and class.
2. This course aims to give broad knowledge about the general characteristics, classification and structural organization of the Phylum Chordata.
3. It covers various systems including digestive system, skeletal system, circulatory system, excretory system of different organisms belonging to various classes of subphylum vertebrata.
4. This course explores the evolutionary relationships, economic importance, and ecological adaptations of vertebrates.
5. In addition, this course also emphasizes on the affinities, origin and embryological development of different classes.

Course Objectives

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.

Prerequisites	Basic knowledge in Biology or Zoology / Vertebrates

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Level
I	Dissections: Frog (Demo) / Fish: External features, Digestive system, Arterial system, Venous system, 5^{th} Cranial nerve, 9^{th} and 10^{th} cranial nerves, Male and female urinogenital system.	12	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
II	Mounting : Fish: Placoid and Ctenoid scales, Frog: Hyoid apparatus and Brain (Demo).	12	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
III	Osteology: Frog: Skull and lower jaw, Vertebral column, Pectoral girdle, Pelvic girdle, Forelimb, Hind limb.	12	CO 1 CO 2	K1, K2, K3, K4, K5, K6

	Chelonia- Anapsid skull, Pigeon - skull and lower jaw, synsacrum.		CO 3 CO 4 CO 5	
IV	Specimen and Slides : Hemichordata : Balanoglossus, Tornaria larva. Urochordata : Ascidian, Ascidian larva. Cephalochordata : Amphioxus, Amphioxus - T.S. through pharynx. Specimens : *Doliolum, Salpa, Petromyzon*, Ammocoetus larva, *Scoliodon sorrakowah, Narcine, Rhinobatus, Protopterus, Catla, Clarias, Anabas, Hippocampus, Tetradon, Cynoglossus, Pterois, Echeneis, Bufo melanostictus, Hyla, Rhacophorus, Amblystoma*, Axolotl larva,*Proteus, Ichthyophis, Hemidactylus*, Chamaeleon, *Draco*, Mabuya,Varanus, Cobra, Krait, Russell's viper, *Echis carinatus, Testudo elegans*, Carapace, Plastron, King fisher, Parrot, Owl, Hornbill, Wood pecker, Armadillo, Bat.	12	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
V	Embryology: Stages in the development of Amphioxus, Frog and Chick- Placenta in shark and mammals.	12	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6

Text Books

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.

Suggested Readings

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

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	Identify and recall the name and distinct external and internal features of animals belonging to phylum Chordata.	K1, K2
CO 2	Explain the structural organization of various organs and systems in different classes of vertebrates.	K3
CO 3	Analyse, compare and distinguish the morphological features and developmental stages of chordates.	K4
CO 4	Dissect and explain various organs and internal systems in different vertebrates and correlate its function.	K5
CO 5	Summarise the morphology and ecological adaptations in vertebrates and list out the economic importance.	K6

Course Code	UAZ 2503
Course Title	Cell Biology
Credits	04
Hours/Week	04
Category	Major Core (MC) - Theory
Semester	II
Regulation	2019

Course Overview

1. Cell biology is an interdisciplinary subject integrating the fields of biochemistry, molecular cell biology and genetics.
2. The aim of the course is to give basic knowledge about the structure and function of cells and cellular components.
3. The different modules of the course will examine different areas of cellular biology including structure and function of prokaryotic and eukaryotic cells, membrane and organelle structure and function, chemical composition of the cell, cell organelles and cellular communication.
4. In this course, we will also examine the methods to fractionate cells and cellular components.
5. The other important aspects of cell biology that will be discussed in the course includes: mechanisms behind organelle transport and secretion, cell communication; intercellular contacts, cell surface receptors, extracellular matrices and cell signalling; the organisation and structure of the cell nucleus, chromatin and chromosomes.

Course Objectives

1. To understand the structures and purposes of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes and organelles.
2. To understand how these cellular components are used to generate and utilize energy in cells.
3. To understand the cellular components underlying mitotic cell division.
4. To apply the knowledge of cell biology to selected examples of changes or losses in cell function.

Prerequisites	Basic knowledge in Biology or Zoology

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Level
I	History of Cell Biology, Tools and Techniques of Cell Biology Cell Fractionation, Homogenization, Centrifugation, Isolation of sub cellular Components. Biochemical Techniques - Chromatography - Electrophoresis and their Application, Tissue Culture and Cell Culture Techniques. Histological techniques - Staining - Vital Stains. – Cytoplasmic and Nuclear Stains. Micro Technique Methods, Microscopes - Types - Light,	12	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6

	Phase contrast, SEM, TEM - Units of measurement.			
II	The Cell - Cell theory - Viruses -Types and Structure - Bacteria – Bacterial membrane - Ultra structure of Plant & Animal cell - Cytoplasm - Structure and Composition, Function - Extra Cytoplasmic Structure - Cilia Flagella - Cytoplasmic Inclusions.	10	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
III	Cell components - Plasma Membrane Ultra Structure - Different Models - Functions - Ultrastructure, Composition and Function of Endoplasmic reticulam, Ribosomes, Golgi Complex, Lysosomes, Centrioles, Plastids, Chloroplasts, Microtubules & Microfilaments, Mitochondria, and Microsomes.	10	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
IV	Nucleus - Ultrastructure, Composition and Functions - Nuclear Membrane - Nucleoplasm - Chromosomes - Heterochromatin and Euchromatin - Nucleolus - Nucleolus Cycle - DNA and RNAs - Protein Synthesis & regulation.	10	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
V	Cell Divisions and Cell Cycle - Amitosis, Mitosis and Meiosis and their Significance - Cancer, Ageing of Cells and Stem cell studies.	10	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6

Text Books

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

Suggested Readings

1. Burke, Jack. D., 1970. Cell Biology, Scientific Book Agency, Calcutta.
2. Cohn, N. S., 1979, Elements of Cytology, Freeman Book Co., New Delhi – 110007, 495 pp
3. DeRobertis, E.D.P. and E.M.F. De Robertis, 1988. Cell and Molecular Biology, 8th Edition, International Edition, Infomed, HonKong, 734pp.
4. Giese, A.C., 1979. Cell Physiology, Saunders Co., Philadelphia, London, Toronto, 609 pp.
5. Power, C.B., 1989. Essential of Cytology, Himalaya Publishing House, Bombay - 400 004, 368 pp.
6. Dowben, R., 1971. Cell Biology, Harper International Edition. Harper and Row Publisher, New York, 565 pp.
7. Loewy, A.G. and P.Sickevitz, 1969. Cell Structure and Function, Amerind Publishing Co., NewDeihi - 110 020, 516 pp.
8. Swansen, C.P. and P.L.Webster, 1989. The Cell, Prentice Hall of India Pvt. Ltd., New Delhi - 110 001, 373 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. Cooper G.M. (2019) The Cell – A Molecular Approach, 8th Edn., Sinauer Associates Inc., Oxford University Press p.813.
12. 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.
13. Albert B., Hopkin K., Johnson A.D., Morgan D., Raff M., Roberts K. and Walter P. (2018) Essential Cell Biology 5th Edn.,(paper back) W.W. Norton & Company p.864.
14. Mason K.A., Losos J.B. and Singer S.R. (2011) Raven and Johnson's Biology. 9th Edn. Mc Graw Hill publications. p.1406.
15. Alberts B., Johnson B., Lewis J., Morgan D., Raff M., Roberts K. and Walter P. (2015). Molecular biology of cell, 6th edn., Garland Science, Taylor and Francis, p. 1465.
16. 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.

Web Resources

1. https://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/

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	To understand and recall the basic structure, origin and development of cell organelles.	K1, K2
CO 2	To integrate and assess the biochemical, cytological and histological tools to infer cellular basis of organization.	K3
CO 3	To analyze and differentiate organisms based on structure, composition and inter and intra cellular interactions.	K4
CO 4	To explain the role of cells and cell organelles in various biological processes.	K5
CO 5	To construct and simulate the role of different cytological tools to explain the structure and complexity of cells and cell organelles.	K6

Course Code	UAZ 3501
Course Title	Animal Physiology and Biochemistry
Credits	04
Hours/Week	04
Category	Major core (MC) – Theory
Semester	III
Regulation	2019

Course Overview

1. Animal physiology and Biochemistry is the integrated study that investigates the biological, physical and chemical processes of cells and organs in the major physiological system that is needed for an animal to exist.
2. It covers the basic concepts and principles of biophysics, chemistry, anatomy, animal behaviour, endocrinology, and ecology and thereby examines the function and regulation of the organ system.
3. This course elaborates the basic structural organization and functions of different organs, the mechanism of biomolecules and their interaction between different organs to examine the impact on its disruption.
4. This course explores the comparative approach of the physiological adaptations of animals based on different environmental conditions.
5. In addition, this course also emphasizes the biochemical aspects of various functions of organs such as metabolism at molecular level.

Course Objectives

1. To understand the basic concepts of physiology.
2. To understand the biological process of various organs and their functions in animals.
3. To understand the functions of biomolecules.
4. To understand the role of enzymes in metabolism.

Prerequisites	Basic knowledge in Biology or Zoology

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Level
I	Physiology of Digestion: Physiology of Digestion: Alimentary canal, mechanism of digestion. Digestive-enzymes and their role in digestion. Digestion of Carbohydrates, Proteins and Lipids. Absorption and Assimilation of digested food. Fat and water soluble vitamins.	12	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
II	Respiration and Circulation: Definition of Respiration and Respiratory mechanisms – External and Internal Respiration. Respiratory Pigments; transport of O_2 and CO_2 in mammals, Bohr and Haldane effect, Chloride shift. Circulation - Types of circulation - Structure of Mammalian Heart, Types of hearts – Neurogenic and	12	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6

	Myogenic; Conduction and regulation of heart beat; Blood Clotting mechanism.			
III	Excretion, Nervous and Endocrine System: Excretion: Classification of Animals on the basis of excretory products, Structure and function of Nephron - physiology of urine formation in mammals. Nitrogenous wastes - urea cycle. Homeostasis - regulatory mechanism; Osmoregulation - Maintaining water and electrolyte balance and its regulation in fishes. Nervous system - General organization, structure of the nerve cell, Resting and action potentials. Endocrine glands - Structure, secretions and functions of Pituitary, Thyroid and Parathyroid.	12	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
IV	Biomolecules and Metabolism: Carbohydrates: Classification and function of Carbohydrates. Carbohydrate metabolism - Glycolysis, Krebs cycle, Gluconeogenesis, Glycogenesis and Glycogenolysis. Energy metabolism- ATP production. Energy cost of locomotion. Classification and function of amino acids, Lipids and Nucleic acids.	12	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
V	Enzyme Kinetics: Enzymes – Classification and nomenclature of Enzymes – Physio-Chemical properties of enzymes – enzyme kinetics – mechanism of enzyme action-factors affecting enzyme activity.	12	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6

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.

Verma P.S., Tyagi B.S & Agarwal V.K., 2010. Animal Physiology, S. Chand & Co. Ltd., New Delhi Publishing., 417 pp.

Suggested Readings

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 (4thedn). 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

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	Understand and recall the anatomy, functions and basic concepts of metabolism.	K1, K2
CO 2	Explain, and interpret the physiological process of various organs and their interaction between them.	K3
CO 3	Analyse and compare the biochemical interaction in cells and relate their changes in response to the environment.	K4
CO 4	Assess the importance and coordination of biomolecules in normal body function.	K5
CO 5	Collate and discuss the normal and abnormal physiology and prepare a flowchart for biochemical processes.	K6

Course Code	UAZ 3502
Course Title	Animal Physiology and Biochemistry Lab
Credits	02
Hours/Week	02
Category	MC (P)
Semester	III
Regulation	2019

Course Overview

1. Provide students with knowledge in the cellular basis of animal physiology.
2. Learn fundamental approaches for experimentally investigating biochemical parameters.
3. Understand the integrated functioning of the organism and the processes by which regulation of physiological and biochemical functions occur.
4. To gain knowledge in the theoretical foundations and understand the applicability of the laboratory techniques in real life.
5. The students will be able to perform, analyse and report on experiments and observations in animal physiology and biochemistry.

Course Objectives

1. To give students competent lab skills in animal physiology and biochemistry.
2. To understand the physiological processes that regulate body functions.
3. To strive to demonstrate the role of experimentation in developing our understanding of living animals.
4. To attain knowledge of important biomolecules such as carbohydrates, lipids, amino acids, proteins and enzymes.
5. Measure and interpret experimental data and demonstrate laboratory skills in animal physiology and biochemistry.

Prerequisites	Basic knowledge on Biology or Zoology

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Level
I	Digestive Enzymes: Survey of digestive enzymes in Cockroach, counting of cockroach haemocytes using haemocytometer. Ptyalin activity in relation to temperature and pH in human saliva.	12	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
II	Ecological Methods: Estimation of oxygen consumption in an aquatic and a terrestrial animal.	12	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
III	Biochemical Tests: Use of pH meter for estimation of pH in water and soil samples, Study of micro arthropods of	12	CO 1 CO 2	K1, K2, K3, K4, K5, K6

	water and soil samples Determination of dissolved O2, free CO2 of water, Zoo-plankton count by standard methods		CO 3 CO 4 CO 5	
IV	Qualitative Detection of Biomolecules: Qualitative tests for identification of carbohydrates, proteins and lipids. Amino acid in haemolymph of any insect by chromatographic technique.	10	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
V	Haematology: Estimation of Haemoglobin by Cyanmethemoglobin method, Blood grouping - total and differential counts. Determination of plasma hemoglobin, Total erythrocyte count by hemocytometer.	14	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6

Text Books

1. Widmaier, E.P., Raff, H. and Strang, K.T. 2008. Vander's Human Physiology, XI Edition., McGraw Hill., 770 PP.
2. Bishop, ML.,Fody, E.P., Schoeff, LE. 2010. Clinical Chemistry: Principles, Procedure, correlations. Wolters Kluwer, Inida, 298 PP.
3. Burtis, C.A. and Ashwood, E.R. 2008. Tietztext book of Fundamentals of clinical chemistry and molecular diagnostics, Elsevier, Philadelphia.
4. Tortora G.J.&Derrickson B.., 2016. Principles of Anatomy and Physiology, John Wiley and Sons, Inc. 1232 PP.

   Agarwal R A., Anil K Srivastava., Kaushal Kumar.,1978. Animal Physiology and Biochemistry, S. Chand & Co. Ltd., New Delhi Publishing., 377 PP.

Suggested Readings

1. Hoar, W.S. 1983. General and Comparative Physiology. Prentice Hall of India, New Delhi., 928 PP.
2. Prosser C.L., 1985. Comparative Animal Physiology, Satish Book Enterprise, Agra - 282 003, 966 PP.
3. Wood, D.W., 1968. Principles of Animal Physiology, Edward Arnold Ltd, London.,342 PP.
4. 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.
5. Wilson, J.A. 1984, Principles of Animal Physiology, Macmillan Publishing., 426 PP

Web Resources

1. https://bit.ly/3hNyeFN
2. https://www.medicinenet.com/alp_test/article.htm
3. https://vlab.amrita.edu/?sub=3&brch=63
4. https://www.asbmb.org/education/online-teaching/online-lab-work

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	List and recall the basic equipment used in physiology and biochemistry lab and develop skill about quantitative determination of biomolecules and quantitative analysis of blood.	K1, K2
CO 2	Demonstrate the instruments, discuss the clinical importance and its applications, and explain the principle of bioinstruments.	K3
CO 3	Understand and identify the chemical composition of major and minor nutrients and analyse Physio - chemical parameters that regulate metabolism.	K4
CO 4	Evaluate and Examine the various parameters of haematology and biochemistry and Identify the nitrogenous waste products of animals.	K5
CO 5	Summarise the effect of various physical and chemical factors on enzyme activity/. Compile the changes in various physiological parameters in man and other animals using various tools and techniques.	K6

Course Code	UAZ 3503
Course Title	Developmental Biology
Credits	03
Hours/Week	03
Category	Major Core (MC) – Theory
Semester	III
Regulation	2019

Course Overview

1. Developmental biology deals with the study of the biological processes involved the development of a single fertilized zygote into a complete organism.
2. The course lays the foundation for basic principles of development and the process of gametogenesis.
3. The intricate mechanisms of cellular behaviour during development and the pathways of morphogenesis and organogenesis are explored in detail to understand the embryonic structural and cellular organization.
4. The most important aspects emphasized in the course are the roles of genetics, environment, regeneration capacity and stem cells in embryonic developmental processes.
5. The course offers technical knowledge on artificial reproductive technologies and uncovers the causes and consequences of multiple births, conjoined babies and congenital disorders to help the students to correlate the significance of cellular processes in organogenesis.

Course Objectives

1. To understand and correlate the significance of cellular processes in embryonic development and specifically in organogenesis.
2. To describe and elaborate on the involvement of specific cell types in the formation of specific organs and explain the importance of morphogens.
3. To help students to distinguish between the different types of developmental mechanisms in various organisms.
4. To help students to understand the role of environment and genetics in influencing embryonic development.

Prerequisites	Basic knowledge on Biology or Zoology

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Level
I	Basic Concepts of Development: History of developmental biology; Cell differentiation, commitment and aging; Cell specification and its types; Concept of organizers and inductors; Oogenesis and Spermatogenesis.	12	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
II	Fertilization and Morphogenesis: Fertilization in sea urchin and mammals; Cleavage patterns and planes;	12	CO 1 CO 2	K1, K2, K3, K4, K5, K6

	morphogens - movement and gradients; Types of morphogenetic cell movements - invagination, involution, ingression, delamination and epiboly; Gastrulation in sea urchin, frog, chick and mammals; fate maps.		CO 3 CO 4 CO 5	
III	Organogenesis : Development of Eye, Ear, Brain and Heart and Limb in chick; development of the placenta and extra embryonic membranes in chick; Axis formation (anterior-posterior and dorsal-ventral axis) and genetic control of pattern formation and morphogenesis in *Drosophila melanogaster*.	12	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
IV	Regeneration : Types, regeneration in hydra, limb regeneration in salamander and pattern formation in regeneration blastema; liver regeneration; regeneration and aging; Stem cells - types of stem cells, role in regeneration and development.	12	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
V	Developmental Issues : Congenital malformation - causes and examples; environmental disruption of normal development by teratogenic agents and endocrine disruptors; Multiple births, conjoined twins; Types of assisted reproductive techniques and procedure of in vitro fertilization and ART.	12	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6

Text Books

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

Suggested Readings

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

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	To describe and illustrate the significance of cellular processes in embryonic development**.**	K1, K2
CO 2	To relate the factors that contribute to the developmental process, construct fate maps and illustrate the steps in morphogenesis and organogenesis.	K3
CO 3	To correlate the involvement of specific cell types in the formation of specific organs and explain the importance of morphogens.	K4
CO 4	To distinguish between the different types of developmental mechanisms in various organisms and appraise the species-based differences in development.	K5
CO 5	To justify and validate the role of environment and genetics in influencing embryonic development**.**	K6

Course Code	UAZ - 3504
Course Title	Evolutionary Biology
Credits	03
Hours/Week	03
Category	Major Core (MC) – Theory
Semester	III
Regulation	2019

Course Overview

1. Evolutionary Biology is a fast growing area of study, utilizing ever-more sophisticated technology to unravel the history of life on earth and the goal of this course is to provide a clear evolutionary context for understanding biology, from the origin of the cell to human intelligence.
2. This course provides an overview of the mechanisms and processes of change at the population, organismal, cellular, and molecular levels. It also provides an overview of the history of Earth and its biota including geological time, fossils, and man.
3. Students will understand that natural selection is one of several processes that can bring about evolution, and promote stability rather than change
4. This course is aimed at providing the key principles underpinning the various theories in evolutionary biology, including principles of natural and sexual selection, basic population genetics, molecular evolution, phylogenetic, speciation and diversification, co-evolution, life history evolution, and evolutionary developmental biology.
5. The major aspects of evolutionary biology that will be discussed in the course includes: mechanisms of origin of life, Modes of speciation-Hybridization, Law of Adaptive Radiation in reptiles and mammals, Animal colouration and Mimicry, different forms of evidences supporting evolution, Natural selection, fossils, Eugenics, Euphenics and Euthenics and Geological Time Scale.

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. This course helps to understand the important processes, principles, and concepts on evolution.
2. To provide adequate information on the Lamarckism - Neo Lamarckism – Darwinism, Neutral Theory of Molecular Evolution, and Human Genome Project.
3. 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.
4. 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.

Prerequisites	Basic knowledge on Biology, and Genetics

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Level
I	Inorganic and organic evolution-History of evolutionary thought, Primordial earth and primeval atmosphere, Chemical origin of life: Synthesis of organic molecules, Urey-Miller experiment, Origin of prokaryotes and eukaryotes.	12	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
II	Lamarckism - Neo Lamarckism - Darwinism - Neo Darwinism and modern synthetic theory - DeVrie's Mutation theory – modern concepts of mutation - Mutation and their role in evolution - Animal colouration and Mimicry.	12	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
III	Isolating mechanisms - Modes of speciation- Hybridization is an evolutionary catalyst- Law of Adaptive Radiation- Adaptive radiation in reptiles and mammals - Convergence and parallelism - Evolutionary constancy.	12	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
IV	Morphological, physiological and biochemical, embryological, Taxonomical and geographical evidences - Palaeontological evidences – evolutionary genomics. Types of rocks - Geological time scale – Nature of fossils- Dating of fossils - Fossil records of man and fossil records of horse.	12	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
V	Natural selection in action in man- level of selection- Eugenics, Euphenics and Euthenics- Adaptation- Human Genome Project – Evolution and ethics.	12	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6

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. Stricberger, 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.

Suggested Readings

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 Resources

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

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	To understand the Primordial earth and theories on origin of life	K1, K2
CO 2	To integrate and assess Lamarckism - Neo Lamarckism – Darwinism	K3
CO 3	To analyse various fossil records of man and fossil records of horse, various types of rocks - Geological time scale.	K4
CO 4	To explain the Nature of fossils- Dating of fossils, evidences of evolution, Adaptive radiation in reptiles and mammals,	K5
CO 5	To construct and compile the role of Human Genome Project, Evolution in the diagnosis, and treatment of diseases.	K6

Course Code	UAZ 4501
Course Title	Environmental Biology
Credits	04
Hours/Week	04
Category	Major Core (MC) - Theory
Semester	IV
Regulation	2019

Course Overview

1. Environmental biology course in on environmental protection and ecology.
2. The aim of the course is to give basic knowledge about the structure and function of ecosystem and the impact of human behaviour on our planet in a global perspective and the solutions for environmental sustainability.
3. It gives a basic understanding of the relationship between living organisms and their surroundings.
4. Addresses different levels of ecosystem, energy flow and relationship between trophic levels.
5. The other important aspects that will be discussed in the course includes: climate change, pollution, chemical waste and disposal, biodiversity, degradation of habitat, role of government and non-government agencies in environment management and environmental ethics.

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.

Prerequisites	Basic knowledge in Biology or Zoology

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Level
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).	12	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
II	Population And Biological Cycles : Structure and distribution – Growth curves - Groups, natality, Mortality	10	CO 1 CO 2	K1, K2, K3, K4, K5, K6

	-Density indices, Life study tables - factors affecting population growth -Carrying capacity. Population regulation and human population control. Complete and incomplete biogeochemical cycles - Sedimentary cycle.		CO 3 CO 4 CO 5	
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.	10	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
IV	Environmental Pollution: Definition- cause, effects and control measures of: -Air pollution - Water pollution - Soil pollution -Marine pollution - Noise pollution - Thermal pollution -Nuclear hazards.	10	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
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.	10	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6

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.

Suggested Readings

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

5. https://bit.ly/3hVJZtU
6. https://www.bnhs.org/
7. https://bit.ly/3Av1Ejg

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	Understand the fundamental structure and functions of the ecosystem.	K1, K2
CO 2	Assess the inter-relationship between organisms and between biotic and abiotic factors in an ecosystem.	K3
CO 3	Analyze the factors that cause pollution, climate change, loss of biodiversity and depletion of resources.	K4
CO 4	Evaluate the impact of human population growth and socio-economic development on the structure and function of the ecosystem.	K5
CO 5	Design plans to scientifically solve environmental problems using biological tools, technologies and government policies.	K6

Course Code	UAZ 4502
Course Title	Environmental Biology Lab
Credits	02
Hours/Week	02
Category	MC(P)
Semester	IV
Regulation	2019

Course Overview

1. This course provides knowledge in laboratory techniques related to environmental monitoring.
2. A course designed to explore the connections between human health and the environment.
3. An introduction to science that investigates the effects of pollutants and toxins on the ecology of individuals, populations and communities of organisms.
4. A field course designed to expose students to basic research techniques and methods used in the study of ecology.
5. Students will be introduced to methods for assessing and monitoring the environmental health of ecosystems.

Course Objectives

1. To introduce students to the biological and chemical analysis of fresh water.
2. To analyse methods for assessing and monitoring the environmental health of ecosystems. Stimulate various phenomena in biology, ecology, and environmental science.
3. To use an interdisciplinary approach to analyse environmental issues/problems; show knowledge of the interplay between the ecological, social, cultural and economic aspects of environmental problems.
4. To demonstrate an understanding of core ecological principles, and define scientific principles and concepts as related to environmental studies and sustainability.
5. To participate in field research for documentation of biodiversity.

Prerequisites	Basic knowledge on Biology or Zoology

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Level
I	Estimation of Abiotic Factors: Estimation of dissolved Oxygen, Dissolved carbon-di-oxide, Determination of alkalinity in water samples, Determination of salinity of water samples, Determination of bicarbonate and carbonates.	8	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
II	Mounting Techniques: Collection, isolation, identification and mounting of marine and freshwater plankton.	6	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
III	Adaptation and Animal Associations: Study of sandy shore fauna- Study of rocky shore fauna - Study of	6	CO 1 CO 2	K1, K2, K3, K4, K5, K6

	animal Association.		CO 3 CO 4 CO 5	
IV	Collection of Microarthropods : Study of different soil microarthorpods - Extraction and identification of soil micro arthropods through Tullgren's funnel method and Ladell's Floating Method.	7	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
V	Field Work: Visit to a local area to document environmental assets river/forest/grassland/hill/mountain. Visit to a local polluted site-Urban/Rural/Industrial/Agricultural. Study of common plants, insects, birds. Study of simple ecosystems-pond, river, hill slopes, etc.	5	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6

Text Books

1. Abhijit Dutta, 2009. Experimental biology: A Laboratory Science, Narosa, New Delhi.
2. Michael, P, 1984. Ecological Methods for field visit and laboratory investigation. Tata McGraw Hill, New Delhi.
3. APHA, 1992. Standard Methods for the examination of water and waste water, American Public Health association, Washington D.C.

Suggested Readings

1. Eugenia, 2008. Environmental Biotechnology and cleavers Bioprocesses, London.
2. Ramesh, R & M, Anbu 1996. Chemical methods for environmental Analysis of water and sediment. Macmillan India Limited, Chennai.

Web Resources

1. https://bit.ly/2VZQFiT
2. https://bit.ly/3zmMETe
3. https://www.ametuniv.ac.in/
4. https://open.umn.edu/opentextbooks/textbooks/687
5. https://bit.ly/3lO29yP

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	Recall the procedure for the estimation of abiotic factors and list out the identification characters of organisms.	K1, K2
CO 2	Estimation of various parameters of water and collection and of organisms belonging to different habitats.	K3
CO 3	Illustrate abiotic/biotic interactions and symbiotic relationships	K4
CO 4	Analyse and interpret the impact of lifestyle on the environment.	K5
CO 5	Summarize the abundance and distribution of organisms. Discuss the environmental hazards and social and economic ramifications.	K6

Course Code	UAZ 4601
Course Title	Essentials of Marine Biology
Credits	04
Hours/Week	04
Category	Major Elective (ME) - Theory
Semester	IV
Regulation	2019

Course Overview

1. Marine Biology Course introduces students to the study of life in marine environments. Students will gain knowledge about the physical characteristics of the Earth's oceans.
2. Explain the concept of marine ecology and demonstrate the expected distribution of fauna in a given area – based on a theoretical understanding of the ecology of that area.
3. To introduce students to marine organisms, their behaviors and interactions with the environment. Discuss about biological oceanography and the associated fields of chemical, physical, and geological oceanography to understand marine organisms.
4. In this course students will learn about life in the ocean depths, at the Polar extremes, in coral reefs, estuaries, in the open sea, marine birds, reptiles, invertebrates and fish.
5. Marine Biology focuses on the identification, classification and interaction of marine organisms. Information is presented in an integrated approach with science as inquiry, science & technology, science & social perspectives, and the history & nature of science.

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 and to develop an awareness of the career possibilities available to students in this area.

Prerequisites	Basic knowledge on Environmental biology, Ecology or Zoology

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Level
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.	10	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6

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.	12	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
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.	10	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
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.	12	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
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.	12	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6

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 Resech Jr.1979, Marine Biology. Reston Publishing Company, Virginia. 257 pp.

Suggested Readings

1. Barbara E. Curry, 2016. Advances in Marine Biology, Volume 74, Ist 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, Ist 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

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	Define marine ecosystem, recognize and describe the interrelationship between biology and ocean technology.	K1, K2
CO 2	Articulate and classify the dynamics and the physical attributes of the ocean, interpret the factors which affect the global climate.	K3
CO 3	Identify and analyze the physical and biological factors of marine environments, and focus life in the open sea.	K4
CO 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.	K5
CO 5	Categorize marine pollutants and develop controlling measures in collaboration with the institutions for ocean management.	K6

Course Code	UAZ 4602
Course Title	Essentials of Marine Biology Lab Course
Credits	02
Hours/Week	02
Category	Major Elective (ME) - Lab
Semester	IV
Regulation	2019

Course Overview

1. This course demonstrates marine laboratory concepts, techniques, and procedures, and describe the identifying characteristics of marine organisms.
2. Marine biology lab course will provide a practical laboratory experience session to accompany the study of marine biology.
3. This course is designed to explore marine organisms, demonstrate marine laboratory concepts, techniques, and procedures, describe the identifying characteristics of marine organisms.
4. The topics students study include ecological concepts of the sandy beach, rocky shore and benthic communities, seaweeds, planktonic forms, plankton and their relationship to marine life cycles, nekton, benthos, marine biological resources, and marine pollution.
5. The course integrates unifying science concepts and processes of systems, order & organization, evidence, models & explanation, change, consistency and equilibrium.

Course Objectives

1. To acquire knowledge about marine fauna and flora, biodiversity, chemical composition and primary production.
2. To identify and describe major energy transformations in the marine environment and analyze current issues in marine science and technology.
3. To describe how information is acquired through observations and measurements of marine phenomena.
4. To demonstrate a manifestation of the critical thinking skills by examining marine biological-oriented problems.
5. To describe the structure, function, and behavior of representative marine life forms.

Prerequisites	Basic knowledge on Biology, Ecology, Environmental Science or Zoology

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Level
I	Identification of Plankton and Marine Flora **:** Phytoplankton and zooplankton (diatoms, dinoflagellates, hydromedusae, copepods, pteropods, chaetognatha, thailaceae and planktonic larvae) - Identification of locally available macroalgae, sea grass and holophytes including mangrove plants.	12	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
II	Field Survey **:** Field collection - submission of 10 herbarium sheets - Extraction and quantification of plant	10	CO 1 CO 2	K1, K2, K3, K4, K5, K6

	pigments - Determination of primary production using light and dark bottle techniques.		CO 3 CO 4 CO 5	
III	Estimation of Abiotic Factors : Estimation of salinity, pH, dissolved oxygen and dissolved salts.	12	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
IV	Community Studies **:** Collection and identification of animals and community studies of different environments. Pelagic, Muddy shore, Sandy shore, Rocky shore, Interstitial, Phytal fauna, fouling and boring organisms. Assessment of biodiversity of any one of the above communities.	12	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
V	Field Study **:** Preparation of field report.	10	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6

Text Books

1. Thurman, Harold., 2001 Introduction to Oceanography, Prentice Hall Inc. New Jersey.
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.

Suggested Readings

1. Pickard, G.L. and W.J. Emery 1995. Descriptive Physical Oceanography. Pergamon Press, London.
2. Gage. J.D. and P.A. Tyler, 1991. Deep Sea Biology, Cambridge University Press, Cambridge
3. Riley, J.P. and Skirrow, 1975-1984. Chemical Oceanography Vols. 1 to 8. Academic Press, London.
4. Strickland J.D.H and T.R. Parsons, 1972. A Practical Hand Book of Seawater analysis. Fisheries Research Board, Ottawa.

Web Resources

1. https://www.livescience.com
2. https://www.icriforum.org
3. https://www.cbd.int
4. https://www.cmfri.org.in

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	Understand and Identify planktons, explain the economic importance of marine organisms.	K1, K2
CO 2	Apply the suitable bioanalytical techniques to separate plant pigments and analyse other marine biomolecules.	K3
CO 3	To correlate and appraise the use of specific samples for specific biological experiments and infer the results of such experiments with reference value.	K4
CO 4	To compile laboratory observations and report the principle, procedure and results of experiments accurately and effectively.	K5
CO 5	Arrange field survey and field study, develop laboratory techniques related to marine research and ocean technology.	K6

Course Code	UAZ 4603
Course Title	Biophysics and Biostatistics
Credits	04
Hours/Week	04
Category	Major Elective (MC) – Theory
Semester	IV
Regulation	2019

Course Overview

1. Biophysics and Biostatistics is an interdisciplinary subject where the application of basic physical concepts and statistical principles are integrated with biology.
2. This course integrates physics, chemistry, physiology, medicine, mathematics, statistics and biology.
3. This course highlights the basic principles of diffusion, centrifugation, radiology and ultrasonics and its instrumentation, step by step procedure of various bioanalytical techniques for identification, separation of biomolecules and its application in medicine for diagnosis.
4. This course gives a basic idea on the selection of biological sample for preparation and classification of data for analysis
5. In addition, this course provides the introduction of statistical methods that can be used to study the qualitative and quantitative problems in biology.

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 calculate standard deviation, correlation coefficient, chi-square analysis and student 't' test using the formula.

Prerequisites	Basic knowledge in Biology, Physical science and Basic mathematics

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Level
I	Biophysical Principles: Physical laws in living system: diffusion – Factors affecting diffusion- types of diffusion – Fick's law – Biological significance of diffusion – Osmosis – Osmotic pressure (endocytosis, pinocytosis, phagocytosis, exocytosis plasmolysis and haemolysis) Principles of viscosity – Brownian movement – surface tension – turgor pressure – Centrifugation: Principle – types – applications.	12	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
II	Applications of Biophysics: Principle and applications of colorimeter – electrophoresis –principle, instrumentation –	12	CO 1 CO 2	K1, K2, K3, K4, K5, K6

	applications of gel electrophoresis. Radioactivity: Types of radioactive decay – Radioactive isotopes – Autoradiography – biological impacts – Geiger-Muller counter: Principle – working procedure – advantages and disadvantages. Medical and biological uses of X-rays, Ultrasound andLaser		CO 3 CO 4 CO 5	
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. Variables: discrete – continuous. Frequency distributions.	12	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
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.	12	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
V	Descriptive & Inferential Statistics: Measure of central tendency: Arithmetic mean – median– mode. Measures of dispersion: Standard deviation–Standarderror–Coefficient of variance. Test of significance: Chi-square test for goodness of fit – Student 't' test.	12	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6

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. An introduction to Biostatistics, MJP, Chennai, 250pp.
4. Palanichamy, S and M. Shanmugavelu, 1991. Principles of Biostatistics. Palani Paramount. India. 350pp
5. Roy, R.N. 1996. A Text Book of Biophysics, New Central Book Agency Ltd, Calcutta. 992pp.
6. Shakila Devi. G.T., and R.S. Ramya Balaji, 2011. Biostatistics, Margham Publications, Chennai.10.39pp.

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. Betty Karasek, 2015. Advanced concepts of biophysics, Callistro Reference, 198pp.
3. Daniel, W. W., 2000. Biostatistics: A foundation for analysis in the health sciences, 7th Ed. John Wiley & Sons Ltd. New York. 328pp.
4. Edward K. Yeargers, 2018. Basic Biophysics for Biology, CRC Press, 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., Whitlock and Dolph Schluter, 2009. The analysis of biological data, 2nd Ed.

Mac Millan Publishers, New York, 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, 6th Ed. Duxbury press, Singapore.784pp
12. Sail Bose, 2000, Elementary Biophysics, Vijaya printers, Maduari.
13. Tanford, C., 1961. Physical chemistry of macromolecules, John Wiley & Sons Ltd. England. 710pp.
14. Yadav, B.S., 2020. Text book of biophysics, Arjun Publishing House, New Delhi.

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

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	Understand and recall the basic biophysical concepts, statistical data and formula.	K1, K2
CO 2	Apply suitable physical techniques and statistical methods to solve biological problems.	K3
CO 3	Identify and relate the bioanalytical techniques and statistical principles for the application of biological experiments.	K4
CO 4	Select suitable biophysical techniques to study the biological process and statistical approach to assess the experimental results.	K5
CO 5	Integrate the bioanalytical techniques and statistical methods to validate research investigations.	K6

Course Code	UAZ 4604
Course Title	Biophysics and Biostatistics Lab Course
Credits	02
Hours/Week	02
Category	Major Elective (ME) – Practical
Semester	IV
Regulation	2019

Course Overview

1. Biophysics and Biostatistics lab course is an interdisciplinary subject where the application of basic physical concepts and statistical principles are integrated with biology.
2. This course employs separation techniques such as centrifugation and chromatography to separate and examine biomolecules
3. This course applies photochemical principles to estimate the qualitative and quantitative examination of samples.
4. This course gives a basic idea on the selection of biological sample for the preparation and classification of data for analysis
5. In addition, this course provides the introduction of statistical methods, to test the significance

Course Objectives

1. To understand the principle of centrifugation for separation of cream from milk, plasma from blood and paper chromatography for separation of amino acids.
2. To understand the photochemical techniques to determine reducing sugar.
3. To understand and calculate standard deviation, chi-square, student 't' test.
4. To estimate the level of significance.

Prerequisites	Basic knowledge in Biology, Physical science and Basic mathematics

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Level
I	Separation Techniques : Separation of amino acids using circular paper chromatography –separation of cream from milk / Isolation of Chloroplast / Photosynthetic pigments from leaves / plasma from blood using centrifuge.	10	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
II	Photometry : Estimation of reducing sugars / Estimation of proteins.	4	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
III	Measures of Central Tendency: Measures of central tendency using leaf: Arithmetic mean- median-mode Measures of dispersion: Standard deviation – Standard error.	4	CO 1 CO 2 CO 3 CO 4	K1, K2, K3, K4, K5, K6

			CO 5	
IV	Measurements: Test of significance: Chi-square test for goodness of fit – Student 't' test. Correlation coefficient - Height and weight comparison, BMI index calculation.	10	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
V	Statistical Software and Spotters: Hands on training of SPSS. Spotters: TLC, Centrifuge, PAGE, colorimeter, Spectrophotometer, PCR	2	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6

Text Books

1. Bajpai, P. K. 2006. Biological Instrumentation and Methodology, S.Chand & Company Ltd. New Delhi. India.305pp
2. Gurumani, N., 2005. An introduction to Biostatistics, MJP, Chennai, 250pp.
3. Rajan, S. and Selvi Christy, R., 2001. Experimental procedure in Life sciences, Anjanaa book house, 1st Ed, Chennai. 560pp
4. Sundar Rao, P.S.S and J. Richard, 2012. Introduction to biostatistics and research, 5th Ed. PHI learning private Ltd. New Delhi, India. 268pp.

Suggested Readings

1. Geddes, L.A., 1972. Electrodes and the measurement of bioelectric events, John Wiley & Sons Ltd. New York.382pp.
2. Jay L. Nadeau, 2011. Introduction to experimental biophysics. Biological methods for physical scientists, 2nd Ed. CRC Press, USA, 700pp.
3. Lehninger, A. L., 2006. Biochemistry, Freeman, New York. 1104pp
4. Mauro Geller and Mendel scumaucher, 2012. Practical biostatistics: A friendly step-by-step approach for evidence-based Medicine, Academia press, USA. 248pp
5. Rajan, S. and Selvi Christy, R., 2001. Experimental procedure in Life sciences, Anjanaa book house, 1st edition, Chennai.560pp.

Web Resources:

1. https://bit.ly/3EDxWLf
2. https://vlab.amrita.edu
3. https://www.mathsisfun.com/data/standard-deviation.html
4. https://onlinecourses.nptel.ac.in/noc19_bt19

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	Understand and recall the experimental principles, procedure and formula.	K1, K2
CO 2	Apply the suitable bioanalytical techniques to separate and analyse biomolecules; statistical methods to test significance.	K3
CO 3	Calculate the data to get the observed and expected result.	K4
CO 4	Compare the results to determine the level of significance.	K5
CO 5	Compile and create an experimental research design.	K6

Course Code	UAZ 5501
Course Title	Molecular Biology
Credits	04
Hours/Week	04
Category	Major Core (MC) - Theory
Semester	V
Regulation	2019

Course Overview

1. Molecular Biology is the study of biological systems in the molecular level.
2. The aim of the course is to study the biochemical mechanisms that control the expression and maintenance of genome.
3. The course also focuses on the steps involved in protein synthesis.
4. We will also discuss about the synthesis of nucleic acids, difference in transcription and translation in prokaryotes and eukaryotes and key concept of gene regulation emphasizing more on the role of regulatory genes.

Course Objectives

5. To understand the structures and functions of important biomolecules in the cell.
6. To know the mechanism underlying gene expression.
7. To explain the process of replication, transcription and translation.
8. To know about the importance of regulatory factors in DNA repair mechanism.

Prerequisites	Basic knowledge in Biology or Zoology

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Level
I	Nucleic Acids and DNA Replication : Salient features of DNA and RNA. Watson and Crick model of DNA. DNA Replication in Prokaryotes and eukaryotes, mechanism of DNA replication, Semi-conservative, bidirectional and semi-discontinuous replication, RNA priming, Replication of circular and linear *ds*-DNA, replication of telomeres.	12	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
II	Transcription and Translation: RNA polymerase and transcription Unit, mechanism of transcription in prokaryotes and eukaryotes, synthesis of rRNA and mRNA, transcription factors. Genetic code, Degeneracy of the genetic code and Wobble Hypothesis; Process of protein synthesis in prokaryotes: Ribosome structure and assembly in prokaryotes, fidelity of protein synthesis, aminoacyl tRNA synthetases and charging of tRNA; Proteins involved in initiation, elongation and termination of polypeptide chain; Inhibitors of protein synthesis;	10	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6

	Difference between prokaryotic and eukaryotic translation.			
III	Post Transcriptional Modifications and Processing of Eukaryotic RNA : Structure of globin mRNA; Split genes: concept of introns and exons, splicing mechanism, alternative splicing, exon shuffling, and RNA editing, Processing of tRNA.	10	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
IV	Gene Regulation : Transcription regulation in prokaryotes: Principles of transcriptional regulation with examples from *lac* operon and *trp* operon; Transcription regulation in eukaryotes: Activators, repressors, enhancers, silencer elements; Gene silencing, Genetic imprinting	10	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
V	DNA Repair Mechanisms and Regulatory RNAs : Pyrimidine dimerization and mismatch repair Ribo-switches, RNA interference, miRNA, siRNA.	10	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6

Text Books

1. Ajoy Paul, 2011. Text books of cell & molecular biology, 3rd edition, Books & allied
2. (P) Ltd., Kolkata, India.
3. Lodish, H., Berk, A., Matsudaira, P., Kaiser, C.A. 2007. Molecular cell biology, what freeman, New York.
4. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, and Peter Walter, 2002. Molecular biology, Garland science. New York.
5. Watson, J.D, 2004. Molecular Biology of the gene. Pearson Education, New Delhi.
6. De Robertis, E.D.F. & De Robertis, E.M.F., 1981. Cell and Molecular Biology, Saunders International, Philadelphia.

Suggested Readings

1. George M. Malacinski, 2010. Essential of molecular biology, 4th edition, Narosa publication.
2. John T. Hancock, 2006. Cell signaling, 2nd edition, oxford University press.
3. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). *The World of the Cell.* VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.
4. Karp, G. 2010. *Cell and Molecular Biology: Concepts and Experiments*. VI Edition. John Wiley and Sons. Inc.
5. McLennan A., Bates A., Turner, P. and White M. (2015). *Molecular Biology* IV Edition. GS, Taylor and Francis Group, New York and London.

Web Resources

1. https://bit.ly/3hT8Eiw
2. https://bit.ly/3Ewr9TE
3. https://bit.ly/39oEOOf
4. https://bit.ly/3EE5edm
5. https://bit.ly/3hSLFnT
6. https://www.youtube.com/watch?v=gG7uCskUOrA

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	To understand the basic structure of nucleic acids and the molecular basis of central dogma.	K1, K2
CO 2	To identify the biochemical pathways in the synthesis of nucleic acids and proteins.	K3
CO 3	To analyse and differentiate the structural elements and biological processes in prokaryotes and eukaryotes in controlling cellular activity.	K4
CO 4	To evaluate the role of regulatory factors in the synthesis of nucleic acids and maintenance and expression of genes.	K5
CO 5	To summarize the molecular mechanisms by which genetic material controls the character and growth of organisms.	K6

Course Code	UAZ 5502
Course Title	Genetics
Credits	04
Hours/Week	04
Category	Major Core (MC) – Theory
Semester	V
Regulation	2019

Course Overview

1. The aim of the course is to give basic understanding of inheritance and regulation of cellular activities in molecular level.
2. In this course, we will explain the role of nucleic acids in inheritance.
3. We will also explain about the relationship between mutation and phenotypic variations.
4. We will discuss the role of mutation in evolution.
5. The other important aspects that will be discussed in the course includes: Mendelian concepts, deviations from Mendelian inheritance, linkage and crossing over, pedigree analysis, concepts of eugenics, euthenics and euphenics, microbial genetics, and genetic elements.

Course Objectives

1. To understand the structure and functions of nucleic acids in the cell.
2. To know the causes and effects of mutations.
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 and the molecular basis of variations.

Prerequisites	Basic knowledge on Biology or Zoology

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Level
I	Mendelian Genetics and Inheritance: Mendelian genetics: Mendelian experiments, laws of Mendel, Monohybrid, Dihybrid, back and test cross; Interaction of genes: Incomplete dominance, co dominance, complementary genes, supplementary genes, inhibiting genes, lethal genes and atavism. Inheritance: Polygenic inheritance- skin colour; multiple alleles- ABO blood groups and coat colour in rabbit; extra chromosomal inheritance- shell coiling, kappa particles; sex linked inheritance – eye colour in drosophila, colour blindness and hemophilia in man.	12	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
II	Linkage and Crossing Over: Linkage: Linked genes, complete and incomplete linkage. Crossing over: molecular mechanisms of crossing over, kinds of crossing	10	CO 1 CO 2 CO 3	K1, K2, K3, K4, K5, K6

	over, models of recombination. Chromosome mapping: inference and coincidence, haploid mapping, somatic cell hybridization.		CO 4 CO 5	
III	Cytogenetics: Variation in chromosome number and structure: position effect, chromosomal mutation and evolution. Gene mutation: types, molecular basis of mutation, mutational hot spots, reversion; radiation and chemical agents as mutagens; Detection of mutation - CIB method and muller-5 method.	10	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
IV	Human and Microbial Genetics: Human genetics: Karyotype and ideogram; sex determination - Barr body technique, drumstick method; chromosomal abnormalities in humans, Pedigree analysis; diagnosis of genetic abnormalities; Eugenics, Euphenics, and Euthenics. Population genetics and evolution: gene pool, gene frequency and genotype frequency; Hardy-Weinberg law of equilibrium. Bacterial genetics : Conjugation, transformation, transduction and chromosome mapping .	10	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
V	Molecular Genetics: Insertion elements, transposable elements, retroelements; integrons and antibiotic resistance cassettes; the lactose system and operon model, tryptophan operon, role and relative positions of promoters and operators, feedback mechanism.	10	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6

Text Books

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

Suggested Readings

1. Geoffrey M. Cooper, 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. Fletcher H and Hickey I., 2015. Genetics, IV Edition. GS, Taylor and Francis Group, New York and London.
4. Peter J. Russel, 2013. iGenetics: A Molecular Approach, Pearson.
5. Klug, W. S., Cummings, M. R., Spencer, C. A., 2012. Concepts of Genetics. X Edition. Benjamin Cummings.
6. Anne Gardner, 2009. Human Genetics, Scion Publishing Ltd.
7. Harvey Lodish, Arnold Berk *et al* .,2007. Molecular cell biology. 6th edition, W. H. Freeman.
8. Strickberger M. W., 1995. Genetics, Prentice Hall India Learning Private Limited.
9. Lewis J Kleinsmith, Valerie M Kish., 1995. Principles of Cell and Molecular Biology,

Harpercollins College Div.
10. Dobzhansky T., 1982. Genetics and The Origin of Species, Columbia University press.

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

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	Understand the basis of inheritance and expression of genes.	K1, K2
CO 2	Correlate changes in genetic makeup and phenotypic changes in progeny.	K3
CO 3	Analyse the causes of variations in genetic material and predict the effect in a population using different techniques.	K4
CO 4	Explain the role of cellular processes and different genetic elements in the expression of genes.	K5
CO 5	Compile the factors which contribute to changes in gene expression and specify the changes which contribute to evolution.	K6

Course Code	UAZ 5503
Course Title	Animal Biotechnology
Credits	04
Hours/Week	04
Category	Major Core (MC) - Theory
Semester	V
Regulation	2019

Course Overview

1. Animal biotechnology deals with the use of biotechnological techniques to improve the quality of animals and animal products for commercial and medical use.
2. The course elaborates the methodology for growing and maintaining animal cells in culture.
3. The basic tools needed for genetic manipulation of animal cells are described in detail with emphasis on the step-wise exploration of the genetic manipulation techniques and ethical considerations in this field of study.
4. The main aspect of the course is the methodologies of transgenic technology in animals and inference of how this could be useful in livestock production and maintenance.
5. The methodologies for development of recombinant therapeutics and gene therapy protocols are uncovered to help the student grasp the applications of animal biotechnology.

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.

Prerequisites	Basic knowledge on Biology or Zoology

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Level
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.	12	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
II	Techniques in Animal Biotechnology : Isolation and purification: DNA and mRNA; Blotting techniques:	12	CO 1 CO 2	K1, K2, K3, K4, K5, K6

	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.		CO 3 CO 4 CO 5	
III	Transgenic Animal Technology : Transgenesis: Concept, transgenes, transgenic animal models - knock out mice, sheep; Applications of transgenesis : Molecular farming, Transgenic fishes, transgenic live stocks, and animals as bioreactors.	12	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
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.	12	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
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.	12	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6

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. Sathyanarayran 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 Dehi.

Suggested Readings

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.
6. Primrose S.B., R. M. Twyman and R. W. Old, 2001. Principles of gene manipulation, Wiley- Blackwell, UK.
7. Primrose S. B., 2001. Molecular Biotechnology, Panima Publishing Corporation, New Delhi, India.
8. 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

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 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.	K1, K2
CO 2	To develop and explain the protocols for genetically manipulating cells and produce transgenic animals.	K3
CO 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.	K4
CO 4	To choose the correct methods of transgenesis and to consider their use in improving animal husbandry nationally and globally.	K5
CO 5	To speculate on the environmental implications of animal biotechnological methods and design responsible, ethical solutions to livestock production and health issues.	K6

Course Code	UAZ 5504
Course Title	Immunology
Credits	04
Hours/Week	04
Category	Major Core (MC) - Theory
Semester	V
Regulation	2019

Course Overview

1. The course includes a detailed description of cells involved in the immune response either innate or acquired and to provide students with a broad overview of basic immunology especially mammalian immune response.
2. The course includes the mechanisms of antibody formation and molecular aspects of cellular immunity, including T and B cell interactions and lymphocyte memory formation.
3. To understand the functions and Dysfunctions of the immune system such as allergies, asthma, and autoimmune disease as well as immune deficiency disorders.
4. This course will include presentations and discussions on autoimmunity, the principle of herd immunity and immunity against the four major categories of pathogen, transplantation and tumor immunology.

Course Objectives

1. To understand the fundamentals of immunology in protection against disease and also the key principles of antigen- antibody reaction in the immune system.
2. To list basic mechanisms that regulate immune responses, describe the main steps in the generation of cells and organs of the immune system.
3. To describe the basic mechanisms that provide innate immunity and antigen processing and presentation.
4. To differentiate B and T cell receptors, organs, and microenvironments of the Immune System.
5. To promote critical thinking and provide students with knowledge on how the immune system works building on their previous knowledge from biochemistry, genetics and cell biology.

Prerequisites	Basic knowledge on Physiology, Cell Biology, Biochemistry and Zoology

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Level
I	Immune Cells and Organs: Overview of Immune System - General concepts and Haematopoeisis. Cells of the immune system - T and B-lymphocytes, NK cells; Monocytes and macrophages; Neutrophils, eosinophils, and basophils -Mast cells and dendritic cells. Organs of the Immune system: Primary lymphoid organs - Thymus and bone marrow; Secondary Lymphoid organs - Lymph	13	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6

	nodes and spleen; Lymphatic tissues - Peyer's patches and Kupffer cells, MALT, GALT and CALT.			
II	Innate and Adaptive Immunity: Innate and Adaptive Immunity; Anatomical barriers, Inflammatory response, Cells and molecules involved in innate immunity, Adaptive immunity (Cell mediated and humoral). Receptors and Signaling: Cytokines and Chemokines - General Properties of Cytokines and Chemokines. Major Histocompatibility Complex (MHC): Organization and inheritance of the MHC. Structure and cellular distributionof HLA antigens.	14	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
III	Antigen and Antibodies: Antigens- Antigenicity and immunogenicity: Properties -foreignness, molecular size, heterogeneity. B & T epitopes, T-dependent and T-independent B cell responses. Antibodies: Structure, function and properties of the Immunoglobulins, Different classes of Immunoglobulins; antigenic determinants on antibodies (isotype, allotype and idiotype). Hybridoma technology - production of monoclonal antibodies and catalytic antibodies (abzymes).	12	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
IV	Hypersensitivity and Autoimmune Diseases: Hypersensitivity: classification and brief description of various types of hypersensitivities. Autoimmunity: cause of autoimmune diseases - classification of autoimmune diseases. Transplantation immunology: Types of grafts, immunologic basis of graft rejection, immunosuppressive therapy and clinical transplantation.	14	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
V	Clinical Immunology: Immunity and tumors- tumor antigens (TSTA and TAA), immune response to tumors. Tumor evasion of the immune system, Immunotherapy for tumors. Immunity against - viral, bacterial and parasitic infections. Vaccines: Types and uses - Immunization schedule for children.	12	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6

Text Books

1. Kuby, J, Punt, J, Stranford, S, Jones,Pand Owen, J, 2018. Immunology, 8th Edition, W.H.Freeman Publishing, New York, 944 pp.
2. Roitt, M, Peter J. Delves, Seamus J. Martin and Dennis R. Burton, 2017. Essential Immunology, 13th Edition, Wiley-Blackwell Publishing,USA, 576 pp.
3. Coleman,R.M., 2014. Fundamental Immunology, 2nd Edition, Published by Mc Graw Hill Education India, 357 pp.
4. Raj Khanna, 2011. Immunology, Oxford University press, New Delhi. 428 pp.
5. Rao.C.V. 2011. Immunology, Narosa Publishing House, New Dehli. 426 pp.

Suggested Readings

1. Abul A. Andrew, Lichtman. H, Shiv. P, 2014. Cellular and Molecular Immunology, 8th Edition, Published by W.B. Saunders, 544 PP.
2. Chapel. H, Haeney. M, Misbah. S, and Snowden. N, 2006. Essentials of Clinical

Immunology, 5th Edition. Blackwell Publishing, 368 PP.
3. William R. Clark, 1985. The Experimental Foundations of Modern Immunology, Published by Johns Hopkins University Press, New York. 326 PP.
4. Kenneth Murphy & Casey Weaver, 2016. Janeway's Immunology, Garland Science publishers, 924 pp.

Web Resources

1. https://www.aaaai.org/
2. https://www.bsaci.org/
3. https://www.immunology.org/
4. https://nptel.ac.in/courses/102/103/102103038/
5. https://microbenotes.com/category/immunology/

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	Understand and recall the basic structural and functional components of the immune system, compare and contrast cells with respect to origin and maturation.	K1, K2
CO 2	Classify and explain types of immunity, state the significance of antigen and examine their relevance to immunizations.	K3
CO 3	Describe and differentiate the biological characteristics of the antibodies, analyze and formulate the procedure for antibody production.	K4
CO 4	Compare and rate the mechanism of various types of hypersensitivity reactions, assess and identify the different types of autoimmune diseases.	K5
CO 5	Summarize immune responses against pathogens and formulate different laboratory techniques applicable in the diagnosis of immune diseases.	K6

Course Code	UAZ 5505
Course Title	Genetics, Molecular Biology & Animal Biotechnology Lab Course
Credits	04
Hours/Week	02
Category	Major Core (MC) - Lab
Semester	V
Regulation	2019

Course Overview

1. This lab course introduces the concepts of genome organization and genetic inheritance.
2. The techniques for isolating and handling genetic material are emphasized throughout the course.
3. The methods used for studying genomic differences in species and genetic changes during disease are uncovered in this course.
4. The course includes the study of molecular and cell culture techniques to help the students to grasp the concepts of transformation and transgenic technology.
5. The theoretical aspects of the course are uncovered through practical hands-on experiments.

Course Objectives

1. To encourage students to interpret the organization of genomic material and to research theories of genetic inheritance.
2. To impart the skills required to prepare samples of genetic molecules and to determine their purity, structure and characteristics and to analyze genomic preparations.
3. To study the changes in genetic material and to predict and consider the consequences of those changes.
4. To encourage students to report and justify the results of molecular and genetic experiments in an accurate and meaningful manner.

Prerequisites	Basic knowledge on Biology or Zoology

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Level
I	Techniques in Genetic studies: Staining and observation of chromosomes in onion root tip cells at various stages of mitosis. Staining and observation of polytene chromosomes in salivary glands of chironomous larva. Karyotyping (with the help of photographs) – normal male and female karyotypes and study of karyotypes of different genetic syndromes. Verification of the Mendelian laws of inheritance using coloured beads	12	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
II	Isolation of genetic molecules: Isolation of DNA from spleen. Total RNA isolation from plant/animal cells	12	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6

III	Qualitative and quantitative analysis of genetic molecules: Determination of the purity of isolated DNA and RNA samples by UV spectrophotometry. Quantitative	12	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
IV	Molecular analysis: Agarose gel electrophoresis of DNA. Restriction fragment length polymorphism study using the teaching kit	12	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
V	Basic animal cell culture technique and transgenesis: Trypsinization of liver cells. Determination of the viability of trypsinized cells by Trypan Blue method. Creation of transgenic flies through virtual lab activity (https://media.hhmi.org/biointeractive/vlabs/transgenic_fly/ index.ht ml)	12	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6

Text Books

1. Surya Nandan Meena, Milind Naik, 2019. Advances in Biological Science Research: A Practical Approach, Academic Press, New York, USA.
2. Michael Perlin, William Beckerson, Adarsh Gopinath, 2017. Cell, Genetics, and Molecular Biology: A Lab Manual (First Edition), Cognella Inc., USA.
3. Saxena J., Baunthiyal M., Ravi I., 2015. Laboratory Manual of Microbiology, Biochemistry and Molecular Biology, Scientific Publishers, India.
4. Bansal M.P., 2013. Molecular Biology and Biotechnology: basic experimental protocols, The Energy and Resources Institute (TERI), New Delhi, India.
5. Chaitanya K.V., 2013. Cell and molecular biology: A Lab Manual, Phi Learning Pvt. Ltd., New Delhi, India.

Suggested Readings

1. Andreas Hofmann, Samuel Clokie, 2018. Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology, Cambridge University Press, UK.
2. Sarah Stauffer, Aaron Gardner, Wilko Duprez, Dewi Ayu Kencana Ungu, Philip Wismer, 2018. Labster Virtual Lab Experiments: Basic Genetics, Springer Publishers, NY, USA.
3. Leonard Davis, Mark Dibner, James Battey, 2012. Basic Methods in Molecular Biology, Elsevier Science Pubilshing Co., NY, USA.
4. Robert F. Schleif, Pieter C. Wensink, 2012. Practical Methods in Molecular Biology, Springer-Verlag, NY, USA.
5. Ian Freshney R., 2010. Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications, John Wiley & Sons, 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/

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	To describe, examine and interpret the organization of genomic material and to research theories of genetic inheritance.	K1, K2
CO 2	To prepare samples of genetic molecules and to determine their purity, structure and characteristics.	K3
CO 3	To experiment with genomic preparations and devise techniques to distinguish genetic material in different organisms to survey biodiversity.	K4
CO 4	To assess the changes in genetic material and to predict and consider the consequences of those changes.	K5
CO 5	To report and justify the results of molecular and genetic experiments in an accurate and meaningful manner.	K6

Course Code	UAZ 5506
Course Title	Bioinformatics Lab course
Credits	02
Hours/Week	02
Category	Major core (MC) – Lab
Semester	V
Regulation	2019

Course Overview

1. Bioinformatics is an interdisciplinary subject integrating the fields of biological molecules, biochemistry and animals
2. The aim of the course is to give basic knowledge about the bioinformatics tools like phylogenic analysis, gene mapping, analysis of molecular structure and drug discovery.
3. Explain the data base used in drug discovery and species differentiation.
4. The other important aspects of this course is to predict gene and protein structure from their sequences and evaluate their physiochemical properties.

Course Objectives

1. To help students to explore the biological data stored in the databases and to describe the data meaningfully using bioinformatics tools.
2. To encourage students to annotate protein sequences and determine their structures, functions and evolutionary relationships.
3. To enable correlation between gene, protein sequences and structures using statistical tools to infer their physicochemical properties.
4. To derive simulations of 3D structures of proteins and drug compounds using bioinformatics tools and design therapeutic agents.

Prerequisites	Basic knowledge on biological molecules and proteins

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Level
I	Exploration of the NCBI, ExPASy and PDB databases. Literature retrieval from NCBI PubMed database. Retrieval of information about a genetic disorder from OMIM database.	6	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
II	Retrieval of gene and protein sequences in FASTA format from NCBI database. Sequence similarity search using BLASTn and BLASTp. Multiple sequence alignment and phylogenetic tree construction using Clustal Omega.	6	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
III	Gene Prediction using GENSCAN. Protein structure prediction using Phyre2	6	CO 1 CO 2 CO 3	K1, K2, K3, K4, K5, K6

			CO 4 CO 5	
IV	Exploration of the PubChem and ChEMBL databases. Drug discovery tools – Swiss Similarity and Swiss Target Prediction.	2	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
V	Determination of protein properties using ExPASy ProtParam tool. Downloading protein structures from PDB. Visualizing protein structures at PDB using their NGL Viewer'	6	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6

Text Books

1. Prakash S. Lohar, 2019. Bioinformatics, MJP Publishers, Chennai, India.
2. Chandra Sekhar Mukhopadhyay, Ratan Kumar Choudhary, Mir Asif Iquebal, 2018. Basic Applied Bioinformatics, John Wiley & Sons, UK.
3. Supratim Choudhuri, 2014. Bioinformatics for Beginners, Elsevier Inc., Academic Press, New York, USA.
4. Harisha S., 2010. Fundamentals of Bioinformatics, I.K. International Publishing House Pvt. Limited, India.
5. Sharma T.R., 2010. Genome Analysis and Bioinformatics: A Practical Approach, I.K. International Publishing House Pvt. Limited, India.

Suggested Readings

1. Low Lloyd, Tammi Martti, 2017. Bioinformatics: A Practical Handbook of Next Generation Sequencing and Its Applications, World Scientific Publishing Co. Pvt. Ltd., Singapore.
2. Vince Buffalo, 2015. Bioinformatics Data Skills, O'Reilly Media Inc., USA.
3. Florencio Pazos, Mónica Chagoyen, 2014. Practical Protein Bioinformatics, Springer International Publishing, Switzerland.
4. Michael Agostino, 2012. Practical Bioinformatics, 1st Ed., Garland Science, NewYork, USA.
5. Bernd Mayer, 2011. Bioinformatics for Omics Data: Methods and Protocols, Humana Press, USA.

Web Resources

1. http://www.expasy.org/
2. http://www.ebi.ac.uk/
3. http://www.ncbi.nlm.nih.gov/
4. http://www.rcsb.org/
5. http://www.isb-sib.ch/
6. https://www.genome.gov/about-genomics

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	To visualize the biological data stored in the databases and to describe the data meaningfully using bioinformatics tools.	K1, K2
CO 2	To examine gene and protein sequences and determine their structures, functions and evolutionary relationships.	K3
CO 3	To correlate gene, protein sequences and structures using statistical tools to infer their physicochemical properties.	K4
CO 4	To assess and score the differences and similarities between biological molecules using bioinformatics tools.	K5
CO 5	To simulate 3D structures of proteins and drug compounds using bioinformatics tools in order to design therapeutic agents.	K6

Course Code	UAZ 5507
Course Title	Behavioural Biology
Credits	02
Hours/Week	04
Category	Major Core (MC) - Theory
Semester	V
Regulation	2019

Course Overview

1. This course highlights the biological study of animal behavior, how genes and the environment affect behavior, learning, and animal consciousness; hormones and their role in aggression and reproduction.
2. To introduce the scientific basis of paradigms in behavioural biology, specifically to understand the physiological and ecological basis of behaviour
3. The aim of course is to integrate behavioural ecology and biological psychology, with emphasis on evolutionary explanations, including selection processes, evolutionarily stable strategies, and extra-genetic inheritance.
4. Discuss about innate behaviors, which have a strong genetic component and are largely independent of environmental influences, from the learned behaviors, which result from environmental conditioning.
5. The course covers regulations, learning and cognitive processes of acquiring behaviour and also social behaviour and organization of circadian system.

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.

Prerequisites	Basic knowledge on Ecology, evolution Biology or Zoology

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Level
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, Evolution of adaptive strategies.	12	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
II	Evolution and Social Behaviour : Sexual selection, Altruism, Sexual strategy and social organisation, Animal	10	CO 1 CO 2	K1, K2, K3, K4, K5, K6

	perception, Neural control of behaviour, Sensory processes and perception, Visual adaptations to unfavourable environments.		CO 3 CO 4 CO 5	
III	Animal and the Environment: Coordinationand Orientation, Homeostasis and Behaviour, Physiology and Behaviour in changing environments, Animal Learning, Conditioning and Learning, Biological aspects of learning, Cognitive aspects of learning.	13	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
IV	Understanding Complex Behaviour :Instinct and learning, Displacement activities, Ritualization and Communication, Decision making behaviour in Animals, Complex behaviour of hobey 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.	12	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
V	Chronobiology : Organization of circadian system in multicellularanimals; 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.	13	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6

Text Books

1. David McFarland, 1985.Animal Behaviour, Longman Scientific & Technical, UK.576pp.
2. HarjindraSingh,1990.ATextBookofAnimalBehaviour,AnomolPublication,293pp.
3. HoshangS.GundeviaandHareGovingSingh,1996.AnimalBehaviour,S.Chand&Co, 280pp.
4. Shukla, J. P 2010, Fundamentals of Animal Behaviour, Atlantic, 587pp.
5. Vinod Kumar, 2002. BiologicalRhythms. NarosaPublishingHouse, 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, USA.

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/

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	Recall and record genetic basis and evolutionary history of behaviour.	K1, K2
CO 2	Classify movement and migration behaviors and explain environmental influence upon behaviour.	K3
CO 3	Analyze and identify innate, learned and cognitive behavior and differentiate between various mating systems.	K4
CO 4	Assess complexity involved in behavioural traits and evaluate hormones and their role in aggression and reproduction.	K5
CO 5	Discuss the rhythmicity of behavioural expressions and the scientific concepts in behavior and behavioral ecology.	K6

Course Code	UAZ 5601
Course Title	Medical Laboratory Techniques
Credits	04
Hours/Week	04
Category	Major Elective (ME) - Theory
Semester	V
Regulation	2019

Course Overview

1. Learn techniques for analysing clinical samples and also study the nature and composition of clinical samples.
2. Analyse the prognosis and diagnosis through clinical sample analysis. Monitoring the development and spread of infection by pathogens.
3. Carry out Advanced laboratory tests using standard laboratory methods.
4. Conduct community-based research in collaboration with other categories of health professionals.
5. To know more about laboratory investigation to increase the quality and efficiency of the healthcare industry. Discuss about effective control measures against prevalent diseases.

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.

Prerequisites	Basic knowledge on Biology or Zoology

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Level
I	Laboratory Safety and Human Health and Hygiene : Laboratory safety –toxic chemicals and biohazards waste-biosafety level- good laboratory practice – hygiene and health issue – physiology effect of alcohol, tobacco, smoking & junk food & its treatment - biomedical waste management.	13	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
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 WBC-blood grouping and typing- haemostasis- bleeding disorder of man - Haemolytic disease of newborn, Platelet count, reticulocytes count, Absolute Eosinophil count.	13	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6

III	Medical Microbiology and Instrumentation Techniques : Definition and scope of microbiology- structure and function of cells - parasites - Entamoeba- Plasmodium- Leishmania and Trypanosome- Computer tomography (CT scan) – Magnetic Resonance imaging – flowcytometry – treadmill test – PET.	13	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
IV	Medical Physiology : Cardiovascular system- Blood pressure - Pulse – regulation of heart rate, cardiac shock. Heart sounds, Electrocardiogram (ECG) – significance – ultra sonography- Electroencephalography (EEG).	12	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
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.	13	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6

Text Books

1. Godker, P. B. and Darshan, P, Godker, 2011. Text book of medical Laboratory
2. Technology, Mumbai.
3. Guyton and Hall, 2000. Text Book of medical Physiology, 10th edition, Elseiner, New Delhi.
4. Mukerjee, K.L, 1999. Medical Laboratory Technology- Vol,I,II,III. Tata MC GrawHill, New Delhi.
5. 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

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	Understand protocols and procedures to collect clinical samples for blood analysis and to study human physiology.	K1, K2
CO 2	Explain the characteristics of clinical samples.	K3
CO 3	Demonstrate skill in handling clinical equipment.	K4
CO 4	Evaluate the hematological and histological parameters of biological samples.	K5
CO 5	Elaborate the role of medical laboratory techniques in health care industry.	K6

Course Code	UAZ 5602
Course Title	Medical Laboratory Techniques Lab
Credits	02
Hours/Week	02
Category	Major Elective (ME) - Lab
Semester	V
Regulation	2019

Course Overview

1. This course is an introduction to procedures used in medical laboratory.
2. Learn the application of basic techniques and instruments used in all area of medical laboratories.
3. Learn techniques for analysing clinical samples and also study the nature and composition of clinical samples.
4. Conduct community-based research in collaboration with other categories of health professionals.
5. Mastering the laboratory quality control measures for specimen collection in health care facilities.
6. Discuss about the effective control measures against prevalent diseases.

Course Objectives

1. To understand and identify the different types of protocols and procedures to collect clinical samples.
2. To explain the characteristics of clinical samples and application of basic techniques and instruments used in medical laboratories.
3. To demonstrate skill in handling clinical equipment. Use of laboratory wares, instruments and sterilization techniques.
4. To evaluate the safety precautions while handling clinical samples.
5. Understand the role of the laboratory and its contribution to the nation's health service.
6. To summarise specimen processing, analysis of test result and quality control data.

Prerequisites	Basic knowledge on Biology or Zoology

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Level
I	Basics of Laboratory Techniques : Microscope handling, collection of blood, Blood Pressure, Pulse rate, hemocytometer, cell counter.	6	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
II	Haematology : Clotting time, Bleeding time, Haemoglobin estimation, Erythrocyte Sedimentation Rate, packed cell volume, platelet count.	7	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6

III	Haemogram : Differential count, Total Red Blood cell count, Total White blood cell count, Eosinophilic count, Reticulocyte count and blood group.	8	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
IV	Qualitative Estimation: Qualitative Test - Protein, Carbohydrate and Lipid.	6	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
V	Field Visit : Field visit to different hospitals- report submission- clinical laboratory visit & Demonstration.	5	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6

Text Books

1. Godkar, P.B. and D.B. Godkar, 2006. Medical Laboratory Technology, Bhalani, NewDelhi.
2. Mukerjee, K.L. and S. Ghosh, 2010. Medical Laboratory Technology, Volume II, McGraw Hill, New Delhi.17.
3. M N Chatterjea & Rana Shinde,(2012),Text book of Medical Biochemistry,8th edition, Jayppe Publications .
4. Singh & Sahni,(2008),Introductory Practical Biochemistry,2nd edition, Alpha science
5. Lehninger,(2013),Principles of Biochemistry,6th edition, W H Freeman

Suggested Readings

1. Cheesbrough, M, 2006, Medical Laboratory Manual for Tropical Countries Vol. I and II, Cambridge University Press; UK
2. Ochei, J. and A. Kolhatkar, 2000. Medical Laboratory Science, Theory and Practice, McGraw Hill, New Delhi.
3. Sood, R., 2006. Medical Laboratory methods and Interpretation, Jaypee, New Delhi.
4. D M Vasudevan, (2011),Text book of Medical Biochemistry,6th edition Jaypee Publishers

Web Resources

1. https://bit.ly/39CY4Id
2. https://bit.ly/39nEzmH
3. https://bit.ly/2XKu7mT
4. https://www.radiologyinfo.org/

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	Understand and recall master procedures related to handling clinical samples.	K1, K2
CO 2	Apply standard protocols for handling clinical samples.	K3
CO 3	Prescribe appropriate analytical tools to diagnose a disease.	K4
CO 4	Interpret clinical parameters after estimation.	K5
CO 5	Summarize the importance of prognosis and diagnosis.	K6

Course Code	UAZ 5603
Course Title	Bioinstrumentation Science
Credits	04
Hours/Week	04
Category	Major Elective (ME) - Theory
Semester	V
Regulation	2019

Course Overview

1. The course covers all biological techniques that are applicable in the biological sciences.
2. Good laboratory practices and handling of basic laboratory equipment are introduced to the students through the course.
3. The course emphasizes the working principle and design of the instrumentation and techniques.
4. Techniques involved in cellular separation, isolation and study of biological macromolecules are covered in this course.
5. The specific applications of each and every technique and instrumentation is elaborated.

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.

Prerequisites	Basic knowledge on Biology or Zoology

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Level
I	Good Laboratory Practices : Guide lines, Laboratory symbols; Cleaning and sterilization of labware and reagents; 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; Buffers: definition and preparation of buffers, pH meter; Safety and ethical issues in laboratory settings	12	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
II	Microscopy - Light microscope, SEM, TEM, Atomic force microscope; Cryopreservation - principle and procedure; Fluorescence activated cell sorting; X-ray crystallography.	12	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6

III	Centrifugation - working principle and types of centrifugation; Spectrophotometry; Mass spectrometry; Chromatography - principle and types of chromatography	12	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
IV	Biomedical Instrumentation : ESR measurement, haemoglobin measurement, blood pressure, blood flow, ECG, cardiac pacemakers; X- ray imaging, CT scan and NMR imaging; Ultrasound imaging; medical applications of laser; Biosensors - glucose biosensor, alcohol biosensor, artificial retina, environmental biosensors, cantilever-based biosensors, DNA biosensor.	16	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
V	Molecular Techniques : Isolation of DNA, RNA and proteins; Electrophoresis of DNA and proteins; Polymerase chain reaction; ELISA; Immunofluorescence; Fluorescent in situ hybridization; Southern and Western blotting.	16	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6

Text Books

1. Sabari Ghosal 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 Univeristy 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

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	To describe and explain the steps in the use of various biological instrumentation that are used in the study of different animal specimens.	K1, K2
CO 2	To relate the applications of biological techniques and employ them for the study of cells, tissues and genetic material.	K3
CO 3	To correlate and appraise the use of specific bioinstrumentation for specific biological experiments and infer the results of such experiments.	K4
CO 4	To compare the working principle of different bioinstrumentation and to summarize their applications.	K5
CO 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.	K6

Course Code	UAZ 5604
Course Title	Bioinstrumentation Science Lab Course
Credits	02
Hours/Week	02
Category	Major Elective (ME) - Lab
Semester	V
Regulation	2019

Course Overview

1. The course exposes the students to hands-on training in biological laboratory instrumentation and techniques.
2. The course will uncover the applications of different techniques and the need for selection of the appropriate technique for particular research goals.
3. The main emphasis of the course is on good laboratory practices and ethical and environmental consciousness in the laboratory setting.
4. Accurate experimental calculations for every technique and measurements that are needed to prepare laboratory reagents are uncovered in the course.
5. The course will instill confidence in students to work in sophisticated lab facilities.

Course Objectives

1. To help students to imbibe the methods for proper handling of laboratory equipment and maintain instrument accuracy.
2. To employ the best eco-friendly and ethical laboratory practices with regard to handling of animals and tissue specimens.
3. To motivate and inculcate best practices to analyze and infer experimental results by correlating them with the working principles of the technique.
4. To carry out quantitative and qualitative analysis using different kinds of laboratory instrumentation and to encourage trouble shooting of protocols.
5. To encourage compilation of laboratory observations and report the principle, procedure and results of experiments accurately and effectively.

Prerequisites	Basic knowledge on Biology or Zoology

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Level
I	Preparation of solutions of varying percentage, molarity and pH. Working in a laminar flow hood for preparation of bacterial cultures on an agar slant/plate.	12	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
II	Isolation of mitochondria from liver sample by differential centrifugation. Estimation of glucose concentration by colorimetry.	12	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6

III	Separation of amino acids by paper chromatography. Separation of plant pigments by column chromatography.	12	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
IV	Measurement of blood pressure. Study of ECG patterns. Measurement of glucose levels using commercially available glucose strip biosensors.	12	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
V	Isolation of casein protein from milk. ELISA	12	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6

Text Books

1. Surya Nandan Meena, Milind Naik, 2019. Advances in Biological Science Research: A Practical Approach, Academic Press, New York, USA.
2. Saxena J., Baunthiyal M., Ravi I., 2015. Laboratory Manual of Microbiology, Biochemistry and Molecular Biology, Scientific Publishers, India.
3. Chaitanya K.V., 2013. Cell and molecular biology: A Lab Manual, Phi Learning Pvt. Ltd., New Delhi, India.
4. Sengar R.S., 2013. Laboratory Manual of Biochemistry: Methods and Techniques, New India Publishing Agency, India.
5. Prakash Singh Bisen, Anjana Sharma, 2012. Introduction to Instrumentation in Life Sciences, CRC Press, Taylor & Francis Group, New York, USA.

Suggested Readings

1. Benjamin F. Lasseter, 2019. Biochemistry in the Lab: A Manual for Undergraduates, CRC Press, Taylor & Francis Group, New York, USA.
2. Sue Carson, Heather Miller, Melissa Srougi, Scott Witherow, 2019. Molecular Biology Techniques: A Classroom Laboratory Manual, Academic Press, New York, USA.
3. Reilly M.J., 2016. Bioinstrumentation, CBS Publishers & Distributors, Chennai, India
4. Sylvia S. Mader, 2015. Lab Manual for Biology, McGraw-Hill Education, USA.
5. Timea Gerczei, Robert Pattison, 2015. Biochemistry Laboratory Manual For Undergraduates: An Inquiry-Based Approach, De Gruyter Open Ltd., Germany.

Web Resources

1. https://www.jove.com/
2. https://www.ibiology.org/biology-techniques/
3. https://www.biointeractive.org/classroom-resources/cardiology-virtual-lab
4. https://www.youtube.com/watch?v=Nqj41O8FH5c

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	To describe the methods for proper handling and care of laboratory equipment and observe and identify the instrumentation accurately.	K1, K2
CO 2	To employ the use of specific techniques to specific biological applications and to choose the best eco-friendly and ethical laboratory practices with regard to handling of animals and tissue specimens.	K3
CO 3	To analyze and infer experimental results of various techniques and to correlate them to the working principles of the technique.	K4
CO 4	To measure quantitatively and qualitatively using different kinds of laboratory instrumentation and to find errors in the working of the instrument when the need arises.	K5
CO 5	To compile laboratory observations and report the principle, procedure and results of experiments accurately and effectively.	K6

Course Code	UAZ 6501
Course Title	Environmental Biotechnology and Toxicology
Credits	04
Hours/Week	05
Category	Major Core (MC) - Theory
Semester	VI
Regulation	2019

Course Overview

1. The course is an introduction to various applications of biotechnology in environmental monitoring and management.
2. This course is designed to provide an overview of environmental toxicology, including an examination of the major classes of pollutants, their fate in the environment,
3. Addresses the role of natural and man-made toxins, their distribution, transport, and fatal effects on organisms.
4. Discuss the types of toxins and to calculate the risk of contaminants and management strategies.
5. This course includes special lectures on current research in the application of biotechnology in environmental management.

Course Objectives

1. To understand the various biotechnological principles used in management strategies.
2. To explain the bioremediation processes, biogas production and waste management.
3. To know about the interaction between environmental toxicants and organisms.
4. To observe and analyse the results obtained in fieldwork and laboratories to assess the impact of toxins on individual organisms.
5. To critically evaluate the occurrence and significance of major environmental toxicants and to apply the knowledge in the context of environmental quality, public health, and sustainability.

Prerequisites	Basic knowledge on Biotechnology or Biology

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Level
I	Environmental Biotechnology Overview : Important areas of Environmental Biotechnology- Waste water treatment – Biomass as source of energy – waste as renewable and non-renewable source of energy, sources of wastes (Industrial, agricultural, forestry, municipal source), Drinking water treatment Biotechnology of the marine environment.	13	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
II	Bio-Energy and Medical Biotechnology: Biogas production, process of bioleaching, Bioreactors-types and applications of bioreactor. Biogas technology in India, Bioremediation, Anaerobic digestion, Solubilization, hydrolysis, Acidogenesis, Methanogenesis, Methanogens. Conversion of Biomass Waste technology.	14	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6

	phytoremediation, GMO, Gene therapy-invitro and in vivo, Nanomedicine and Biochip.			
III	Toxicology: History, Scope & sub-divisions of toxicology; Dose-effect and dose-response relationship, acute toxicity, chronic toxicity; Classification of toxic agents, natural toxins, animal toxins, plant toxins, food toxins and chemical toxins.	12	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
IV	Factors Affecting Toxicity: Species and strain, age, sex, nutritional status, environmental factors, circadian rhythms, absorption, distribution and elimination of toxicants- portals of entry –skin; Heavy metal contamination.	14	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
V	Ecotoxicology: Examples of ecotoxicology, Entry, movement, and fate of pollutants in ecosystems. Air pollution – Classification and properties of air pollutants, control device for air pollutants acid rain, photochemical smog, health effects of air pollution; water pollution-origin of water, toxic water pollutants and their health effects	12	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6

Text Books

1. Allan Scragg, 2020. Environmental Biotechnology, Oxford University Press.
2. Bhatia, S . C . 2011. Hand B o o k o f Environmental Biotechnology, Atlantic Publishers Ltd. New Delhi.
3. Bharti P.K. and Chauhan A. (Editors). 2013. Environmental Biotechnology and Application, Discovery publishing house PVT.Ltd., New Delhi, pp. 245.
4. Eugemia et al. 2008. Environmental Biotechnology and cleaner Bio Process, Tylor and Francis London, UK.
5. Gupta, PK. 2015. Elements of Biotechnology, Rastogi Publications, New Delhi, pp. 424.
6. Rose, J. 2003. Environmental Toxicology, CRC Press, 414 pp.
7. Dong, H.M. 2018. An Introduction to Environmental Toxicology, Create space Independent Pub., 4rd edition, pp.528.

Suggested Readings

1. Ahmed, N. F.M. Qureshi and Q.Y. Khan. 2001. Industrial Environmental Biotechnology, Horizon Press.
2. Ramesh, K.V. 2005. Environmental Microbiology, MJP Publishers, Chennai.
3. Francis, B.M. 1994. Toxic Substances in the Environment, John Wiley and Sons.
4. Hodgson E. (Editor). 2010. A Textbook of Modern Toxicology, A John Wiley & Songs, Inc., Pub. Canada, pp.674.
5. Yu M.H., Tsunoda H., Tsunoda M. 2011. Environmental Toxicology- Biological and Health Effects of Pollutants, 3rd Edition, CRC Press,pp. 387.

Web Resources

1. https://bit.ly/2XJPmFK
2. https://bit.ly/39uHQ3D
3. https://epdf.pub/principles-of-environmental-toxicology.html
4. https://www.britannica.com/science/air-pollution
5. https://bit.ly/3zyM9FL

6. https://bit.ly/3hZtooN
7. https://bit.ly/3lJvr1u

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	Understand and recall the principles of different biotechnological tools and techniques in production of beneficial products and in environmental management.	K1, K2
CO 2	Distinguish different biological processes used by microorganisms which helps in waste management and production of biofuels.	K3
CO 3	Analyze the methods used to assess toxins in environment and explain the different methods used in the management	K4
CO 4	Elaborate on natural and man-made toxins/toxicants, their distribution, transport, and fatal effects on organisms including man.	K5
CO 5	List out the various factors affecting toxicity with reference to species and strain, age, sex, nutritional status, environmental factors and circadian rhythm and summarize the applications of biotechnological tools in various management strategies.	K6

Course Code	UAZ 6502
Course Title	Environmental Biotechnology and Toxicology Lab
Credits	04
Hours/Week	03
Category	Major Core MC (P)- Practical
Semester	VI
Regulation	2019

Course Overview

1. The aim of the course is to give basic understanding of the environmental toxicological problems that are currently being addressed including water pollution caused by industrial effluents and use of pesticides entering the food chain and causing groundwater contamination.
2. In this course, we will explain the role of research collaboration to address local needs and situations and assessment of risk and safety.
3. We will also explain about the research activities in the area of environmental toxicology and biotechnology, for the protection of the environment and human health.
4. The student will be able to handle the equipment available and identify the suitable and appropriate experiments for their research.
5. The main outcome of the course is to provide basic understanding of biological systems for remediation of contaminated environments (land, air, water), and for environment-friendly processes.

Course Objectives

1. To explain the main mechanisms of environmental toxicants in causing a toxic response in living organisms.
2. To describe the optimal use of nature, in the form of plants, animals, bacteria, fungi and algae, to produce renewable energy, food and nutrients in a synergistic integrated cycle of profit-making processes
3. To provide practical knowledge and hands on tools and techniques for dose-response assessment of hazardous substances.
4. The use of biological systems for remediation of contaminated environments (land, air, water), and for environment-friendly processes.
5. To develop data that can ensure appropriate protection of public health from the adverse effects of exposures to environmental agents.

Prerequisites	Basic knowledge on Biology

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Level
I	Environmental Biotechnology Techniques: Isolation of DNA from animal tissue, Estimation of DNA by spectrophotometer, Estimation of proteins using Biuret / Bradford assay, Bacterial Transformation, Isolation of pure cultures from specific sources (soil, water). ELISA.		CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6

II	Estimation Methods: Estimation of Ammonia, Nitrites, Iron, soil alkalinity, Determination of hardness of water. Estimation of chlorine water.		CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
III	Environmental Determinants: Estimation of BOD/ Estimation of COD.		CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
IV	Toxicity Testing: Methodology of toxicity testing – acute and chronic tests (demonstration), Use of LC50 values – sub lethal effects of critical pollutants on fish.		CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
V	Mini Project and Spotters: Bio gas production - Food toxicity tests - Field visit Reflux condenser, BOD incubator, Spectrophotometer, Colorimeter, Atomic absorption spectroscopy, Ultracentrifuge, Incubator, HPLC, Electrophoresis, Western blot, PCR.		CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6

Text Books

1. Abhijit Dutta, 2009. Experimental biology: A Laboratory Science, Narosa, New Delhi.
2. DAS H.K.,2005. Text Book of Biotechnology. Wiley Dreamtech Pvt Ltd, New Delhi.
3. Rastogi, S.C., 2005. Experimental physiology, New age International publishers, New Delhi.
4. Ramesh, R and M, Anbu 1996. Chemical methods for environmental Analysis of water and sediment. Macmillan India Limited, Chennai.
5. Micheal, P, 1984. Ecological Methods for field visit and laboratory investigation. Tata McGraw Hill, New Delhi.

Suggested Readings

1. Allan S. Cragg, 2010. Environmental Biotechnology, Oxford University Press. UK.
2. Maier, R. M., Pepper I.L. and C. P. Gerba, 2009. Environmental Microbiology. 2 nd ed. AcademicPress. USA
6. Eugenia et al, 2008. Environmental Biotechnology and cleaner Bio Process, Taylor& Francis London, UK.
3. APHA, 2005. Standard Methods for the examination of water and waste water, 21st Ed., American Public Health association, Washington D.C.
4. Rastogi, S.C., 2005. Experimental physiology, New age International Pvt. Ltd. New Delhi.
5. Hauser, B.A., 2001. Drinking Water Chemistry: A Laboratory Manual, Lewis Publishers,Boca Raton, Florida
6. Rump, H.H., 1999. Laboratory Manual for the Examination of Water, Wastewater and Soil,3rd Ed., Wiley-VCH, New York.
7. Csuros, M., 1994. Environmental Sampling and Analysis for Technicians, M. Lewis Publishers,Boca Raton.Florida.
8. Francis, B.M., 1994. Toxic Substances in the Environment, John Wiley and Sons.
9. APHA, 1992. Standard Methods for the examination of water and waste water, American

Public Health association,Washington D.C.
10. Boyd C.E., 1992. Water Quality and Pond Soil Analysis for Aquaculture, C.E. Boyd, C.S. Tucker,Auburn University.

Web Resources

1. http://www.envexp.com/technical/method-downloads/cod-method-410
2. https://bit.ly/3u6o0Fb
3. https://bit.ly/3hX8Ux0
4. https://bit.ly/3EN2nz0
5. https://www.ncbi.nlm.nih.gov/pubmed/2170158

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	Understand the properties of toxicants, effects, origin and occurrence in the environment. Explain the principle and procedure for quality evaluation, monitoring and remediation of contaminated environments.	K1, K2
CO 2	Estimate the toxic chemicals in the environment. Apply tools and techniques for experimenting with environmental problems. Identify and implement solutions to the problems.	K3
CO 3	Analyse the consistent and inconsistent range of elements. Interpret the role of the elements in environmental pollution and the effects on organisms.	K4
CO 4	Relate the metabolic activity, diseases, ill health and death with reference to exposure to chemicals. Select the suitable experimental design to assess the toxic effects of pesticides and pollutants.	K5
CO 5	Discuss the applicability of chemical analysis and toxicity data, both individually and together, in risk assessment and environmental monitoring.	K6

Course Code	UAZ 6503
Course Title	Wildlife Biology
Credits	05
Hours/Week	05
Category	Major Core (MC) - Theory
Semester	VI
Regulation	2019

Course Overview

1. The aim of the course is to provide knowledge on modern concepts in wildlife management, relevant conservation policies and their enforcement mechanism at local and global level.
2. The important aspects discussed in the course includes: Advanced scientific basis for wildlife management and successful implementation of National and International policies for sustainable developments.
3. Will analyse the influences that human activities impose on wildlife, values provided and their natural habitats.
4. Students become capable of supporting the cause of wildlife conservation. They may develop the passion to become a Wildlife Biologist, Zoo curator, Wildlife Educator, Forensic Expert, and Public Health Consultant etc.
5. To generate skilled post graduates who can undertake research in the field of Biodiversity, Wildlife biology and Nature conservation.

Course Objectives

1. To understand and discuss the importance of wildlife, its values, modern concepts in wildlife management, and relevant conservation policies.
2. To assess and instil 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.

Prerequisites	Basic knowledge on Botany or Zoology

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Level
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.	10	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6

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.	12	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
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, National and State Biodiversity Action Plans and other Forests and Environmental Acts.	10	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
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, Nodes and corridors. Community Reserve and conservation Reserves.	10	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
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.	10	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6

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 Sinclaire, 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 exsistence? 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 Subhendu Mazumdar, 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/3lHdEYJ
3. https://bit.ly/3CwBCfY
4. https://bit.ly/3EDYr3a
5. https://bit.ly/3tVtG4U

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	To understand and recall the importance of wildlife, extinction and Conservation Approaches of wildlife.	K1, K2
CO 2	To integrate and assess the National, international approaches for biodiversity conservation.	K3
CO 3	To analyse and differentiate threats to wildlife, various action plans, conservation strategies on wildlife of India to turn conflict into tolerance and coexistence.	K4
CO 4	To explain the role PVA models, Wildlife conservation approaches, and limitations.	K5
CO 5	To construct and simulate National and International strategies for Conservation, Wild life laws and ethics.	K6

Course Code	UAZ 6504
Course Title	Reproductive Biology and Endocrinology
Credits	05
Hours/Week	05
Category	Major core (MC) – Theory
Semester	VI
Regulation	2019

Course Overview

1. Reproductive Biology and endocrinology focus on the biological process of reproduction and fundamental principles of endocrinology.
2. This course covers the topics including structural anatomy of male and female reproductive systems, puberty, menopause, fertilization, implantation, parturition, lactation, hormonal interaction and the endocrine systems with physiological functions.
3. This course explores reproductive disorders and abnormalities, regulation and interaction of endocrine system in growth, metabolism, and reproduction.
4. The experimental understanding of endocrine function is also highlighted.
5. In addition, this course also enhances the knowledge on the normal and abnormal secretion of hormones and their interaction with general physiological process.

Course Objectives

1. To understand the reproductive structures and endocrine structures and their development.
2. To understand the physiology of the reproductive system and endocrine system
3. To understand the interaction of hormones.
4. To understand the normal and abnormal secretions of hormones and their impacts.

Prerequisites	Basic knowledge in Biology or Zoology

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Level
I	Introduction to Reproduction: General introduction to reproduction – Sexual Differentiation and Development of gonads, genital ducts, external genitalia. Mechanism of sex differentiation. Developmental abnormalities of male and female sex organs – genetic and endocrine aspects. Reproductive Systems – Female Reproductive System – Male Reproductive System – Structure of mammalian testis and ovary (Spermatogenesis, folliculogenesis) Puberty - Menstrual Cycle.	15	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
II	Reproductive Endocrinology: Gonadal hormones and mechanism of hormone action - hypothalamo – hypophyseal – gonadal axis, regulation of gonadotrophin secretion in male and female. Reproductive cycles and its regulation – changes in the female reproductive tract – Sperm and Ova transport – Sperm capacitation and	15	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6

	Acrosome reaction; fertilization – Hormonal control of implantation – Hormonal regulation of gestation, Placenta – placental hormones. Mechanism of parturition and its hormonal regulation – Lactation and its regulation.			
III	General Endocrinology : Introduction, objectives and scope of endocrinology. Endocrine glands of the body – The hormones – Classification of hormone – Functional organization of endocrine glands – basic concepts of secretion – Mechanism of hormone action – Hormonal regulation – Experimental methods of hormone research.	15	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
IV	Pituitary and Thyroid glands: Pituitary gland – characteristics – embryological origin – histological structure – hormone secretion – functions – Hypothalamic control. Thyroid gland: structural organizations – metabolic effects of thyroid – effects on reproduction – parathyroid structure – secretions and functions.	15	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
V	Pancreas And Adrenal glands: Structure of pancreas – pancreatic hormones and their functions. Structural organizations of adrenals – functions of cortical and medullary hormones – Disorders of adrenocortical functions.	15	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6

Text Books

1. Prakash S. Lohar, 2005. Endocrinology hormones and human health, MJP publishers, Chennai. 305pp
2. Ambika Shanmugam, 2001. Fundamentals of Biochemistry for Medical students, Karthik Offset Printers, Chennai. 590pp.
3. Mac E. Hadley, 2009. Endocrinology, 6th Ed., Pentice hall of India Pvt. Ltd. New Jersey. USA. 500pp.
4. Verma P.S., Tyagi, B.S. and V. K. Agarwal, 2008. Animal Physiology, S. Chand & Company Pvt. Ltd. Ram Nagar, New Delhi. 417pp.
5. Yadav. B.N., 2011. Mammalian Endocrinology, Vishal publishing company, Jalandhar. 132pp.

Suggested Readings

1. Austin, C.R., and Short, R.V. 1984. Reproduction in Mammals (vol. 1-5). Cambridge University Press. Cambridge.
2. Barrington, E.J.W., 1985. An introduction to general and comparative endocrinology. Clared on Press Oxford, 402pp.
3. Bentley, P.J.,1985. Comparative vertebrate endocrinology, 2nd Ed., Cambridge University Press. Cambridge, 526pp
4. Berg, J. M., Tymoczko, J. L. and Stryer, L. 2006. Biochemistry. VI Edition. W.H.Freeman and Co. USA. 862 pp.
5. Elizabeth H. Holt and Harry E. Peery, 2010. Basic medical endocrinology, Academic press. USA. 344pp.
6. Jones R.E. 1997. Human Reproductive Biology, Academic Press. USA., 400pp.

7. Knobil, E. and Neill, 2014. The Physiology of Reproduction. Elsevier. Cambridge. 2684pp
8. Guyton, A.C. and Hall, J.E., 2011. Textbook of Medical Physiology, XII Edition, Harcourt Asia Pvt. Ltd/ W.B. Saunders Company, Philadelphia. 1064pp
9. Mac Hadley, 1992. Endocrinology, 3rd Ed., Prentice-Hall Inc. A Simon & Schuster Company, Engle wood Cliffs, New Jersey. USA, 576pp.
10. Nelson, D. L., Cox, M. M. and Lehninger, A.L. 2009. Principles of Biochemistry. 4th Ed. W.H. Freeman and Co. USA. 1120pp
11. Ramon Pinon J.R. 2002. Biology of Human Reproduction, University Science Books. University of California, San Diego. 432pp
12. Simon Le Vay and Sharon M. Valente, 2003. Human Sexuality, Sinauer Associates, Inc. USA. 615pp.
13. Turner, C.D. and J.T. Bangara. 1986. General endocrinology. W.B. Saunders and Company. International Student edition. Toppan Company Limited. Tokyo, 579pp
14. Tortora, G.J. and Derrickson, B.H. 2009. Principles of Anatomy and Physiology, XII Edition, John Wiley & Sons, Inc. 1336pp.
15. Williams R.H., 1974. Textbook of Endocrinology 5th Ed., Saunders Press, London. 1920pp

Web Resources:

1. https://bit.ly/3ArIpHf
2. https://www.livescience.com/26496-endocrine-system.html
3. https://kidshealth.org/en/teens/endocrine.html.
4. https://onlinelibrary.wiley.com/page/journal/14470578/homepage
5. https://rbej.biomedcentral.com

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	Understand and recall the structural organization of reproductive organs and endocrine glands.	K1, K2
CO 2	Explain the physiology, hormonal regulation and its interaction with other organs to carry out normal functions.	K3
CO 3	Analyse the normal and abnormal levels of hormones that interacts in reproduction and other physiological processes.	K4
CO 4	Assess the importance and coordination of glands and its secretions for normal function and dysfunction	K5
CO 5	Compile and prepare the flowchart for the endocrine interaction towards physiology and related disorders	K6

Course Code	UAZ 6701, 6706
Course Title	Economic Zoology (Theory and Lab)
Credits	10
Hours/Week	12
Category	Major Special (MS) (Theory and Lab)
Semester	VI
Regulation	2019

Course Overview

1. Economic Zoology includes apiculture, sericulture, lac culture, vermiculture, aquaculture poultry and dairy farming.
2. The aim of the course is to study the tools and techniques for self-employability.
3. The course also focuses on the steps involved in production and marketing of the products.
4. We will also discuss the pros and cons of the production methods and marketing strategies which will help the entrepreneurs to be successful globally.

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.

Prerequisites	Basic knowledge in Biology or Zoology

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Level
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.	12	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
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 –Vemiculture unit. Harvesting of vermicompost – vermicast –	10	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6

	advantages of vermicompost – vermiwash and its applications.			
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.	10	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
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.	10	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
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.	10	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6

Text Books

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

12. Ismail, S.A., 1997. Vermitechnology, The biology of earthworms, Orient Longman, India.
13. Prabakaran, R. 1998. Commercial Chicken production. Published by P. Saranya, Chennai.
14. 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 Inter Science, New York.

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) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	To identify the breeds and varieties of poultry, fish, bees, and cattle and understand the basic aspects of farming.	K1, K2
CO 2	To assess and integrate the available tools and techniques to increase the productivity in farms.	K3
CO 3	To analyse the pros and cons of different methods of farming and marketing strategies of products.	K4
CO 4	To evaluate the use of available resources in improving the breeds, vermicomposting, farm products etc..	K5
CO 5	To design new methods to improve farm animals with increased productivity and disease resistance and to construct new methods in vermicomposting.	K6

Course Code	UAZ 1301
Course Title	Animal Diversity
Credits	02
Hours/Week	04
Category	Allied Required (AR) - Theory
Semester	I
Regulation	2019

Course Overview

1. This course will provide an overview of animal diversity, the basic zoological knowledge including understanding the importance of taxonomy and phylogeny.
2. The course will help students develop zoology specific skills such as use of keys and recognizing features that classify animals into phyla and also taxonomic foundation on which to lay future studies of invertebrate and vertebrate zoology.
3. The course takes students through the characteristics of animal kingdom and diversity of animal life, from simple sponges through to the vertebrates.
4. It will provide students with an in-depth knowledge of the diversity in form, structure, organization and life history and habits of invertebrates.

Course Objectives

1. To understand the correct method to classify organisms and write species names.
2. To describe the different geological eras post-life and compare fossil invertebrates with extant animals.
3. To develop a basic understanding of the anatomy and function of molluscs, sea stars and vertebrates.
4. To observe the organization, functional morphology and diversity of representative invertebrates and chordates.

Prerequisites	Basic knowledge on Zoology and Environmental Biology

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Level
I	Protozoan Parasites : Overview of animal diversity- the Characteristics of animal kingdom, multicellular, the history of animals, body plans, new views of animal phylogeny;Introduction to Protozoan parasites-diversity of protozoa groups, life-cycles , taxonomic overview.	13	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
II	Nematode Parasites : Structure, organization and life history of *Taeniasolium*, Nematode parasites of man-*Ascaris* and *Hirudinaria*.	14	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
III	Echinodermata and Mollusca : Structure, organization and life history of *Penaeusindicus*, *Pilaglobosa* and Star fish	12	CO 1 CO 2 CO 3	K1, K2, K3, K4, K5, K6

			CO 4 CO 5	
IV	Amphibia, Reptilia and Aves : Structural Organization of Frog, Calotes, Pigeon and Rat	14	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
V	Embryology : Types of chordate eggs, extra embryonic membranes and their functions in chick, placentation in mammals.	12	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6

Text Books

1. EkambaranathaAyyar and AnathakrishnanT.N. 2009. A Manual of Zoology Vol. I & II (Part1,3), Viswanathan S., Chennai.
2. Barnes, R.D. 2001. Invertebrate Zoology, W.B. Saunders.
3. Verma, P.S., Agarwal, V.K. and Tyagi B.S. 1995. Chordate embryology, S. Chand, New Delhi.
4. Berril, N.J. 1971. Developmental Biology, McGraw Hill, New York.
5. Gilbert S.F. 2013. Developmental Biology. Sinauer Associates Inc, 10th edition, pp. 719.
6. Hickman C. and Roberts L. 2011. Animal Diversity, McGraw-Hill Education, 6th edition, pp 496.

Suggested Readings

1. Barrington: Invertebrate Structure and Function, Nelson, 1987.
2. Marshall & William, Text book of Zoology, Vol I (Parker &Haswell, 7thed.) Macmillian, 1972.

Web Resources

1. https://parasite.org.au/para-site/contents/protozoa-intoduction.html
2. https://bit.ly/3hTCoMo
3. https://bit.ly/3Avxuwk
4. https://bit.ly/3EDMGKf
5. https://www.cdc.gov/parasites/taeniasis/biology.html

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	Describe the characteristics of animal diversity and identify the key features that classify animals into phyla.	K1, K2
CO 2	Observe and identify the structure, organization and life history of parasites of man.	K3
CO 3	Explain and distinguish the structure, organization and diversity in development in the animal kingdom.	K4
CO 4	Compare and Illustrate the types of life cycle in organisms.	K5
CO 5	Construction of phylogenetic tree and elaborate taxonomic overview of organisms.	K6

Course Code	UAZ 1302
Course Title	Animal Diversity Lab course
Credits	01
Hours/Week	02
Category	Allied Required (AR) – Lab
Semester	I
Regulation	2019

Course Overview

1. Animal diversity is a Major core subject integrating the invertebrate and chordate animals.
2. The aim of the course is to give basic knowledge about the animal structure and functions through dissecting and mounting.
3. In this course, we will also examine the methods of dissecting and mounting the animals.
4. The other important aspect of animal diversity is to study the various types of organs, its structure and functions.

Course Objectives

1. Explain the basic concepts of animal sciences and observe the internal system of animals.
2. Illustrate and examine the systemic and functional morphology of both invertebrates and vertebrates.
3. Differentiate and classify the various groups of animals and estimate animal biodiversity.
4. To compare and distinguish the general and specific characteristics within each Phyla.
5. Infer the affinities, evolutionary relationships and adaptation of the major taxa and to express their economic importance.

Prerequisites	Basic knowledge in Zoology

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Level
I	Major Dissection : Cockroach - Digestive system, Nervous system. *Pila globosa* - Digestive system. Prawn - Nervous system. Frog - Arterial system and venous system (Demo)	10	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
II	Minor Dissection : Earthworm: Lateral hearts. Cockroach: Reproductive system	6	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
III	Mounting - Cockroach: Mouth parts and salivary apparatus. Earthworm: Body setae. Prawn: Appendages (Cephalic, thoracic and abdomen). Frog: Hyoid apparatus and brain.	6	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
IV	Spotters – Invertebrate : Representatives from each	2	CO 1	K1, K2, K3,

	phylum based on structural organization and phylogeny		CO 2 CO 3 CO 4 CO 5	K4, K5, K6
V	Spotters – Vertebrate : Representatives from each phylum based on structural organization and phylogeny	2	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6

Text Books

1. Lai, S.S. 2005. A Text Book of Practical Zoology: Invertebrate, Rastogi, Meerut.
2. Ekambaranatha Ayyar and T.N. Ananthakrishnan, 2008 A manual of Zoology Vol.I& II (Part 1,2) S.Viswanathan, Chennai.
3. Barnes, R.D 2001. Invertebrate Zoology, W.B.Saunders, London.
4. Jordan, E.K. and P.S. Verma, 1995. Chordate Zoology and Elements of Animal
5. Physiology, 10th edition, S. Chand & Co Ltd., Ram Nagar, New Delhi, 1151 pp.

Suggested Readings

1. 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
2. Waterman, Allyn J. et al., 1971. Chordate Structure and Function, Mac Millan & Co., New York, 587 pp.

Web Resources

1. https://bit.ly/3zu7Vu2
2. https://bit.ly/3lMGuH0
3. https://bit.ly/3Cvxflp
4. https://bit.ly/3zwnbGW
5. https://bit.ly/3EFhvOz
6. https://bit.ly/3u5k3ko

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	Explain the basic concepts of animal sciences and observe the internal system of animals.	K1, K2
CO 2	Illustrate and examine the systemic and functional morphology of both invertebrates and vertebrates.	K3
CO 3	Differentiate and classify the various groups of animals and estimate biodiversity.	K4
CO 4	To compare and distinguish the general and specific characteristics within each Phyla.	K5
CO 5	Infer the affinities, evolutionary relationships and adaptations of the major taxa and to list out their economic importance.	K6

Course Code	UAZ 3401
Course Title	Agricultural Entomology
Credits	02
Hours/Week	03
Category	Allied Optional (AO) – Theory
Semester	III
Regulation	2019

Course Overview

1. To understand the basic classification structure on insect pests and plant protection to sustain green revolution.
2. The aim of the course is to gives basic knowledge about the insect pest of agriculture
3. In this course, we will also examine the methods of collection and preservation of insect species.
4. Discuss the various types of control methods for sustainable environment.

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.

Prerequisites	Basic knowledge on Agriculture and Insects

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Level
I	Outline classification of insects - Causes for insect assuming pest status - Methods of collection, mounting and preservation of insect pests.	5	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
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.	10	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
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	12	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6

	industry, pests and diseases of silk worm. Lac Culture.			
IV	IPM, physical, mechanical, chemical and biological control methods, Pesticide application equipment	6	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
V	Introduction and steps towards IPM, Pheromones, antifeedents, repellents and biopesticide	6	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6

Text Books

1. David, B and 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. Text book 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, India.

Suggested Readings

1. Abishek Shukla, D. 2009. A Hand Book of Economic Entomology, Ved ams e 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

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	Examine and identify the systemic and functional morphology of various group of agricultural insect pests.	K1, K2
CO 2	Differentiate and classify the various groups of insects and estimate the biodiversity.	K3
CO 3	Explain the pest status in agriculture and control measures.	K4
CO 4	To compare the methods and outcomes of integrated pest management.	K5
CO 5	List the economic importance of agricultural insect species.	K6

Course Code	UAZ 3402
Course Title	Agricultural Entomology Lab course
Credits	01
Hours/Week	02
Category	Allied Optional (AO) – Lab
Semester	III
Regulation	2019

Course Overview

1. To understand the basic aspects of structural and functional details of insect pests
2. The aim of the course is to give basic knowledge about the insect collection and preservation methods.
3. To study parasitic and predatory insects.
4. Discuss important aspects of agricultural entomology lab course and to study the various types of economically important insect rearing methods for sustainable environment.

Course Objectives

1. To identify and describe the insect pest of paddy, sugarcane, cotton, groundnut and coconut.
2. To demonstrate Insecticide formulation and IPM approaches.
3. To survey and identify of economically important pests of paddy, sugarcane, cotton, groundnut and coconut and analyse the collected data.
4. To evaluate and distinguish the specific characteristics of parasitic and predatory insects in relation to biological control.
5. To gain knowledge in insect rearing methods.

Prerequisites	Basic knowledge on Agriculture and Insects

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Level
I	Methods of collection, mounting and preservation of insects. Study of insect segmentation, various tagmata and their appendages; preparation of permanent mounts of different body parts and their appendages of taxonomic importance including male and female genitalia. Sense organs.	5	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
II	Survey and identification of economically important pests of paddy, sugarcane, cotton, groundnut and coconut.	10	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
III	Study of life cycle of Hemimetabolous and Holometabolous insects (at least one example each). Study of parasitic and predatory insects (at least one example each) in relation to biological control.	12	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6

IV	Insecticide formulation and IPM approaches. Population estimation methods; crop loss assessment direct losses, indirect losses, potential losses, avoidable losses, unavoidable losses. Computation of EIL and ETL. Sampling, extraction and estimation of insecticide residues by various methods; calculations and interpretation of data.	6	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
V	Study of silkworm rearing and bee keeping-Lac culture. Field trip to institutions of Agriculture and Field visits to central warehouse and FCI warehouses and institutions.	6	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6

Text Books

1. David, B and 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. Text book 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, India.
5. Dhaliwal GS and Koul O. 2007. Biopesticides and Pest Management. Kalyani Publ., New Delhi.

Suggested Readings

1. Abishek Shukla, D. 2009. A Hand Book of Economic Entomology, Ved ams eBooks, New Delhi.
2. Ministry of Agriculture, Government of India, 1995. Manual on Integrated Pest Management in Rice and Cotton.

Web Resources

1. http://www.ipm.ucdavis.edu
2. http://www.ent.iastate.edu/list/
3. http://naasindia.org/journals.htm
4. https://www.iari.res.in/

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	Identify and describe the insect pest of paddy, sugarcane, cotton, groundnut and coconut.	K1, K2
CO 2	Illustrate and demonstrate the Insecticide formulation and IPM approaches.	K3
CO 3	Survey and identification of economically important pests of paddy, sugarcane, cotton, groundnut and coconut and analyse the collected data.	K4
CO 4	To evaluate and distinguish the specific characteristics of parasitic and predatory insects in relation to biological control.	K5
CO 5	Construct and design new insect rearing methods of economically important insects.	K6

Course Code	UAZ 3801
Course Title	Conservation Biology
Credits	02
Hours/Week	03
Category	Non Major Elective (NME) - Theory
Semester	III
Regulation	2019

Course Overview

1. The aim of the course is to develop passion towards nature and its conservation. imparts knowledge on detailed description of the Scopes, economical and ethical values of conservation biology
2. The course will highlight both Government and Non-Government organizations in conservation of biodiversity.
3. Discuss the functions of (MoEF) , (ZSI), (BSI) and (WWF),etc.,
4. This course will include presentations and discussions on Landscape approach and people participation.
5. Explain modern tools in conservation biology, and role of field biologists.

Course Objectives

1. Define the basic principles of conservation and classify the natural resources and assess the inevitable role of environment in human welfare.
2. Observe the interaction of abiotic and biotic factors and design conservation models that would meet the local and global needs and standards.
3. Record and distinguish the individual and societal commitment towards the appropriate sustainable methods of conservation.
4. Record and relate the priorities of various conservation agencies and connect one's individual understanding with that of the national and global priorities.
5. Name the major conservation programmes of our country and legal measures and treaties of international and national agencies.

Prerequisites	Basic knowledge on Botany and Zoology

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Level
I	Introduction to Conservation Biology: The origin of conservation biology, ethical and economical values of conservation biology, definition of biodiversity, types of biodiversity, threats to biodiversity.	10	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
II	Scopes and importance of conservation methods: In-situ and Ex-situ conservation approaches of Indian animals. Captive breeding (Lion tailed macaque, white tiger and vultures) and reintroduction (Tiger, rhinoceros, gaur).	12	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6

III	Biodiversity: Definition and importance –Biodiversity hotspots in India: Western Ghats, Eastern Himalayas. Mega diversity nations– an introduction. Landscape approach and people participation in biodiversity conservation.	10	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
IV	Role of Government and Non-Government organizations in conservation : Government-Wildlife Institute of India, Ministry of Environment and Forests (MoEF),National Biodiversity Authority (NBA), Zoological Survey of India (ZSI), Botanical Survey of India (BSI), Salim Ali Centre for Ornithology and Natural History (SACON), Centre for Ecological Sciences (CES). NGOs. –Bombay Natural History Society (BNHS), World Wide Fund for Nature (WWF), Wildlife Trust of India (WTI), Nilgiri Wildlife and Environment Association (NWEA), Wildlife Conservation Society (WCS).	10	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
V	Conservation Biology Tools : Biological Parks, Zoological Parks, Forest Research Institute, Agricultural Research Institutions, Gene Pools, Cryopreservation Centres, Interpretation Centres and role of Field Biologists.	10	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6

Text Books

1. Groom, M. J., Meffe, G. R. and C. R. Carroll. 2006. Principles of Conservation Biology. Sinauer Associates, Inc., USA.
2. Van Dyke, F.2008. Conservation Biology Foundations, Concepts, Applications 2nd Edition, Springer.
3. Krishnamurthy, K. V. 2003. Textbook of Biodiversity. Science Publication.
4. Dasmann, Rf. 1964, Wildlife Biology. John and Wiley and sons New York. PP231
5. Seshadri, B.1986 India's Wildlife reserves, Sterling Publishers Pvt. Ltd., New Delhi.
6. Hambler, C. 2004. Conservation. Cambridge University Press
7. Pullin, A. S. 2002. Conservation Biology. University Press, Cambridge, Cambridge, U.K.

Suggested Readings

1. Megadiversity Conservation: Flora, Fauna and Medicinal Plants of India's Hot Spots By AB Chaudhuri, D. D. Sarkar Published by Daya Books, 2004
2. Bailey, J.A. (1984) Principles of Wild Life Management. John Wiley & Sons, New York
3. Ramasamy, B. (2013) General Issues on Environmental Ecology, Bio diversity and Climate change. Pragun Publication.
4. Novacek, M.J. (2010) The Biodiversity Crisis: Losing What Counts. The New Press.
5. Mastrandrea, M.D. and Schneider, S.H. (2010) Preparing for Climate Change. MIT Press.
6. Ex Situ Plant Conservation: Supporting Species Survival in the Wild By Edward O. Guerrant, Kayri Havens, Mike Maunder, Peter H. Raven Published by Island Press, 2004

Web Resources

1. https://bit.ly/3EL0piD
2. https://go.nature.com/3kogYIF
3. https://wwf.to/3AurOCF
4. https://bit.ly/2XBoQ0s
5. https://bit.ly/3u90VC9

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	Understand and recall the important concepts of biodiversity, Scopes, methods, economical and ethical values of conservation biology.	K1, K2
CO 2	Classify and explain the Role of Government and Non-Government organizations in conservation. State the role of Forest Research Institutes, Agricultural Research Institutions in India and examine their relevance to conservation of nature.	K3
CO 3	Differentiate the In-situ and Ex-situ conservation approaches,., analyze and formulate the procedure for Captive breeding and reintroduction of wild animals.	K4
CO 4	Compare and validate the Biodiversity hotspots of India around the world. Identify and Assess the anthropogenic activities for conservation of environment.	K5
CO 5	Explain the Role of Government and Non-Government organizations in policy making, formulate and propose different modern tools for Conservation Biology.	K6

Course Code	UAZ 3802
Course Title	Public Health and Hygiene
Credits	02
Hours/Week	03
Category	Non Major Elective (NME) - Theory
Semester	III
Regulation	2019

Course overview

1. Public health and hygiene deals with various aspects in maintaining personal and public hygiene and to know the basic concepts which help to improve the health sector.
2. The aim of the course is health education among the public.
3. The course also focuses on policies and regulations pertaining to health care management.
4. We will also discuss about the cause of infections, evaluation and implementation of appropriate control measures.

Course Objectives

1. To understand the basic principles of public health care.
2. To gain knowledge about vector borne diseases and predict appropriate control measures.
3. To understand different types of natural defence mechanisms of human body and relate factors that could strengthen or weaken immune defence mechanism.
4. To bring awareness about spread of infection to mankind and the control measures.

Prerequisites	Basic knowledge in Environmental science

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Level
I	Public Health and Nutrition: Introduction-Definition, Significance, Evolution of Public & Community Health Genesis and Development of the concept, Healthcare versus Medical Care, Approaches to Public Health Determinants of Health –Biological, Behavioral, Socio-economic, Cultural, Environmental, Geographical etc. Health Education-definition, components, principles of health- education, methodology- individual, group and mass methods use of audio visual aids.	12	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
II	Medical Entomology : Control of household pest with special reference to mosquito, housefly etc.; Environmental, chemical, biological and generic control. Concept of Primary Health Care. Community Diagnosis & Needs Assessment. Community perception and priorities on health and disease. Disease profiles & Epidemiological transition. Public Health delivery system in India. Ecology	10	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6

	of health. Right to health.			
III	Immunity : Classification, specific and non-specific immunity, Immunoglobulins, Cellularand hormonal, immune response, Immunization active and passive immunization schedule, Immunizing agents, Hazards of immunization.	10	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
IV	Health care Management : Primary health care system with special reference to Maternal and Child Health care and maternal& infant mortality and morbidity. Primary health system functioning in rural areas and health indicators and various health organizations, Malaria and AIDs Control-NHP, WHO, UNICEF. Introduction to National HealthPolicy –1983 & 2002, National PopulationPolicy –2005, National Rural Health Mission (NRHM) and National Urban Health Mission (NUHM), National Public Health Programs.	10	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
V	Food Sanitation & Hygiene : Hygiene, Social and preventive medicine, basic aspects of personal hygiene. Diseases transmission. Food Borne Disorders: Food borne infections- Typhoid, Para typhoid, cholera, infective hepatitis, amoebiasis Food borne intoxications- Disorders caused by; Natural toxins, chemicaltoxins and Microbiological toxins in food- Lathyrism, staphylococcal intoxication, Botulism, clostridium perfrignens, Mycotoxins.	10	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6

Text Books

1. Epidemiology and Management for Health Care: Sathe,P.V. Sathe, A.P., PopularPrakashan, Mumbai, 1991.
2. International Public Health: Diseases, Programs, Systems, and Policies by MichaelMerson, Robert E Black, Anne J Mills -Jones and Bartlett Publishers.
3. Preventive and Social Medicine, K Park, Bansaridas Bhanot Publishing House. Epidemiology by P.V.Sathe, Popular Prakashan. Gordis Leon Epidemiology (3rd edition) ,W B Saunders and Co.
4. Beaglehole. R. Bonita, et. al Basic Epidemiology :., WHO Publication, Geneva, 1993.
5. David E., et. al.Foundations of Epidemiology : Oxford University Press, New York, 1984.
6. Barkar, D.J.P., Practical Epidemiology:Churchill pub, Livingstone, 1982.
7. Epidemiology in health care planning:E.A. Knox (ed), Oxford University Press, New York,1979.
8. Katz Mitchell: Study Design and Statistical Analysis: A Practical Guide for Clinicians.
9. Last, J.M., Spasoff, R.A. Harris, S. S. and Thuriaux, M.C. (Eds): A Dictionary of
10. Epidemiology, Oxford University Press, New York, 4th Ed., 2001.
11. Mayer Dan Essential Evidence-Based Medicine Series: Essential Medical Texts for Students and Trainees.
12. Silman and McFarland: Epidemiological Studies A Practical Guide 2nd Edition.
13. Aschengrau and Seage: Essentials of Epidemiology in Public Health.
14. Friis Robert: Epidemiology for Public Health Practice, Third Edition.

15. Timmreck Thomas C: An Introduction to Epidemiology, Third Edition 2002.
16. Szklo Moyses: Epidemiology: Beyond the Basics –2003.
17. Berkman, L.F. and Kawachi, I, Eds. 2000. Social Epidemiology. New York, Oxford University Press16.Krieger, N. 2000. Epidemiology and Social Sciences: Towards a Critical Reengagement in the 21st Century. Epidemiologic Review, vol. 22-1: 155-63.

Suggested Readings

1. Oxford textbook of Public Health Ed. Roger Detels, James Mcewen, Robert Beaglehole, and Heizo Tanaka Oxford University Press (OUP) 4th Edition: 2002.282.
2. Public Health at the Crossroads –Achievements and Prospects. Robert Beaglehole and Ruth Bonita 2nd Edition Cambridge University Press
3. Maxcy-Rosenau-Last Public Health & Preventive Medicine, Fourteenth Edition Ed RobertWallace, MD, et al.

Web Resources

1. https://bit.ly/3zumVIk
2. https://www.icmr.nic.in/
3. https://www.mohfw.gov.in/
4. https://www.who.int/

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	To understand the fundamentals of personal hygiene and recall the cause of diseases.	K1, K2
CO 2	To assess the importance of nutrition and hygiene in personal and public health sector.	K3
CO 3	To analyze the factors that cause infection and management strategies to compact spread of disease.	K4
CO 4	To evaluate the role of health education, control measures and health organizations in public health management.	K5
CO 5	To design plans to scientifically solve public health problems using biological tools, technologies and government policies.	K6

Course Code	UAZ 4401
Course Title	Animal Biotechnology and Bioinformatics
Credits	02
Hours/Week	03
Category	Allied Option (AO) - Theory
Semester	IV
Regulation	2019

Course Overview

1. The students will learn about the definitions of biotechnology, animal biotechnology and various branches of animal biotechnology.
2. This course also deals with the details on tools of molecular biology and biotechnology for the improved production and protection of animals, animal products.
3. The class lectures on the basis of principles and applications of different DNA technology, Gene cloning, PCR, construction of genomic library and DNA sequencing.
4. This course also attempts to build computational models of the biological systems, more specifically creating databases, systems, and web applications to solve problems in molecular biology.

Course Objectives

1. To understand the definitions and scope of Animal biotechnology.
2. To understand the procedures and applications of cell culture, genetic manipulation of animals and molecular diagnosis.
3. To apply the bioinformatics tools for accessing, analyzing and interpreting biological data.
4. To study animal genomics and its varied applications - gene transfer technology, cloning and transgenic animals.
5. To identify and characterize animal breeds and developing DNA - based diagnostic tools.

Prerequisites	Basic knowledge on Physiology, Cell Biology, Biochemistry and Zoology

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Level
I	Types of animal cell culture, Culture media, Initiation of primary cultures and maintenance of cell lines, Concept and application of Tissue engineering, Cryopreservation, Applications of animal cell culture, Production and applications of monoclonal antibodies.	13	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
II	Methods of gene transfer into animal cells, Transgenic animals and their applications, Cloning of Dolly the sheep, Stem cells and their applications, assisted reproduction in farm animals.	14	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
III	Molecular detection of diseases by Southern blotting and polymerase chain reaction, Gene therapy for genetic disorders, DNA barcoding of animals, Human genome	12	CO 1 CO 2 CO 3	K1, K2, K3, K4, K5, K6

	project. Structures and functions of DNA, RNA & Protein, Prokaryotic and Eukaryotic gene structure, Central dogma, definition of bioinformatics, goals of bioinformatics analysis.		CO 4 CO 5	
IV	Definition and applications of biological databases, Types of biological databases – nucleic acid and protein databases, structural databases and specialized databases. Sequence formats, accession number, gene annotation, Sequence analysis – global and local alignments, pairwise and multiple sequence alignments, BLAST tool and its applications, Clustal Omega tool and its applications.	14	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
V	Protein structure visualization tools, Pharmacogenomics and its applications, Steps in drug discovery, Drug compound databases, Computer-aided drug discovery and design, Microarray technology and its applications.	12	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6

Text Books

1. Birbal Singh, Gorakh Mal, Sanjeev K. Gautam, Manishi Mukesh, 2019. Advances in Animal Biotechnology, Springer International Publishing, Switzerland.
2. Prakash S. Lohar, 2019. Bioinformatics, MJP Publishers, Chennai, India.
3. Yashpal Singh Malik, Debmalya Barh, Vasco Azevedo, S.M. Paul Khurana, 2019. Genomics and Biotechnological Advances in Veterinary, Poultry, and Fisheries, Academic Press, New York, USA.
4. Ashish S. Verma, Anchal Singh, 2014. Animal Biotechnology: Models in Discovery and Translation, Academic Press, New York, USA.
5. Supratim Choudhuri, 2014. Bioinformatics for Beginners, Elsevier Inc., Academic Press, New York, USA.
6. Harisha S., 2010. Fundamentals of Bioinformatics, I.K. International Publishing House Pvt. Limited, India.

Suggested Readings

1. Low Lloyd, Tammi Martti, 2017. Bioinformatics: A Practical Handbook of Next Generation Sequencing and Its Applications, World Scientific Publishing Co. Pvt. Ltd., Singapore.
2. Vince Buffalo, 2015. Bioinformatics Data Skills, O'Reilly Media Inc., USA.
3. Alan J. Holland, Andrew Johnson, 2012. Animal Biotechnology and Ethics, Springer International Publishing, Switzerland.
4. Michael Agostino, 2012. Practical Bioinformatics, 1st Ed., Garland Science, New York, USA.
5. Ian Freshney R., 2010. Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications, John Wiley & Sons, USA.
6. Richard Twine, 2010. Animals as Biotechnology: Ethics, Sustainability and Critical Animal Studies, Earthscan Ltd., UK.

Web Resources

1. https://www.nature.com/subjects/animal-biotechnology
2. https://jasbsci.biomedcentral.com/articles
3. https://www.sciencedaily.com/news/plants_animals/biotechnology/
4. http://www.expasy.org/
5. http://www.ebi.ac.uk/
6. http://www.ncbi.nlm.nih.gov/

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	Narrate the procedures for animal cell culture and explain the principles of cloning and molecular diagnosis.	K1, K2
CO 2	Illustrate the structure of genetic molecules and develop novel genetic procedures for animal welfare	K3
CO 3	Explore the biological databases and retrieve biological data	K4
CO 4	Analyze the properties of gene and protein sequences and deduce their functions, structure and evolutionary relationships	K5
CO 5	Analyze and interpret biological and drug-related data to discover new drugs and therapeutic protocols	K6

Course Code	UAZ 4402
Course Title	Animal Biotechnology and Bioinformatics lab course
Credits	01
Hours/Week	02
Category	Allied Optional (AO) – Lab
Semester	IV
Regulation	2019

Course Overview

1. Animal Biotechnology is an interdisciplinary subject integrating the fields of animals, biochemistry, cell biology, genetics and Bioinformatics.
2. The aim of the course is to give basic knowledge about animal cell culture, cell counting, and estimation of protein and DNA.
3. The different modules of the course will examine different areas of animal biotechnology and bioinformatics.
4. In this course, we will also examine the methods of biotechnology like gene cloning, blotting techniques, PCR, sequencing etc.,
5. The important aspects of molecular biology that will be discussed in the course includes: cell culture, isolation of DNA, prediction of protein, structure, drug discovery and similarity search using bioinformatics tools.

Course Objectives

1. To examine the tools to study the properties of biological molecules and interpret the results.
2. To articulate the importance of DNA as genetic material and proteins from animal samples and examine with suitable techniques.
3. To organize and classify biological data with bioinformatics tools.
4. To analyze the properties of gene and protein sequences and distinguish their functions, structure and evolutionary relationships.
5. To construct and simulate the biological molecules and compounds as 3D structures and validate their active sites, ligand bonding and chemical interactions.

Prerequisites	Basic knowledge on Biotechnology and computer

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Level
I	Trypsinization of liver cells. Counting of trypsinized cellsusing haemocytometer. Determination of cell viability by Trypan Blue method.	6	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
II	Isolation of DNA from spleen. Agarose gel electrophoresis of DNA. Isolation and estimation of protein (casein) from milk sample.	6	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6

III	Exploration of the NCBI and PDB databases. Retrieval of gene and protein sequences in FASTA format. Sequence similarity search using BLASTn and BLASTp.	6	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
IV	Multiple sequence alignment using Clustal Omega. Exploration of the PubChem and ChEMBL databases. Use of Discovery Studio Visualizer.	2	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
V	Compute pI, MW tool for proteins. Downloading protein structures from PDB. Visualizing protein structures at PDB using their NGL Viewer.	6	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6

Text Books

1. Prakash S. Lohar, 2019. Bioinformatics, MJP Publishers, Chennai, India.
2. Surya Nandan Meena, Milind Naik, 2019. Advances in Biological Science Research: A Practical Approach, Academic Press, New York, USA.
3. Gautam B. Singh, 2014. Fundamentals of Bioinformatics and Computational Biology, Springer International Publishing, Switzerland.
4. Supratim Choudhuri, 2014. Bioinformatics for Beginners, Elsevier Inc., Academic Press, New York, USA.
5. Sunita Dutta, 2011. Experimental Biotechnology: Practical Manual, New India Publishers, India.

Suggested Readings

1. Hansjörg Hauser, Roland Wagner, 2017. Animal Cell Biotechnology: In Biologics Production, De Gruyter, Germany.
2. Tsai Jeffrey J. P., Ng Ka-lok, 2017. Computational Methods With Applications In Bioinformatics Analysis, World Scientific Publishing Co. Pvt. Ltd., Singapore.
3. Michael Agostino, 2012. Practical Bioinformatics, 1st Ed., Garland Science, New York, USA.
4. John M. Davis, 2011. Animal Cell Culture: Essential Methods, John Wiley & Sons, USA.
5. Bernd Mayer, 2011. Bioinformatics for Omics Data: Methods and Protocols, Humana Press, USA.
6. Ian Freshney R., 2010. Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications, John Wiley & Sons, USA.

Web Resources

1. http://www.expasy.org/
2. http://www.ebi.ac.uk/
3. http://www.ncbi.nlm.nih.gov/
4. https://learn.genetics.utah.edu/
5. https://www.genome.gov/about-genomics
6. https://www.dnatube.com/

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	To examine the tools to study the properties of biological molecules and interpret the results.	K1, K2
CO 2	To articulate the importance of DNA as genetic material and proteins from animal samples and examine with suitable biotechniques.	K3
CO 3	To organize and classify biological data with bioinformatics tools.	K4
CO 4	To analyze the properties of gene and protein sequences and distinguish their functions, structure and evolutionary relationships.	K5
CO 5	To construct and simulate the biological molecules and compounds as 3D structures and validate their active sites, ligand bonding and chemical interactions.	K6

Course Code	UAZ 4801
Course Title	Green Technologies
Credits	02
Hours/Week	03
Category	Non Major Elective (NME) - Theory
Semester	IV
Regulation	2019

Course Overview

1. This course introduces the study of human-environment interactions with a special emphasis on agriculture and the environmental problems in different locations.
2. It also provides basic principles of ecosystem function; biodiversity and its conservation; water resources and management; water, air and soil pollution; climate change; energy resources, and sustainability.
3. The primary focus of the course will be on understanding the scientific basis of alternative and renewable energy sources like production of biofuels, wind and solar power.
4. This course is designed to analyze data which include dynamics of bio - waste management and water contamination, pollution and global climate change.

Course Objectives

1. To introduces the basic concept of green technology, its goals and advantages. It also highlights potential role of green technologies in realizing the goal of sustainable development and focuses on community participation to tap the economic benefits associated with switching to green technologies.

2. To gain the knowledge about global warming, water resources, toxic wastes, ozone depletion, and renewable and non-renewable resources.

3. To understand the production of biodegradable polymers, microbial fuel cell technology and Biodiesel from biological waste materials.

Prerequisites	Basic knowledge on Science and Environmental Biology

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Level
I	Biomass Energy Technology : Biomass classification, Biomass characteristics, Biomass production techniques, Harvesting of biomass, Biomass processing for rural use, Energy efficiency biomass burner, Gasifier and its process, Producer gas, Bio-ethanol production, bio-diesel production, Electricity generation from biomass.	13	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
II	Biogas technology: Importance of biogas production, Biological process involved in Anaerobic digestion, Suitable raw materials, factors affecting for biogas production, Uses of biogas, uses of digested material, Designing of small biogas digesters, Construction of a	14	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6

	digester, Industrial level biogas plants for electricity generation.			
III	Sustainable Solid Waste and Wastewater Management: Properties of wastes, Basic requirements of waste management, Waste management techniques, Waste collection, Sorting, Concepts of sustainable waste management, Development of Integrated Sustainable Waste Management System. Integrated Water Resource Management, Properties of wastewater (physical, chemical, biological, etc), different treatment technologies (Physical, Chemical, Biological including Phytoremediation), Wastewater sampling and analysis.	12	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
IV	Precision Agricultural Technology: Basic, strategies and tools, Potential application of remote sensing, Collection of crop, field data and mapping, Procedure for accurate yield mapping, Yield map interpretation, Data layer smoothing and interpolation in yield mapping and interpretation, Mapping of land and crop information using GIS techniques, Variable Rate Technology (VRT) in precision Agriculture, Site specific management strategies, Site specific management of crop and land parameters , Techniques for conducting field scale research with precision agriculture tools.	14	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
V	Green Buildings and Ecological Sanitation: Land degradation causes, Impacts, Need of land improvement, Land improving technologies. What is green building?, architecture of green building, planning and management of green building, What is ecological sanitation?, Sanitizing human excreta, Design and management features, recycling the nutrients, Grey water and management; Planning, promotion and support; Future development.	12	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6

Text Books

1. Anastas, P.T. & Warner, J.C. 1998. Green Chemistry: Theory & Practice. Oxford University Press.
2. Arceivala, S.L. 2014. Green Technologies: For a Better Future. Mc-Graw Hill Publications.
3. Baker, S. 2006.Sustainable Development. Routledge Press.

Suggested Readings

1. Donald L. Klass, 1998. Biomass for Renewable Energy, Fuels, and Chemicals, Academic Press.
2. Hrubovcak, J., Vasavada, U. & Aldy, J. E. 1999.Green technologies for a more sustainable agriculture(No. 33721). United States Department of Agriculture, Economic Research Service.
3. Nijaguna B T, 2002. Biogas Technology, New Age International Publisher. Vertès, A.A., N Qureshi, H Yukawa, 2009. Biomass to biofuels: strategies for global industries", John Wiley and Sons.

4. Woolley, T. & Kimmins, S. 2002. Green Building Handbook (Volume 1 and 2). Spon Press.
5. Rai G D, 2011. Non-Conventional Energy Sources, Khanna Publishers,
6. David M. Mousdale, 2010. Introduction to Biofuels, CRC Press.
7. Samir S Sofer and Oskar R Zaborsky, 2012. Biomass conversion process for energy and fuels, Springer Science & Business Media.
8. Thangavel, P. & Sridevi, G. 2015. Environmental Sustainability: Role of Green Technologies. Springer Publications.

Web Resources

1. https://mnre.gov.in
2. https://www.neeri.res.in
3. https://www.ge.com

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	Describe the principles of sustainable management of energy resources.	K1, K2
CO 2	Identify and analyze green technologies relevant to environmental sustainability.	K3
CO 3	Manipulate and evaluate green technologies involved in the management of solid and liquid wastes.	K4
CO 4	Categories and reproduce precision agriculture practices to enhance food production and environmental safety.	K5
CO 5	Discuss and formulate the concept of green infrastructure and eco-friendly sanitation.	K6

Course Code	UAZ 4802
Course Title	Natural Hazards and Disaster Management
Credits	02
Hours/Week	03
Category	Non Major Elective (NME) - Theory
Semester	IV
Regulation	2019

Course Overview

1. Natural hazards and disaster management is the integrated scientific study that emphasizes the causes and effects of various hazards and management.
2. This course explains the importance of the ecosystem and also classifies the hazards into natural and anthropogenic.
3. This course highlights the causes, effects and management of cyclones, Tsunami, earthquakes and floods.
4. This course also focuses the risk assessment based on likelihood and consequences.
5. It also focuses on the management strategies and governmental action plan to mitigate and prepare for hazards

Course Objectives

1. To understand the natural environment and its interaction with human activities.
2. To understand the human impacts on the environment.
3. To Understand the causes, effects and management of natural hazards.
4. To acquire knowledge on mitigation and preparedness.

Prerequisites	Basic knowledge in Environmental Science

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Level
I	Introduction: Definition of hazard; natural, technological, and context hazards; concept of risk and vulnerability; reasons of vulnerability -rapid population growth, urban expansion, environmental pollution, epidemics, industrial accidents, inadequate government policies.	12	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
II	Natural hazards : hydrological, atmospheric & geological hazards; earthquake: seismic waves, epicenter; volcanoes: causes of volcanism, geographic distribution; floods: types and nature, frequency of flooding; landslides: causes and types of landslides, landslide analysis; drought: types of drought -meteorological, agricultural, hydrological, and famine; Glacial Lake Outburst Floods (GLOF); tornadoes, cyclone & hurricanes; tsunamis: causes and location of tsunamis; coastal erosion, sea level changes and its impact on	12	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6

	coastal areas and coastal zone management.			
III	Anthropogenic hazards: Impacts of anthropogenic activities such as rapid urbanization, injudicious ground water extraction, sand mining from river bank, deforestation, mangroves destruction; role of construction along river banks in elevating flood hazard; disturbing flood plains. deforestation and landslide hazards associated with it; large scale developmental projects, like dams and nuclear reactors in hazard prone zones; nature and impact of accidents, wildfires and biophysical hazards. Case studies of Bhopal, Minamata and Chernobyl disaster	12	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
IV	Risk and vulnerability assessment : Two components of risk: likelihood and consequences, qualitative likelihood measurement index; categories of consequences (direct losses, indirect losses, tangible losses, and intangible losses); application of geoinformatics in hazard, risk & vulnerability assessment.	12	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6
V	Mitigation and preparedness: Concept of mitigation; types of mitigation: structural and non-structural mitigation, use of technologies in mitigations such as barrier, deflection and retention systems; concept of preparedness; importance of planning, exercise, and training in preparedness; role of public, education and media in hazard preparedness. Disaster management in India Lessons from the past : Bhuj earthquake, tsunami disaster, and Bhopal tragedy; National Disaster Management Framework, national response mechanism, role of government bodies such as NDMC and IMD; role of armed forces and media in disaster management; role of space technology in disaster management; case study of efficient disaster management during cyclone 'Phailin' in 2013.	12	CO 1 CO 2 CO 3 CO 4 CO 5	K1, K2, K3, K4, K5, K6

Text Books

1. Keller, E. A. 1996. Introduction to Environmental Geology. Prentice Hall, Upper Saddle River, New Jersey. 624pp.
2. Coppola D. P. 2007. Introduction to International Disaster Management. Butterworth Heinemann.684pp.
3. Shrivastava, A.K. 2021. Text Book of Disaster Management, Scientific Publishers, 250pp.

Subramanian, R. 2005, Disaster Management, Vikas Publishing House, 323pp.

Suggested Readings

1. Schneid, T.D. & Collins, L. 2001. Disaster Management and Preparedness. Lewis Publishers, New York, NY.
2. Smith, K. 2001. Environmental Hazards: Assessing Risk and Reducing Disaster. Routledge Press.
3. Wallace, J.M. & Hobbs, P.V. 1977. Atmospheric Science: An Introductory Survey.

Academic Press, New York.
4. Pine, J.C. 2009. Natural Hazards Analysis: Reducing the Impact of Disasters. CRC Press, Taylor and Francis Group.
5. Wasson, R.J., Sundriyal, Y.P., Chaudhary, S., Jaiswal, M.K., Morthekai, P., Sati, S.P.& Juyal, N. 2013. A 1000-year history of large floods in the upper Ganga catchment, central Himalaya, India. Quaternary Science Reviews 77: 156–166.

Web Resources

1. https://www.ndma.gov.in/en/
2. http://www.ndrf.gov.in/
3. https://bit.ly/3ko5Iw1
4. https://mha.gov.in/
5. https://www.fema.gov/

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	Understand and recall the basic information about disasters of all kinds.	K1, K2
CO 2	Apply risk management principles to identify and reduce the causative agents which cause environmental hazards.	K3
CO 3	Identify and analyse the human impact on the environment.	K4
CO 4	Explain the causes and integrate the concepts to apply environmental problems.	K5
CO 5	Summarise and organise the major disasters and Create appropriate planning, preparation and mitigation	K6

CL AND CO BASED CIA QUESTION PAPER FORMAT FOR UG THEORY COURSES MC, AR, AO, MS, ME, GL and NME*
(Excluding other languages)

SECTION	MARKS	Q. NO	K1	K2	K3	K4	K5	K6
A	Answer ALL (6 x 1 = 6)	1	+					
		2	+					
		3	+					
		4		+				
		5		+				
		6		+				
B	Answer 1 out of 2 (1 x 6 = 6)	7			+			
		8			+			
C	Answer 1 out of 2 (1 x 6 = 6)	9				+		
		10				+		
D*	Answer 1 out of 2 (1 x 12 = 12)	11					+	
		12						+
No. of CL based Questions with Max. marks			3 (3)	3 (3)	1 (6)	1 (6)	1 (12)	1 (12)
No. of CO based Questions with Max.marks			CO 1		CO 2	CO 3	CO 4	CO 5
			6 (6)		1 (6)	1 (6)	1 (12)	1 (12)

- **MC**-Major Core, **AR**–Allied Required, **AO**–Allied Optional, **MS**-Major Skill, **ME**-Major Elective, **GL**-General Languages, **NME**-Non Major Elective.
- **Section A** could have one or more of the following: Fill in the blanks, True or False, Match the following, Definition, Comment on, Reason out etc.,But, K1 and K2 should carry equal weightage.
- In **Section D** students have choice between K5 and K6. III Component Assessment carries 40% of CIA and the assessment(s) should be for cognitive levels **K1 to K4** and all should carry equal weightage.

LOYOLA COLLEGE (AUTONOMOUS), CHENNAI 60034

Department of Advanced Zoology and Biotechnology

FIRST CONTINUOUS ASSESSMENT TEST, JULY, 2021

UAZ 2503 Cell Biology (MC)

II BSc Advanced Zoology and Biotechnology 15.07.2021

Time : 10.00am to 11.30 am Max. Marks : 30

SECTION A			
Answer ALL the Questions in one or two sentences		**(6 x 1 = 6 Marks)**	
1.	Define 'Apoptosis'.	K1	CO1
2.	Recall the central dogma of protein synthesis.	K1	CO1
3.	State the importance of 'Ribosomes'.	K1	CO1
4.	Describe 'Isoelectric point'.	K2	CO1
5.	Differentiate 'Biopsy from Autopsy'.	K2	CO1
6.	Write down the importance of primordial germ cells.	K2	CO1
SECTION B			
Answer any ONE of the following in 100 words		**(1 x 6 = 6 Marks)**	
7.	Classify 'Endoplasmic reticulum' giving reasons	K3	CO2
8.	Illustrate the animal cell and enumerate points on cell organelles	K3	CO2
SECTION C			
Answer any ONE of the following in 100 words		**(1 x 6 = 6 Marks)**	
9.	Analyse the role of ribosomal subunits in protein synthesis	K4	CO3
10.	Distinguish the roles of Euchromatin and Heterochromatin.	K4	CO3
SECTION D			
Answer any ONE of the following in 200 words		**(1 x 12 = 12 Marks)**	
11.	Evaluate the types, causes, prognosis and diagnosis of cancer.	K5	CO4
12.	Double helical structure gives stability to DNA molecule – Defend.	K6	CO5

CL AND CO BASED END SEMESTER EXAMINATION QUESTION PAPER FORMAT FOR UG THEORY COURSES (MC, AR, AO, MS, ME and GL)

SECTION		Q. NO	K1	K2	K3	K4	K5	K6
A	(4 x 5 = 20) Answer ALL	1	+					
		2	+					
		3		+				
		4		+				
B	(2 x 10 = 20) Answer 2 out of 4	5			+			
		6			+			
		7			+			
		8			+			
C	(2 x 10 = 20) Answer 2 out of 4	9				+		
		10				+		
		11				+		
		12				+		
D	(2 x 20 = 40) Answer 2 out of 4	13					+	
		14					+	
		15						+
		16						+
No. of CL based Questions with Max. marks			2 (10)	2 (10)	2 (20)	2 (20)	2 (40)	2 (40)
No. of CO based Questions with Max. marks			CO 1		CO 2	CO 3	CO 4	CO 5
			4 (20)		2 (20)	2 (20)	2 (40)	2 (40)

- **MC**-Major Core, **AR**–Allied Required, **AO**–Allied Optional, **MS**-Major skill, **ME**-Major Elective, **GL**-General Languages.
- **Section A** could have one or more of the following: Fill in the blanks, True or False, Match the following, Definition, Comment on, Reason out, but K1 andK2 should carry equal weightage.
- In **Section D** students have choice between K5 and K6.

LOYOLA COLLEGE (AUTONOMOUS), CHENNAI 60034

Department of Advanced Zoology and Biotechnology

END SEMESTER EXAMINATION, OCTOBER, 2021

UAZ 2503 Cell Biology (MC)

III BSc 15.11.2021

Duration : 3 hrs Max. Marks : 100

	SECTION A			
Answer ALL the Questions				
1.	**Define the following**		**(5 x 1 = 5 Marks)**	
a)	PPLO.		K1	CO1
b)	Resolving power of a microscope.		K1	CO1
c)	Suicide bags.		K1	CO1
d)	Transcription.		K1	CO1
e)	Genetic code.		K1	CO1
2.	**Fill in the blanks**		**(5 x 1 = 5 Marks)**	
a)	Uncontrolled proliferation of cells is known as _____.		K1	CO1
b)	_____ is a vital stain.		K1	CO1
c)	Proliferative cell division is known as _____.		K1	CO1
d)	_____ is an example for a fixative.		K1	CO1
e)	_____ is an example for an oncogene.		K1	CO1
3.	**Match the following**		**(5 x 1 = 5 Marks)**	
a)	BRCA1	Chromosome	K2	CO1
b)	G1 Phase	Cancer marker	K2	CO1
c)	Centriole	DNA	K2	CO1
d)	Replication	Codon	K2	CO1
e)	UGA	mRNA	K2	CO1
4.	**TRUE or FALSE**		**(5 x 1 = 5 Marks)**	
a)	All cells have a cell wall.		K2	CO1
b)	Chromosomes are found in the cytoplasm.		K2	CO1
c)	There is a cell membrane around all cells.		K2	CO1

d)	All cells have a central cell vacuole filled with fluid.	K2	CO1
e)	A nucleus is smaller than a molecule.	K2	CO1
SECTION B			
Answer any TWO of the following in 150 words		**(2 x 10 = 20 Marks)**	
5.	Explain Signal peptide hypothesis.	K3	CO2
6.	Illustrate and explain the structure and principle behind SEM.	K3	CO2
7.	Prepare and present the protocol of tissue sectioning by microtome.	K3	CO2
8.	Interpret the role of lysosomes in cell digestion.	K3	CO2
SECTION C			
Answer any TWO of the following in 150 words		**(2 x 10 = 20 Marks)**	
9.	Analyse the role of macrophage in defense mechanism.	K4	CO3
10.	Classify cell organelles giving reasons.	K4	CO3
11.	Compare the structural properties of plant and animal cell.	K4	CO3
12.	Correlate the details on ribosomal subunits with protein synthesis.	K4	CO3
SECTION D			
Answer any TWO of the following in 250 words		**(2 x 20 = 40 Marks)**	
13.	Evaluate the types, causes, prognosis and diagnosis of cancer.	K5	CO4
14.	Summarize the process of mitosis and meiosis with illustrations.	K5	CO4
15.	Double helical structure gives stability to DNA molecule – Substantiate.	K6	CO5
16.	Construct the road map for cell cycle and gene manipulation.	K6	CO5

UNIT WISE DISTRIBUTION OF CL AND CO BASED QUESTIONS AND MARKS FOR END OF SEMESTER QUESTION PAPER SETTING FOR UG COURSES
(MC, AR, AO, MS, ME and GL)

	SECTION A (1 Mark/Question)		SECTION B (10 Marks/Question)	SECTION C (10 Marks/Question)	SECTION D (20 Marks/Question)	
	K1	**K2**	**K3**	**K4**	**K5**	**K6**
UNIT I	2 (1)	2 (1)	-	1 (10)	-	
UNIT II	2 (1)	2 (1)	1 (10)	1 (10)	1 (20)	-
UNIT III	2 (1)	2 (1)	1 (10)	1 (10)	1 (20)	-
UNIT IV	2 (1)	2 (1)	1 (10)	1 (10)	-	1 (20)
UNIT V	2 (1)	2 (1)	1 (10)	-	-	1 (20)
No. of CL based Questions with Max. Marks	**10 (10)**	**10 (10)**	**2 (20)**	**2 (20)**	**2 (40)**	**2 (40)**
No. of CO based Questions with Max. Marks	**CO1**		**CO2**	**CO3**	**CO4**	**CO5**
	20 (20)		**2 (20)**	**2 (20)**	**2 (40)**	**2 (40)**

MC-Major Core, **AR**–Allied Required, **AO**–Allied Optional, **MS**-Major Skill, **ME**-Major Elective, **GL**-General Languages.

In **Section D** students have choice between K5 and K6.

CL AND CO BASED MARKS DISTRIBUTION FOR DIRECT ASSESSMENTS OF UG COURSES
MC, AR, AO, MS, ME and GL

SECTION	CL	CO	CIA I	CIA II	III Component	Semester	Total (200)	CL and CO %
A	K1, K2	CO1	6	6	20	20	52	26%
B	K3	CO2	6	6	10	20	42	21%
C	K4	CO3	6	6	10	20	42	21%
D	K5, K6	CO4, CO5	12	12	-	40	64	32%

MC-Major Core, **AR**–Allied Required, **AO**–Allied Optional, **MS**-Major Skill, **ME**-Major Elective, **GL**-General Languages.

CL AND CO BASED CIA AND SEMESTER QUESTION PAPER FORMAT FOR UG LAB COURSES* (MC, AR, AO, ME)

SECTION	MARKS	Q. NO	K1	K2	K3	K4	K5	K6
A	20	1	+					
		2		+				
B	20	3			+			
C	20	4				+		
D	20	5					+	
E	20	6						+
No. of CL based Questions with Max. marks			1(10)	1(10)	1(20)	1(20)	1(20)	1(20)
No. of CO based Questions with Max. marks			CO 1		CO 2	CO 3	CO 4	CO 5
			2(20)		1(20)	1(20)	1(20)	1(20)

No Comp III for Lab Courses and total marks assigned to CIA is 50

LOYOLA COLLEGE (AUTONOMOUS), CHENNAI 60034

Department of Advanced Zoology and Biotechnology

FIRST CONTINUOUS ASSESSMENT TEST, JULY, 2021

UAZ 1502 Invertebrata Lab Course (MC)

II BSc Advanced Zoology and Biotechnology 16.07.2021

Time : 10.30am to 12.30 pm Max. Marks : 100

SECTION A			**(20 Marks)**
1.	Identify, classify and draw a labelled Diagram of the spotters A, B, C, D and E.	K1	CO1
2.	Record, Observation Note Book and Viva	K2	CO1
SECTION B			**(20 Marks)**
3.	Furnish details on Systematic position, morphology, sexual dimorphism and ecological Importance of the identified spotters.	K3	CO2
SECTION C			**(20 Marks)**
4.	Mount the parts of the following A, B, C and D	K4	CO3
SECTION D			**(20 Marks)**
5.	Dissect, display and evaluate the structural features of the given specimen.	K5	CO4
SECTION E			**(20 Marks)**
6.	Prepare a comparative account on the structural and functional properties of the specimen and summarize the details.	K6	CO5

COMPONENT III ASSESSMENTS AND RUBRICS

Mini Project

The project work is included as part of the curriculum to impart research skills. It is optional for UG and mandatory for PG students. Students can select any staff from the department as their research guide. They are encouraged to select research problems relevant to society and environment. The project report of UG and Dissertation of PG students will be evaluated by external examiners and the students will present their work in viva voce.

Rubrics for evaluation

S. No	Criteria	Max. Marks
1.	Review of Literature	10
2.	Hypothesis Design	10
3.	Materials and Methodology	5
4.	Experimental Design	10
5.	Validation of scientific Data	10
6.	Discussion and Recommendation	10
7.	Report/Dissertation	20
8.	Presentation	10
9.	Relevance of the study	15

Seminar/Assignment

Seminars are optional to UG and mandatory to PG. Topics for the seminar are suggested by the course teacher and the students are encouraged to collective exhaustive information on the chosen topic, arrange them in order and make a presentation. They are expected to use visual aids, models, tools for the presentation and circulate relevant literature to the students.

Rubrics for evaluation

S. No	Criteria	Max. Marks
1.	Topic introduction	10
2.	Collection of literature (primary, secondary and tertiary)	10
3.	Presentation methodology	20
4.	Articulation and Communication skills	10
5.	Time management	10
6.	Discussion and Interaction	20
7.	Summary and Conclusion	20

Internship/Field visit

Internship allows the students to gain hands on experience and industry exposure. The internship for UG is conducted during the Christmas Vacation for minimum of 15 days. The UG students will be sent to industries/organization the department signed MoU with. The PG students are free to select industry/organization of their choice and minimum period of internship is 15 days.

Rubrics for evaluation of Internship

S. No	Criteria	Max. Marks
1.	Industry/Organization profile	10
2.	Thrust areas and specialization	10
3.	Internship module and participation	20
4.	Expertise of the industry/organization	10
5.	Regularity and hands on training	10
6.	Presentation/Demonstration	20
7.	Report writing	20